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Heat insulating box body and refrigerator

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ABSTRACT

Provided is a refrigerator, including: a box body formed of an external box and an internal box, the box body including: a rear wall; and lateral walls; a storage compartment formed by partitioning an inside of the box body with a partition wall to have an opening portion formed on a front side of the box body; a pull-out case housed in the storage compartment and pulled out through intermediation of rail members arranged respectively on the lateral walls of the storage compartment; a vacuum heat insulating material formed of a fibrous core material made of an inorganic fiber or an organic fiber, and arranged between a part of the internal box and a part of the external box corresponding to each of the lateral walls on which the rail members are arranged; and a heat insulating material charged between the internal box and the vacuum heat insulating material at a position of facing each of the rail members. A thickness of the heat insulating material is set to less than 10 mm at the position of facing the each of the rail members, and a density of the heat insulating material charged between the internal box and the vacuum heat insulating material is set to more than 60 kg/m^3.

HEAT INSULATING BOX BODY AND REFRIGERATOR

Technical Field

[0001]

The present invention relates to a heat insulating box body including a vacuum heat insulating material, a refrigerator including the vacuum heat insulating material, a showcase, a hot water storage device, a device including the vacuum heat insulating material, and the like.

[0001A]

Incorporated herein by reference, in its entirety, is PCT/JP2014/065001 (published as WO 2014/196609), filed on 5 June 2014.

Background Art

[0001B]

Reference to any prior art in the specification is not, and should not be taken as, an acknowledgment or any form of suggestion that this prior art forms part of the common general knowledge in any jurisdiction or that this prior art could reasonably be expected to be understood, regarded as relevant and/or combined with other pieces of prior art by a person skilled in the art.

[0002]

In recent years, in view of protection of global environment and safety of nuclear power plants, various attempts have been made to achieve resource saving and increase energy efficiency, and more particularly, to achieve power saving.

[0003]

In view of the energy efficiency and the power saving, there has been proposed a technology of arranging not only rigid urethane foam but also a vacuum heat insulating material in a heat insulating box body having an outer shell including an external box and an internal box. Specifically, there has been proposed an invention of a heat insulating box body including the rigid urethane foam and the vacuum heat insulating material, in which a coverage of the vacuum heat insulating material relative to the surface area of the external box is specified (refer to Patent Literature 1).

[0004]

Further, in order to increase internal capacities of devices including the heat insulating box body, such as a refrigerator, a wall thickness of the box body needs to be reduced. Thus, there has been proposed a device in which a vacuum heat insulating material is arranged between the external box and the internal box, and is attached directly to the internal box and the external box without intermediation of the urethane heat insulating material in a part in which the vacuum heat insulating material is arranged (refer to Patent Literature 2).

[0005]

Further, in the refrigerator, rail members for supporting pull-out cases are fixed to the internal box with screws and the like (refer to Patent Literature 3).

Still further, in the refrigerator, the rail members are fixed to pull-out doors of pull-out type storage compartments with screws and the like (refer to Patent Literature 4).

Citation List

Patent Literature

[0006]

Patent Literature 1: Japanese Patent No. 3478810

Patent Literature 2: Japanese Unexamined Patent Application Publication No. Hei 07-120138

Patent Literature 3: Japanese Unexamined Patent Application Publication No. 2006-177654

Patent Literature 4: Japanese Unexamined Patent Application Publication No. 2009-228948

Summary

[0007]

The vacuum heat insulating material has heat insulating performance that is, for example, six times or more as high as heat insulating performance of the related-art rigid urethane foam. Thus, in view of the energy efficiency and the like, not only the rigid urethane foam but also the vacuum heat insulating material has been increasingly arranged in spaces formed between the external box and the internal box. Further, in recent years, along with the increasing demands for higher energy efficiency, the use amount of the vacuum heat insulating material to be arranged in the heat insulating box body has been increased as in the heat insulating box body disclosed, for example, in Patent Literature 1.

[0008]

Meanwhile, in recent years, in view of the space saving and the increase in capacity in the heat insulating box body, demands to reduce the spaces formed between the external box and the internal box, that is, the wall thickness of the heat insulating box body have also been imposed. However, the related-art heat insulating box bodies have been manufactured based on the technical idea that the rigid urethane foam mainly exerts a heat insulating function and the vacuum heat insulating material assists the heat insulating function of the rigid urethane foam. Specifically, the box body strength of the related-art heat insulating box body is secured by charging the rigid urethane foam at a predetermined density into the spaces between the internal box and the external box. However, when a thickness of urethane is reduced so as to reduce the wall surface thickness, a density of urethane is increased due to the reduction in thickness of urethane. As a result, the heat insulating performance is deteriorated. In this way, it has been difficult to satisfy the heat insulating performance while achieving the required box body strength.

[0009]

In other words, in the related-art devices including the vacuum heat insulating material, such as the heat insulating box body and the refrigerator, the heat insulating performance of the wall surface and the box body, and the strengths of the box body and the walls are secured with the rigid urethane foam. When the thickness of the rigid urethane foam is reduced so as to reduce the wall thickness of the heat insulating box body, there arise problems of deficiency in heat insulating performance or strength of the heat insulating box body, with the result that the wall thickness is difficult to reduce.

[0010]

As a countermeasure, in the heat insulating box body disclosed in Patent Literature 1, the use amount (coverage) of the vacuum heat insulating material is increased so as to increase a bending elastic modulus of the rigid urethane foam (rigidity of the rigid urethane foam). With this, the wall thickness may be reduced to some extent in view of the strength of the heat insulating box body. However, the heat insulating box body disclosed in Patent Literature 1 has been manufactured based on the technical idea that the rigid urethane foam mainly exerts the heat insulating function and the vacuum heat insulating material assists the heat insulating function of the rigid urethane foam, and that the rigid urethane foam mainly exerts the heat insulating function and the vacuum heat insulating material assists the heat insulating function of the rigid urethane foam. The heat insulating performance and the strength of the wall surface of the heat insulating box body are secured with the rigid urethane foam. However, when the thickness of the rigid urethane foam is reduced, the density and the bending elastic modulus thereof are increased, but the heat insulating properties are deteriorated. To suppress the deterioration in heat insulating performance of the rigid urethane foam, the bending elastic modulus and the density of the rigid urethane foam are set to predetermined values or less (bending elastic modulus of 10 MPa or less and density of 60 kg/m^3 or less). When the bending elastic modulus and the density exceed the predetermined values, the box body strength is satisfied, but the heat insulating performance is deteriorated. In this way, the rigid urethane foam is difficult to use. For this reason, as for the heat insulating box body disclosed in Patent Literature 1, in order to secure both the strengths of the box body and the wall surface and the heat insulating performance, the thickness of urethane needs to be secured to some extent or larger. Thus, in order that the density of urethane is reduced to the predetermined value or less after foaming (density of 60 kg/m^3 or less), thicknesses of urethane passages at parts to be charged with urethane need to be adjusted to a predetermined thickness or larger. In this way, there is a problem of a difficulty in reducing the wall thickness.

[0011]

Further, in Patent Literature 2, as a measure to secure the strength of the heat insulating box body including the vacuum heat insulating material, an outer wrapping material of the vacuum heat insulating material is made of, for example, a plastic material that is molded into a target shape through vacuum molding, air-pressure molding, and the like. In addition, the vacuum heat insulating material, the internal box, and the external box in use are each molded into a concavo-convex shape and charged with a particulate core material to secure the strength. However, the internal box and the external box are each formed into a concavo-convex shape substantially in conformity with concavo-convex portions of the outer wrapping material of the vacuum heat insulating material so that the internal box and the external box are fitted to the outer wrapping material. With this, the strengths of the internal box and the external box are secured. As a result, the outer wrapping material, the internal box, and the external box are complicated in shape, which causes problems of increase in cost, deterioration in assembly efficiency, and the like. Further, in order to secure the strength, the outer wrapping material of the vacuum heat insulating material also needs to be molded into the concavo-convex shape, and the core material to be sealed in the outer wrapping material needs to conform to the concavo-convex shape of the outer wrapping material. Thus, a particulate material having fluidity needs to be used as the core material, which may cause increase in cost and deterioration in heat insulating performance in comparison with the cases where fibrous core materials such as a glass fiber are used. Further, rear surfaces of compartments (housing spaces for items to be stored in the heat insulating box body) are each formed into a complicated concavo-convex shape, which is poor in design property.

[0012]

In this way, in the related-art heat insulating box bodies and devices, in particular, the related-art refrigerators, it is difficult to secure predetermined heat insulating performance and predetermined box body strength, and to thin heat insulating walls including the vacuum heat insulating material, or the heat insulating material. Thus, it is difficult to further increase the internal capacity of the heat insulating box body, the refrigerator, the device, and the like, or to reduce outer dimensions of those devices. Further, in Patent Literature 2, the vacuum heat insulating material is arranged in a rear wall of the heat insulating box body (refrigerator). However, a width of the vacuum heat insulating material is smaller than an internal width of the heat insulating box body (refrigerator), and hence the heat insulating performance is poor. As a countermeasure, when the width of the vacuum heat insulating material is enlarged so as to enhance the heat insulating performance, urethane injection ports formed at end portions in a width direction (or end portions in a vertical direction) on the rear of the heat insulating box body interfere with the vacuum heat insulating material. Thus, the vacuum heat insulating material cannot be enlarged in the width direction (or vertical direction), thereby being difficult to enhance the heat insulating performance.

[0013]

Further, in the refrigerators disclosed in Patent Literature 3 and Patent Literature 4, the rail members for supporting the cases of the pull-out type storage compartments, or door frames are fixed to the heat insulating walls (to the internal box, the urethane heat insulating material between the internal box and the external box, or reinforcing members arranged between the internal box and the external box) with screws. However, when the vacuum heat insulating material is arranged between the external box and the internal box and the thickness of the heat insulating material is small at a part between the vacuum heat insulating material and the internal box, the outer wrapping material of the vacuum heat insulating material may be damaged or torn by the fixing screws of the rail members or the door frames depending on, for example, non-uniformity in thickness of the vacuum heat insulating material. As a result, there are risks in that the heat insulating performance and reliability of the vacuum heat insulating material are deteriorated.

[0014]

Further, threaded portions of the screws may be shortened so as not to damage the vacuum heat insulating material. However, when the strength of the urethane heat insulating material (such as density and bending elasticity) to be charged between the vacuum heat insulating material and the internal box is small, not only the holding strength of the screws but also the strength of the heat insulating walls to be formed integrally with urethane is small. Thus, there is a risk in that the heat insulating walls and the box body are deformed, or the screws are loosened. In this way, the reliability may be deteriorated, and hence lengths of the threaded portions cannot be set to a predetermined length or smaller. As a countermeasure, when separate members held or fixed with the screws, fitting structures, or the like (such as heavy load support members for supporting heavy loads, specifically, rail members for supporting the cases, or door frames, or vibration influenced members to be influenced by vibration during operation, specifically, cooler for generating cooling air for cooling storage compartments, or fan for sending the cooling air into the storage compartments) are mounted to the heat insulating walls including the vacuum heat insulating materials, parts to which the separate members are mounted need to have a wall thickness enough to exhibit the mounting strength. Further, in view of the mounting strength of the screws, the lengths of the threaded portions of the fixing members such as the screws are difficult to set to a predetermined length (specifically, 15 mm) or smaller.

In this way, it is difficult to reduce the wall thickness, and to increase the internal capacity.

[0015]

Aspects of the present disclosure have been made to solve at least one of the problems as described above, by securing heat insulating performance and strength of a heat insulating box body. Further, aspects of the present disclosure provide, for example, a heat insulating box body, a refrigerator, a hot water storage device, and a device including a high-temperature unit or a low-temperature unit, in which heat insulating walls or a heat insulating material can be thinned.

[0016]

Aspects of the present disclosure also increase internal capacities of a heat insulating box body, a refrigerator, a device, and the like in comparison with internal capacities of those devices in the related art (increase capacities of compartments), or provide a heat insulating box body, a refrigerator, a hot water storage device, a device, and the like, which can be reduced in outer dimensions (downsized in outer dimensions) of the heat insulating box body, the refrigerator, the device, and the like.

[0017]

Furthermore, aspects of the present disclosure provide a heat insulating box body, a refrigerator, a hot water storage device, a device, and the like, in which, also when separate members held or fixed with screws, fitting structures, or the like (such as heavy load support members or vibration influenced members) are mounted to heat insulating walls including vacuum heat insulating materials, the heat insulating walls or the heat insulating materials can be thinned. In addition, aspects of the present disclosure provide a heat insulating box body, a refrigerator, a hot water storage device, a device, and the like, which are excellent in reliability and large in internal capacity.

[0018]

Aspects of the present disclosure reduce wall thickness, and enhance design properties of compartments (such as storage compartments for housing items to be stored).

[0019]

Aspects of the present disclosure also provide a compact heat insulating box body, refrigerator, hot water storage device, device, and the like, which are reduced in outer size (such as outer diameter, width, depth, and height) of the heat insulating box body such as a box body having thinned heat insulating walls, a cylindrical shape or an angular cylindrical shape, and a front opening to insulate heat of a heat source such as a hot water storage tank.

[0019A]

According to a first aspect of the invention there is provided a refrigerator having a storage compartment including a rear wall, a lateral wall and an opening portion formed on a front side, comprising: a convex portion formed at a corner portion of an internal box forming an inner surface of the lateral wall and an inner surface of the rear wall and provided so as to project toward the front side with respect to an inner surface of the rear wall; a plate-like vacuum heat insulating material provided between the internal box forming an inner surface of the rear wall and an external box forming an outer surface of the rear wall and arranged so as to be partially overlapped with the convex portion in a width direction; a first intermediate member charged or sealed in the convex portion, the first intermediate member bonding, attaching, or fixing the internal box and the vacuum heat insulating material; a second intermediate member bonding, attaching, or fixing the vacuum heat insulating material and the external box, the second intermediate member being different from a foam heat insulating material; and an injection port that is provided on the rear wall to inject a liquid raw material of the first intermediate member, wherein the injection port is provided at a position corresponding to the convex portion, and the vacuum heat insulating material is arranged so as not to block at least part of the injection port and integrally formed with the internal box and the external box at the convex portion.

[0020]

According to one aspect of the present disclosure, there is provided a refrigerator, including:

a box body formed of an external box and an internal box, the box body including:

a rear wall; and

lateral walls;

a storage compartment formed by partitioning an inside of the box body with a partition wall to have an opening portion formed on a front side of the box body;

a pull-out case housed in the storage compartment and pulled out through intermediation of rail members arranged respectively on the lateral walls of the storage compartment;

a vacuum heat insulating material formed of a fibrous core material made of an inorganic fiber or an organic fiber, and arranged between a part of the internal box and a part of the external box corresponding to each of the lateral walls on which the rail members are arranged; and

a heat insulating material charged between the internal box and the vacuum heat insulating material at a position of facing each of the rail members,

in which a thickness of the heat insulating material is set to less than 10 mm at the position of facing the each of the rail members, and

in which a density of the heat insulating material charged between the internal box and the vacuum heat insulating material is set to more than 60 kg/m^3 at the each of the rail portions.

Further, according to one aspect of the present disclosure, there is provided a refrigerator, including:

a box body formed of an external box and an internal box, the box body including:

a top wall;

a rear wall;

lateral walls; and

a bottom wall;

a storage compartment formed by partitioning an inside of the box body with a partition wall to have an opening portion formed on a front side of the box body;

a pull-out case housed in the storage compartment and pulled out through intermediation of rail members each arranged on the partition wall corresponding to a bottom surface or an upper surface of the storage compartment;

a vacuum heat insulating material formed of a fibrous core material made of an inorganic fiber or an organic fiber, and arranged in the partition wall on which the rail members are arranged; and

a heat insulating material charged, applied, or arranged between an outer shell member forming the partition wall and the vacuum heat insulating material in the partition wall at a position of facing each of the rail members,

in which a thickness of the heat insulating material is set to less than 10 mm at the position of facing the each of the rail members, and

in which a density of the heat insulating material is set to more than 60 kg/m^3.

In addition, according to one aspect of the present disclosure, there is provided a heat insulating box body formed of an external box and an internal box with a rear wall and lateral walls, the heat insulating box body including:

a storage compartment formed in an inside of the heat insulating box body to have an opening portion formed on a front side of the heat insulating box body;

a vacuum heat insulating material arranged on the external box side in the rear wall; and

injection ports formed at end portions in a width direction of the rear wall or end portions in a vertical direction of the rear wall, for injecting a liquid raw material of a foam heat insulating material into the rear wall,

in which the vacuum heat insulating material includes cutout portions including cutouts or openings, the cutout portions being formed at parts to face the injection ports so that the vacuum heat insulating material is prevented from interfering with the injection ports, and

in which a thickness of the foam heat insulating material is set to less than 10 mm after injection.

[0021]

According to the structures described above, the strength of the walls of the refrigerator or the heat insulating box body can be secured, and in addition, the wall thickness of the refrigerator or the heat insulating box body can be reduced. Further, when the heat insulating box body having the structures described above is applied to devices such as a refrigerator, the capacities of the housing spaces and the storage compartments can be increased without enlarging an outer shape of the box body. This is because the wall thickness of the box body can be reduced.

[0021A]

As used herein, except where the context requires otherwise, the term "comprise" and variations of the term, such as "comprising", "comprises" and "comprised", are not intended to exclude further additives, components, integers or steps.

Brief Description of Drawings

[0022]

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

[Fig. 2] Fig. 2 is a sectional side view illustrating the refrigerator according to Embodiment 1 of the present invention.

[Fig. 3] Fig. 3 is a block diagram illustrating a controller of the refrigerator according to Embodiment 1 of the present invention.

[Fig. 4] Fig. 4 is a horizontal sectional view illustrating the refrigerator according to Embodiment 1 of the present invention.

[Fig. 5] Fig. 5 is a horizontal sectional view illustrating another refrigerator according to Embodiment 1 of the present invention.

[Fig. 6] Fig. 6 is a horizontal sectional view illustrating still another refrigerator according to Embodiment 1 of the present invention.

[Fig. 7] Fig. 7 is a horizontal sectional view illustrating yet another refrigerator according to Embodiment 1 of the present invention.

[Fig. 8] Fig. 8 is a horizontal sectional view illustrating yet another refrigerator according to Embodiment 1 of the present invention.

[Fig. 9] Fig. 9 is a front view illustrating the refrigerator according to Embodiment 1 of the present invention in a state in which front doors of the refrigerator are removed.

[Fig. 10] Fig. 10 is a sectional side view illustrating the refrigerator according to Embodiment 1 of the present invention.

[Fig. 11] Fig. 11 is a front sectional view illustrating a heat insulating box body according to Embodiment 1 of the present invention.

[Fig. 12] Fig. 12 is a rear view illustrating the heat insulating box body according to Embodiment 1 of the present invention.

[Fig. 13] Fig. 13 is a perspective view illustrating the heat insulating box body according to Embodiment 1 of the present invention.

[Fig. 14] Fig. 14 is another perspective view illustrating the heat insulating box body according to Embodiment 1 of the present invention.

[Fig. 15] Fig. 15 is a graph showing a relationship between a density and a heat conductivity of rigid urethane foam of the heat insulating box body according to Embodiment 1 of the present invention.

[Fig. 16] Fig. 16 is a graph showing the density and a bending elastic modulus of the rigid urethane foam according to Embodiment 1 of the present invention.

[Fig. 17] Fig. 17 is a graph showing a relationship between a thickness of urethane in a passage at the time when the rigid urethane foam according to Embodiment 1 of the present invention is charged, and a heat conductivity of urethane.

[Fig. 18] Fig. 18 is a graph showing a relationship between the thickness of urethane in the passage at the time when the rigid urethane foam according to Embodiment 1 of the present invention is charged, and a bending elastic modulus of urethane.

[Fig. 19] Fig. 19 is a graph showing a relationship between a composite heat conductivity and a ratio of a thickness of rigid urethane relative to a wall thickness of the heat insulating box body according to Embodiment 1 of the present invention.

[Fig. 20] Fig. 20 is a graph showing a relationship between a charging rate of vacuum heat insulating materials relative to wall internal spaces of the heat insulating box body according to Embodiment 1 of the present invention, and a deformation amount of the heat insulating box body.

[Fig. 21] Fig. 21 is a graph showing a relationship between a ratio of the areas of the vacuum heat insulating materials relative to the surface areas of lateral surface portions and a rear surface portion of the heat insulating box body according to Embodiment 1 of the present invention, and the deformation amount of the box body.

[Fig. 22] Fig. 22 is a rear view illustrating the heat insulating box body according to Embodiment 1 of the present invention.

[Fig. 23A] Fig. 23A is a sectional schematic view illustrating a lateral wall of the heat insulating box body after the rigid urethane foam is foamed.

[Fig. 23B] Fig. 23B is another sectional schematic view illustrating the lateral wall of the heat insulating box body after the rigid urethane foam is foamed.

[Fig. 24] Fig. 24 is a main-part sectional view illustrating a vicinity of a rail mount portion of the refrigerator according to the embodiment of the present invention.

[Fig. 25] Fig. 25 is a main-part sectional view illustrating a vicinity of another rail mount portion of the refrigerator according to the embodiment of the present invention.

[Fig. 26] Fig. 26 is a main-part sectional view illustrating a vicinity of still another rail mount portion of the refrigerator according to the embodiment of the present invention.

[Fig. 27] Fig. 27 is a main-part sectional view illustrating a vicinity of yet another rail mount portion of the refrigerator according to the embodiment of the present invention.

Description of Embodiments

[0023]

Embodiment 1

(Refrigerator)

Fig. 1 is a front view illustrating a refrigerator according to Embodiment 1 of the present invention, and Fig. 2 is a sectional side view illustrating the refrigerator according to Embodiment 1 of the present invention. As illustrated in those figures, in an uppermost stage of a refrigerator 1, a refrigerator compartment 2 is arranged as a side-by-side (or open-and-close type) storage compartment. Under the refrigerator compartment 2, an ice making compartment 3 and a switching compartment 4 are arranged as storage compartments parallel to each other on the left and right. In a lowermost stage of the refrigerator 1, a freezer compartment 6 is arranged as a storage compartment, and a vegetable compartment 5 is arranged as a storage compartment above the freezer compartment 6. The vegetable compartment 5 is arranged under the ice making compartment 3 and the switching compartment 4 arranged parallel to each other on the left and right, and above the freezer compartment 6.

[0024]

An inside of the refrigerator compartment 2 as a storage compartment serves as a stored item housing space for housing items to be stored (such as food and drink). In the stored item housing space, a plurality of shelves 80, which are made of a resin or glass, are arranged so that the stored items are put thereon. On a lower side of the stored item housing space (below the internal shelves), there are arranged substantially sealed containers 2X and 2Y to be used respectively as a chilled compartment 2X that is controlled to fall within a chilled temperature range of from approximately +3 degrees C to -3 degrees C, and a vegetable compartment 2Y that is controlled to fall within a vegetable compartment temperature range, specifically, maintained within a range of from approximately +3 degrees C to +5 degrees C. The substantially sealed containers 2X and 2Y may each be used as an egg compartment for storing eggs. Further, the substantially sealed containers 2X and 2Y each have, for example, a pull-out structure so that the stored items can be taken in and out by pulling out the containers.

[0025]

The structures of the substantially sealed containers 2X and 2Y are formed by providing removable lids to upper surface opening portions of containers each opened on its upper side. Those lids may be arranged on the container side, or may be arranged on the shelf 80 or a partition wall arranged above the containers. Alternatively, the shelf and the partition wall themselves above the containers may be used also as the lids.

[0026]

As a matter of course, this embodiment is not limited by the arrangement of the compartments. Specifically, the ice making compartment 3 and the switching compartment 4 may be arranged parallel to each other on the left and right under the refrigerator compartment 2 arranged in the upper stage. The freezer compartment 6 may be arranged under the ice making compartment 3 and the switching compartment 4 arranged parallel to each other on the left and right and above the vegetable compartment 5 arranged in the lower stage. In this way, there may be employed what is called a mid-freezer type in which the freezer compartment 6 is arranged between the vegetable compartment 5 and each of the ice making compartment 3 and the switching compartment 4 that are arranged parallel to each other on the left and right. With this, low-temperature compartments (such as ice making compartment 3, switching compartment 4, and freezer compartment 6) are arranged close to each other, and hence heat insulating materials need not be arranged between those low-temperature compartments. Further, heat leakage is reduced. Thus, an energy-efficient refrigerator can be provided at low cost.

[0027]

In a front-side opening portion of the refrigerator compartment 2 as a storage compartment, there is arranged a side-by-side refrigerator compartment door 7 that can be freely opened and closed. The side-by-side refrigerator compartment door 7 includes two doors of a left refrigerator compartment door 7A and a right refrigerator compartment door 7B. As a matter of course, a single rotary door may be employed instead of the side-by-side doors. For other storage compartments, specifically, the ice making compartment 3, the switching compartment 4, the vegetable compartment 5, and the freezer compartment 6, there are respectively arranged a pull-out type ice making compartment door 8 capable of freely opening and closing an opening portion of the ice making compartment 3, a pull-out type switching compartment door 9 capable of freely opening and closing an opening portion of the switching compartment 4, a pull-out type vegetable compartment door 10 capable of freely opening and closing an opening portion of the vegetable compartment 5, and a pull-out type freezer compartment door 11 capable of freely opening and closing an opening portion of the freezer compartment 6. Note that, in the pull-out type storage compartment doors (such as ice making compartment door 8, switching compartment door 9, vegetable compartment door 10, and freezer compartment door 11), rail members are each fixed to or held on an internal box 750, which forms the storage compartments, with a rail fixing member 735 such as a screw or a fitting structure, and door frames fixed to or held on door inner plates are slid on the rail members directly or through intermediation of rollers and the like. With this, cases fixed to the doors or the door frames can be pulled out.

[0028]

Further, as described below with reference to Fig. 3, operation switches for performing, for example, temperature setting in the storage compartments (compartment selection switch 60a, temperature range changeover switch 60b, instant freezing switch 60c, ice making changeover switch 60d, and mist supply switch 60e) and an operation panel 60 for displaying temperature information such as internal temperatures and preset temperatures are installed to any one of the left refrigerator compartment door 7A and the right refrigerator compartment door 7B on the left and right of the refrigerator compartment 2 as a storage compartment. Operation information from the operation switches, information to be displayed on a liquid crystal display unit, information of temperatures in the storage compartments, and other information are controlled by a controller 30 including a control board having a microcomputer and the like mounted thereto. The controller 30 is arranged on an upper portion on the rear of the refrigerator (behind the refrigerator compartment).

[0029]

A compressor 12 is arranged in a machine room 1A formed in a lowermost portion on the rear of the refrigerator 1. The refrigerator 1 includes a refrigeration cycle. The compressor 12, which is arranged in the machine room 1A, serves as one of components of the refrigeration cycle, specifically, has a function to compress refrigerant in the refrigeration cycle. The refrigerant compressed by the compressor 12 is condensed by a condensor (not shown). Under the condensed state, the refrigerant is decompressed by a capillary tube (not shown) or an expansion valve (not shown) as a decompression device. A cooler 13, which serves as another of the components of the refrigeration cycle of the refrigerator, is arranged in a cooler room 131. The refrigerant decompressed by the decompression device is evaporated by the cooler 13, and gas around the cooler 13 is cooled by an endothermic effect at the time of the evaporation. A cooling air circulation fan 14, which is arranged near the cooler 13 in the cooler room 131, is configured to send cooling air generated by cooling around the cooler 13 to each of the compartments as the storage compartments of the refrigerator 1 (refrigerator compartment 2, ice making compartment 3, switching compartment 4, vegetable compartment 5, and freezer compartment 6) through cooling air passages (such as switching compartment cooling air passage 16 or refrigerator compartment cooling air passage 50).

[0030]

A defrost heater 150 as a defrosting unit for defrosting the cooler 13 (such as defrosting glass tube heater, specifically, carbon heater using, in a silica glass tube, carbon fibers for emitting light having a wavelength of from 0.2 μm to 4 μm, which is transmitted through the silica glass tube) is arranged under the cooler 13 arranged in the cooler room 131. Above the defrost heater 150, a heater roof 151 is arranged between the cooler 13 and the defrost heater 150 so that defrost water does not directly drop from the cooler 13 onto the defrost heater 150. When a black medium heater such as the carbon heater is used as the defrost heater 150, frost over the cooler 13 can be efficiently molten by radiant heat transfer. Thus, a surface temperature thereof can be set to a low temperature (approximately 70 degrees C to 80 degrees C). With this, even when flammable refrigerant (such as isobutane being hydrocarbon refrigerant) is used as refrigerant to be used in the refrigeration cycle and refrigerant leakage and the like occur, a risk of ignition can be reduced. Further, the frost over the cooler 13 can be more efficiently molten by radiant heat transfer in comparison with that by a nichrome wire heater, and hence the frost formed over the cooler 13 is gradually molten and is less liable to drop in a cluster at once. Thus, noise of the frost to drop onto the heater roof 151 can be reduced. In this way, a refrigerator excellent in quietness and defrosting efficiency can be provided.

[0031]

Note that, examples of the defrost heater 150 may include an inlaid heater that is integrally assembled into the cooler 13. Further, the glass tube heater and the inlaid heater may be used together. The defrost water generated around the cooler 13 or the defrost water that has dropped onto the heater roof 151 drops in the cooler room and is drained to an outside of the refrigerator (such as evaporating dish arranged in the machine room 1A) through a defrost water drain port that is formed on a lower side in the cooler room 131.

[0032]

A switching compartment damper 15 as an airflow rate control unit is configured, for example, to control a rate of the cooling air to be sent into the switching compartment 4 as a storage compartment by the cooling air circulation fan 14, to control the temperature in the switching compartment 4 to a predetermined temperature, and to switch a preset temperature of the switching compartment 4. The cooling air generated by cooling around the cooler 13 is sent into the switching compartment 4 through the switching compartment cooling air passage 16 as a cooling air passage. Further, the switching compartment cooling air passage 16 is arranged on a downstream side in the switching compartment damper 15.

[0033]

Further, a refrigerator compartment damper 55 as an airflow rate control unit is also configured, for example, to control a rate of the cooling air to be sent into the refrigerator compartment 2 as a storage compartment by the cooling air circulation fan 14, to control the temperature in the refrigerator compartment 2 to a predetermined temperature, and to change a preset temperature of the refrigerator compartment 2. The cooling air generated by cooling around the cooler 13 is sent into the refrigerator compartment 2 through the refrigerator compartment cooling air passage 50 as a cooling air passage.

[0034]

Of the storage compartments, for example, the switching compartment 4 is a compartment (storage compartment) in which a temperature in the storage compartment can be selected from a plurality of levels between a freezing temperature range (-17 degrees C or less) and a vegetable compartment temperature range (3 degrees C to 10 degrees C). The temperature in the storage compartment is selected or switched by operating the operation panel 60 installed to any one of the left refrigerator compartment door 7A and the right refrigerator compartment door 7B of the refrigerator 1.

[0035]

A switching compartment thermistor 19 (refer to Fig. 3) as a first temperature detecting unit for detecting an air temperature in the switching compartment 4 is installed, for example, on a depth-side wall surface of the switching compartment 4. A thermopile 22 (or infrared sensor, refer to Fig. 3) as a second temperature detecting unit for directly detecting surface temperatures of stored items put in the switching compartment 4 as a storage compartment is installed, for example, on a ceiling surface (central portion, front surface portion, rear surface portion, or the like) of the switching compartment 4. The switching compartment damper 15 as the airflow rate control unit capable of controlling an airflow rate and closing the air passage to block inflow of the cooling air is arranged in the air passage through which the cooling air is to be sent from the cooler room 131 to the switching compartment 4. The controller 30 controls the switching compartment damper 15 to open and close in accordance with the temperature detected by the switching compartment thermistor 19 as the first temperature detecting unit (or temperature detected by the thermopile 22) so that the temperature in the switching compartment 4 is adjusted to fall within a selected temperature range, or to fall within a preset temperature range. Further, temperatures of food items as stored items in the switching compartment 4 are detected directly by the thermopile 22 as the second temperature detecting unit. Note that, the machine room 1A is arranged in the lowermost portion on the rear of the refrigerator 1 in this example, but may be arranged in the upper portion on the rear thereof (specifically, in an uppermost portion on the rear).

[0036]

(Mist Supply Device)

An electrostatic atomizing device 200 as a misting device for supplying mist for performing, for example, sterilization and humidification of an inside of a storage compartment is arranged, for example, in a partition wall 51 (rear wall, or heat insulating wall) on a depth side (rear side) of the refrigerator compartment 2 as a storage compartment. The electrostatic atomizing device 200 is arranged in an inside of the refrigerator compartment 2 as a storage compartment in a manner that a cooling member (such as cooling plate) thereof for collecting moisture in the air in the storage compartment as dew condensation water is held in contact with or penetrates the rear heat-insulated partition wall 51 on the depth side of the refrigerator compartment 2, or a wall of the cooler room, specifically, a front wall of the cooler room 131 in which the cooler 13, the cooling air circulation fan 14, and the like are arranged. Examples of the partition wall 51 may include a rear wall 730, lateral walls 790, a top wall 740, a bottom wall 780, and partition walls 24 between the storage compartments. This cooling member (such as cooling plate) is arranged to perform cooling by using cooling air in the refrigerator compartment cooling air passage 50 and a refrigerator compartment cooling air passage 760 as cooling air passages formed on a rear side or lateral sides with respect to the partition wall 51 or above or below the partition wall 51, or cooling air in a low-temperature storage compartment (such as freezer compartment, ice making compartment, and switching compartment that are maintained at temperatures lower than those in the other storage compartments) different from the storage compartment that is arranged on the opposite side of the storage compartment (such as refrigerator compartment and vegetable compartment) with respect to the partition wall 51. Instead of the electrostatic atomizing device 200 described herein, there may be arranged a sterilizer, a disinfector, a humidifier, and the like as long as the inside of the storage compartment can be sterilized, disinfected, or humidified.

[0037]

(Display)

Fig. 3 is a block diagram illustrating the controller 30 of the refrigerator 1 according to Embodiment 1 of the present invention. The controller 30 includes a microcomputer 30a, and controls, in accordance with pre-stored programs, for example, the temperatures in the storage compartments of the refrigerator 1, rotation speeds of the compressor 12 and the cooling air circulation fan 14, opening and closing of the switching compartment damper 15 and the refrigerator compartment damper 55, and voltage application to the misting devices (electrostatic atomizing devices) 200. The operation panel 60 includes the following switches.

(1) Compartment selection switch 60a for selecting the storage compartments such as the refrigerator compartment, the freezer compartment, and the switching compartment;

(2) Temperature range changeover switch 60b for switching temperature ranges in the storage compartments such as the switching compartment (such as "Refrigeration," "Freezing," "Chilling," and "Soft Freezing"), and for switching, for example, "Rapid Cooling," "High," "Medium," and "Low" from each other;

(3) Instant freezing switch 60c for adapting an inside of a storage compartment for frozen storage through a supercooling state (instant freezing is also referred to as "supercooling freezing");

(4) Ice making changeover switch 60d for selecting ice making modes such as "Clear Ice," "Normal," "Rapid," and "Stop;"

(5) Mist supply switch 60e for energizing the misting devices 200 to supply mist (electrostatic atomization) into the storage compartment (selection of electrostatic atomization).

(6) Internet connection switch (not shown) for establishing wired or wireless connection to the Internet

(7) Browsing switch (not shown) for browsing information of a server

connected in a wired or wireless manner to the refrigerator, such as a cloud server and a mobile terminal, contents of instructions from the server or the mobile terminal, or information transmitted to the server or the mobile terminal

(8) Recharging switch (not shown) for recharging a mobile phone, a mobile terminal, a personal computer, and the like

[0038]

In this context, description is made of a temperature detecting sensor for detecting a temperature in a storage compartment (such as switching compartment 4). In this embodiment, as the temperature detecting sensor for detecting the temperature in the storage compartment (such as switching compartment 4), the switching compartment thermistor 19 as the first temperature detecting unit and the thermopile 22 as the second temperature detecting unit are arranged. A temperature detected by the switching compartment thermistor 19 as the first temperature detecting unit for detecting a temperature of the air in the storage compartment (such as switching compartment 4) is input to the microcomputer 30a of the controller 30. The microcomputer 30a (specifically, temperature determination unit in the microcomputer 30a) determines the temperature through comparison with a predetermined value, and controls the temperature to fall within a predetermined temperature range. Further, signals of detection by the thermopile 22 as the second temperature detecting unit for directly detecting, for example, the surface temperatures of, for example, the food items in the storage compartment (such as switching compartment 4) are input to the microcomputer 30a and converted to the surface temperatures of, for example, the food items through arithmetic processing by the microcomputer 30a (specifically, arithmetic processing unit in the microcomputer 30a). After that, predetermined temperature control such as rapid freezing control or supercooling refrigeration control is performed. Further, the controller 30 performs various kinds of control such as control of the temperatures in the storage compartments (refrigerator compartment 2, ice making compartment 3, switching compartment 4, vegetable compartment 5, and freezer compartment 6), and control of the energization of the electrostatic atomizing devices 200, and controls the operation panel 60 (display panel) installed to any one of the left refrigerator compartment door 7A and the right refrigerator compartment door 7B, or the server or the mobile terminal to display, for example, preset temperatures of the storage compartments, the (surface) temperatures of the food items, and operating conditions of the electrostatic atomizing devices 200 installed to the storage compartments.

[0039]

(Structure of Box Body of Refrigerator)

Fig. 4 is a horizontal sectional view illustrating the refrigerator according to Embodiment 1 of the present invention. The refrigerator in the horizontal sectional view of Fig. 4 is cut in a plane perpendicular to a vertical direction of the refrigerator 1. In Fig. 4, the parts equivalent to those in Fig. 1 to Fig. 3 are denoted by the same reference symbols to omit description thereof.

[0040]

In Fig. 4, a heat insulating box body 700 of the refrigerator 1 is formed of an external box 710 and the internal box 750, and a vacuum heat insulating material 400 is arranged between the external box 710 and the internal box 750. The vacuum heat insulating material 400 is arranged on the rear of the refrigerator 1 and attached directly to the external box 710 with a second adhesive agent as a second intermediate member such as a hot melt adhesive and a double-faced tape. Further, the vacuum heat insulating material 400 is attached directly to a part of the internal box 750 (specifically, to a substantially central portion in a right-and-left direction of a wall surface corresponding to a rear surface of the internal box 750) with an adhesive agent. At right and left end portions (corner portions) near the lateral walls 790 excluding the substantially central portion of the rear surface of the internal box 750, convex portions 450 are formed to project on a front side with respect to the rear wall 730. The vacuum heat insulating material 400 is arranged to overlap with the convex portions 450 by predetermined lengths, but the convex portions 450 need not necessarily include the parts corresponding to the vacuum heat insulating material 400, and may include a part that is charged only with urethane. Further, a space between the internal box 750 and the vacuum heat insulating material 400 is charged with the adhesive agent as a first intermediate member (for example, a self-adhesive foam heat insulating material such as rigid urethane may be used). The vacuum heat insulating material 400 is arranged between the internal box 750 and the external box 710 through intermediation of the adhesive agent as the first intermediate member (such as rigid urethane). In this way, the vacuum heat insulating material 400 is bonded, firmly attached, or fixed to the internal box 750 or the external box 710 with the first intermediate member and the second intermediate member.

[0041]

Note that, as viewed from the front side (storage compartment side) of the refrigerator 1, the internal box 750 has a rear shape including a concave portion 440 having a shape of a concave groove that is vertically recessed at a substantially central portion (also referred to as "first concave portion"). At the concave portion 440 formed at the substantially central portion, the vacuum heat insulating material 400 is attached directly to the external box 710 and the internal box 750 with the adhesive agent. Further, as viewed from the front side (storage compartment side) of the refrigerator 1, the rear shape of the internal box 750 is a convex shape projected on its widthwise (right-and-left direction) end portion sides toward a front opening portion side (storage compartment side) with respect to the substantially widthwise (right-and-left direction) central portion. In other words, the rear shape of the internal box 750 includes the concave portion 440 having the shape of the concave groove that is recessed at the substantially central portion in the right-and-left direction toward the external box side (rear side of the refrigerator) with respect to the left-and-right end portion sides, and the concave portion 440 is formed in the vertical direction of the refrigerator in the storage compartment (such as refrigerator compartment 2).

In other words, the concave portion 440 is formed of lateral surfaces 452 of the convex portions 450 and the rear wall 730, and the vacuum heat insulating material 400 having a plate shape is arranged between a part of the internal box 750 corresponding to an inner surface (storage compartment side) of the rear wall 730 and a part of the external box 710 corresponding to an outer surface of the rear wall 730. Note that, although not shown, the vacuum heat insulating material 400 having a plate shape may be arranged also between other parts of the internal box 750 corresponding to inner surfaces (storage compartment side) of the lateral walls 790 and other parts of the external box 710 corresponding to outer surfaces of the lateral walls 790. The cooling air passage 760 formed in the rear wall 730 or in the concave portion 440 includes a first air passage component 762 that is a designed cover member, and a second air passage component 764 having heat insulating properties and being arranged on a rear side (internal box 750 side) of the first air passage component 762. The cooling air passage 760 is arranged in the concave portion 440. The first air passage component 762 as the cover member or the second air passage component 764 includes mount portions (engaging portions) to be, for example, fitted to or engaged with mount portions (engaging portions) formed on the convex portions 450 or the rear wall 730 with fixing members such as screws. With this, the cover member 760 is mounted to the convex portions 450 or the rear wall 730.

[0042]

In the convex portions 450 formed on the left-and-right end portion sides on the rear in the storage compartment, on a widthwise central side (range of overlapping length X), the vacuum heat insulating material 400 is arranged between the external box 710 and the internal box 750, and the adhesive agent as the first intermediate member (self-adhesive foam heat insulating material 701 such as rigid urethane) is charged between the vacuum heat insulating material 400 and the internal box 750. Further, the external box 710 and the vacuum heat insulating material 400 are bonded to each other with the second adhesive agent as the second intermediate member. On widthwise end portion sides of the convex portions 450, spaces between the external box 710 and the internal box 750 are charged with the heat insulating material 701 (such as rigid urethane). In this way, there are parts where the vacuum heat insulating material 400 is not arranged. As a matter of course, when the vacuum heat insulating material 400 is enlarged in the width direction in the convex portions 450 so that the area in which the vacuum heat insulating material 400 is arranged in the width direction is increased, there is an advantage in that higher heat insulating performance and box body strength can be obtained. However, this configuration involves increase in cost. Thus, when the heat insulating performance and strength are equal to or more than predetermined values, the parts where the vacuum heat insulating material 400 is not arranged may exist.

[0043]

Note that, in the concave portion 440, the vacuum heat insulating material 400 is attached directly to the external box 710 with the second adhesive agent as the second intermediate member, and is attached to the internal box 750 with the self-adhesive foam adhesive agent as the first intermediate member, such as urethane (the space between the vacuum heat insulating material 400 and the internal box 750 is charged, for example, with rigid urethane foam as an adhesive agent).

[0044]

Thus, in the heat insulating box body or the refrigerator including the vacuum heat insulating material, in comparison with the related art (for example, Patent Literature 2), in which the vacuum heat insulating material 400 is arranged directly in the internal box 750 in the width direction of the rear of the storage compartment without arranging the heat insulating material 701 intended mainly to perform heat insulation, such as urethane, at the parts where the vacuum heat insulating material is arranged, according to this embodiment, the convex portions 450, which are formed of the heat insulating material 701 such as urethane, are arranged over the vertical direction on the left-and-right end portion sides (widthwise end portion sides), and hence the box body is improved in torsional strength and bending strength through the formation of the convex portions 450. In the configuration disclosed in Patent Literature 2, the convex portions 450 and the parts where the vacuum heat insulating material 400 is arranged do not overlap with each other in the width direction of the rear of the storage compartment. Thus, when the box body is twisted, the convex portions 450 and the vacuum heat insulating material 400 may be separated to cause decrease in strength and breakage of the box body. Note that, lobe portions of the vacuum heat insulating material (parts formed only of an outer wrapping material) do not have cores, and hence do not have heat insulating functions. Further, the lobe portions of the vacuum heat insulating material are poor in strength, and hence are excluded from the components of the vacuum heat insulating material.

[0045]

Further, as described in this embodiment, when the convex portions 450 are arranged in the width direction of the rear of the storage compartment to partially overlap (by the overlapping lengths X) at least with the parts where the vacuum heat insulating material 400 is arranged, the rigid urethane foam to be charged into the convex portions 450 is also charged into a part of the space between the vacuum heat insulating material 400 and the internal box 750 on each of the widthwise (right-and-left direction) end portion sides of the vacuum heat insulating material 400. Thus, a thickness of the rigid urethane foam to be charged between the vacuum heat insulating material 400 and the internal box 750 at a positon where the vacuum heat insulating material 400 faces the convex portion 450 can be set larger than a thickness of the rigid urethane foam to be charged between the vacuum heat insulating material 400 and the internal box 750 at a position where the vacuum heat insulating material 400 faces the concave portion 440. Thus, the rigid urethane foam can be increased in bonding area with respect to the vacuum heat insulating material 400, and in thickness of the parts corresponding to the vacuum heat insulating material 400. As a result, the strength of joining between the rigid urethane foam and the vacuum heat insulating material 400 in the convex portions 450 is increased.

[0046]

Thus, even when the thickness of the rigid urethane foam between the vacuum heat insulating material 400 and the internal box 750 is reduced at the part corresponding to the concave portion 440, the strength of joining between the convex portions 450 and the vacuum heat insulating material 400 and the strength of joining between the convex portions 450 and the lateral walls 790 (or peripheral walls where the convex portions 450 are formed) can be significantly increased. As a result, the box body can be significantly improved in strength. Further, in the convex portions 450, the rigid urethane foam can be increased in thickness. Thus, even when there are parts where the vacuum heat insulating material 400 is not arranged, the heat insulating performance is enhanced.

[0047]

Further, in the embodiment of the present invention, unlike Patent Literature 2 in the related art, the vacuum heat insulating material, the internal box, and the external box need not be molded into complicated shapes to secure the strength of the box body. Further, an organic fiber core material and an inorganic fiber core material that are inexpensive and excellent in heat insulating performance (such as cotton-like core material and nonwoven fabric core material) can be used as a core material of the vacuum heat insulating material. Thus, a heat insulating box body, a refrigerator, a showcase, a hot water supplier, a device including a vacuum heat insulating material, and the like, which are low-cost, simple in structure, and excellent in heat insulating performance, can be provided.

[0048]

With this, for example, a risk in that the rear of the box body is deformed to form concavo-convex portions in the storage compartments, a risk in that the box body is deformed to incline the storage compartment doors (such as refrigerator compartment door 7) arranged in the front of the storage compartments (such as refrigerator compartment 2), a risk in that one of the side-by-side doors (7A and 7B) on the left and right is inclined and displaced, and other risks can be eliminated. Thus, the storage compartment doors can be smoothly opened and closed. Further, the storage compartment doors on the left and right are not displaced so that excellent external appearance (excellent design properties) can be maintained. In addition, a risk in that the box body is deformed, for example, to cause inclination or mounting height asymmetry between the left and right of opening-and-closing doors or rail members for pull-out cases, which are fixed to the inner walls or the lateral walls on the left and right of the storage compartments (such as ice making compartment 3, switching compartment 4, vegetable compartment 5, and freezer compartment 6) can be eliminated. With this, the cases can be smoothly pushed in and pulled out. In this way, a refrigerator and a device that are excellent in reliability and usability can be provided.

[0049]

Further, when the vacuum heat insulating material 400 has a flat plate shape, under the state in which the vacuum heat insulating material 400 is mounted to the rear of the refrigerator 1, the vacuum heat insulating material 400 is liable to be bent or twisted in the right-and-left direction (width direction) or in a fore-and-aft direction. Also in this respect, under a state in which the vacuum heat insulating material 400 is mounted to the device such as the refrigerator, when the convex portions 450 including the heat insulating material such as urethane are formed in the vertical direction on the left-and-right end portion sides on the rear so that the vacuum heat insulating material 400 is formed integrally with urethane charged into the convex portions 450, the internal box 750, the vacuum heat insulating material 400, and the external box 710 are bonded integrally to each other through intermediation of the convex portions 450. Thus, the box body 700 can be improved in bending strength (in particular, bending strength in the fore-and-aft direction) and torsional strength. In this way, the opening portions of the storage compartments opened in the front are suppressed from being deflected and deformed or causing leakage of the cooling air due to displacement of sealing members in the opening portions. As a result, a heat insulating box body, a refrigerator, and a device including a vacuum heat insulating material, which are excellent in reliability, performance, and energy efficiency, can be provided.

[0050]

Further, the region between the internal box 750 and the vacuum heat insulating material 400 includes the parts where the foam heat insulating material intended mainly to perform heat insulation, such as urethane, is arranged (convex portions 450), and the part where the adhesive agent not intended mainly to perform heat insulation (for example, urethane may be used as long as the material has self-adhesiveness because heat insulation is not mainly intended but bonding is mainly intended) is arranged (concave portion 440). Thus, unlike the parts where the heat insulating material intended mainly to perform heat insulation, such as urethane, is arranged, the part where the adhesive agent intended mainly to perform bonding is arranged (concave portion 440) need not have a predetermined thickness for exerting heat insulating performance of a heat insulating material as long as predetermined bonding strength is secured. Thus, the part to be used mainly to perform bonding (such as concave portion 440) may be considerably reduced in thickness of the adhesive agent. As a result, when rigid urethane is used as the adhesive agent, a thickness of urethane can be considerably reduced in comparison with that at the parts to be used mainly to perform heat insulation. Thus, a wall thickness can be reduced by an amount corresponding to a difference in thickness of the adhesive agent, and hence the storage compartments can be increased in internal capacity. With this, a refrigerator and a device that are excellent in usability can be provided.

[0051]

Note that, a pipe 720 as a lead wire accommodating member for accommodating lead wires such as control wires and drive power wires of the compressor and the fan is embedded over the vertical direction in the heat insulating material 701 for forming the convex portions 450, such as urethane. The lead wires accommodated in the pipe 720 include controls wires for controlling, for example, opening and closing of various dampers, and operations of, for example, the compressor 12 and the cooling air circulation fan 14, and power wires for supplying electric power, for example, to the compressor 12 and the cooling air circulation fan 14. The lead wires such as the control wires and the power wires are routed through the pipe 720 and connected, for example, to the compressor 12 arranged in the machine room 1A formed on a lower portion (or upper portion) of the refrigerator 1, the controller 30 (such as control board) arranged in a rear surface, a bottom surface, or an upper surface of the refrigerator 1, the cooling air circulation fan 14 arranged, for example, in the cooler room 131, the switching compartment damper 15 and the refrigerator compartment damper 55 that are arranged in the cooling air passages, and the operation panel 60 installed to the opening-and-closing door (such as refrigerator compartment door 7) arranged to cover the front of the storage compartment (such as refrigerator compartment 2).

[0052]

A width in the right-and-left direction of the vacuum heat insulating material 400 arranged on the rear of the refrigerator 1 is set smaller than a width between storage compartment inner walls 791 and 792 of the lateral walls 790 of the refrigerator 1 so that a plurality of charging ports (injection ports) 703 and 704 for the heat insulating material such as urethane, which are formed at the end portions in the right-and-left direction on the rear of the refrigerator 1, are not closed. With this, charging passages for the heat insulating material such as urethane to be charged through the charging ports 703 and 704 are not closed.

[0053]

Note that, when the width in the right-and-left direction of the vacuum heat insulating material 400 arranged on the rear of the refrigerator 1 is set equal to or smaller than a width (distance) between the storage compartment inner walls of the lateral walls 790 of the refrigerator 1 (between the left storage compartment inner wall 791 and the right storage compartment inner wall 792), the charging ports or the charging passages for the heat insulating material such as urethane are not closed. Thus, the urethane heat insulating material is continuously charged, which leads to an advantage in that deterioration in heat insulating performance and the like do not occur. Meanwhile, when the vacuum heat insulating material 400 is arranged at the same positions as the positions at the left-and-right end portions on the rear of the refrigerator 1, at which the charging ports 703 and 704 for the heat insulating material such as urethane are arranged, or is arranged on a central side (inward) with respect to the charging ports 703 and 704, the charging ports 703 and 704 for the urethane heat insulating material are not closed by the vacuum heat insulating material 400. Thus, when being charged through the charging ports 703 and 704, the heat insulating material such as urethane is not hindered from flowing (being charged), for example, through the lateral walls 790, through the convex portions 450, or between the vacuum heat insulating material 400 and the internal box 750. As a result, failure of urethane charging and the like do not occur, or the heat insulating performance is not deteriorated.

[0054]

Meanwhile, when, for example, parts of the vacuum heat insulating material 400 project outward in the width direction with respect to the inner walls of the lateral walls 790 of the refrigerator 1 to close at least a part of the charging ports 703 and 704 for the urethane heat insulating material, there is a risk in that the vacuum heat insulating material 400 blocks or hinders urethane charged through the charging ports 703 and 704 for the heat insulating material such as urethane from flowing, for example, through the lateral walls 790, through the convex portions 450, or between the vacuum heat insulating material 400 and the internal box 750. As a result, failure of charging the heat insulating material such as urethane may occur, for example, in the lateral walls, and the heat insulating performance may be deteriorated.

[0055]

Thus, the vacuum heat insulating material 400 is arranged so as not to protrude outward with respect to the charging ports 703 and 704 for the heat insulating material such as urethane, which are formed at the left-and-right end portions on the rear side of the refrigerator 1, that is, arranged within a range between the charging port 703 on the left side (one side) and the charging port 704 on the right side (another side), which are arranged on the left and right. The heat insulating material such as urethane, which is charged through the charging ports 703 and 704, is not blocked or hindered from being charged into the heat insulating box body (between the internal box 750 and the external box 710, more specifically, into the lateral walls 790, into the convex portions 450, between the vacuum heat insulating material 400 and the internal box 750, and between the vacuum heat insulating material 400 and the external box 710). Thus, a high-performance heat insulating box body and refrigerator that are not deteriorated in heat insulating performance can be provided.

[0056]

Note that, when the width of the vacuum heat insulating material 400 protrudes outward with respect to the charging ports 703 and 704 for the heat insulating material such as urethane, which are formed at the left-and-right end portions on the rear side of the refrigerator 1 (when positions of the widthwise end portions of the vacuum heat insulating material 400 are located on the outsides with respect to the positions at the left-and-right end portions on the rear side of the refrigerator 1, at which the charging ports 703 and 704 for urethane and the like are arranged), the charging ports 703 and 704 may be closed by the vacuum heat insulating material 400. In order that the vacuum heat insulating material 400 does not close at least the part of the charging ports 703 and 704, the vacuum heat insulating material 400 may have cutout portions 33 such as a cutout and an opening, which are formed at parts to face the charging ports 703 and 704. With this, the vacuum heat insulating material 400 can be increased in width. In this way, the arrangement area of the vacuum heat insulating material 400 can be increased, and hence a ratio of the arrangement area (coverage) of the vacuum heat insulating material relative to the outer surface area of the heat insulating box body or the rear wall of the heat insulating box body can be increased. Thus, the heat insulating performance can be enhanced (for example, refer to Fig. 12 and Fig. 22).

[0057]

In this embodiment, the heat insulating material 701 such as urethane is charged or a separate heat insulating material (insulating material other than urethane) is arranged between the internal box 750 and the external box 710, in which the convex portions are formed (or between the internal box 750 and the vacuum heat insulating material 400), to thereby increase the strength of the heat insulating box body 700. In order to further increase the strength of the heat insulating box body 700, reinforcing members may be arranged in the convex portions 450 (specifically, between the vacuum heat insulating material 400 and the internal box 750, and near the widthwise end portions of the vacuum heat insulating material 400), or may be arranged near the convex portions 450, specifically, on the outside of the convex portions 450 (specifically, in an inside of the internal box 750 or an outside of the internal box 750).

[0058]

When members having lower heat conductivity than members made of metals (such as resin members made of resins) are used as the reinforcing members, there is an advantage in that influence on deterioration in heat insulating performance is reduced. However, also when the peripheries of the reinforcing members are covered with the heat insulating materials, there is an advantage in that the heat insulating performance is not lost even when the members made of metals (such as aluminum and aluminum alloy) are used. The reinforcing members may each have a shape of a bar (such as rod and angular bar), or a pipe shape. Further, the internal box 750 may include ribs as long as the heat insulating box body 700 can be increased in box body strength, specifically, in torsional strength and bending strength. Note that, the pipe 720 accommodating the lead wires such as the control wires and the power wires and a refrigerant pipe 725 may be used also as the reinforcing members. When the pipe 720 and the refrigerant pipe 725 are used also as the reinforcing members, additional reinforcing components can be omitted to reduce cost. In addition, the heat insulating box body can be reinforced, and hence can be increased in box body strength. Further, the reinforcing members may be arranged in the convex portions 450 or in a space between the internal box 750 and the external box 710. With this, the reinforcing members are hidden from users, and hence excellent design properties can be obtained. Thus, a heat insulating box body, a refrigerator, and a device, which are low-cost and excellent in reliability and design property, can be provided.

[0059]

(Use of Concave Portion as Cooling Air Passage (1))

The concave portion 440, in which the internal box 750 and the vacuum heat insulating material 400 are attached directly to each other with the adhesive agent (including self-adhesive foam heat insulating material), is recessed with respect to the convex portions 450 formed at the corner portions between the peripheral walls formed around the concave portion 440 (such as lateral walls 790, top wall 740, or partition walls 24). This concave portion may be used as the cooling air passage 760 (note that, for example, when the storage compartment is the refrigerator compartment 2, the cooling air passage 760 corresponds to the refrigerator compartment cooling air passage 50, when the storage compartment is the switching compartment 4, the cooling air passage 760 corresponds to the switching compartment cooling air passage 16, and when the storage compartment is the vegetable compartment 5, the cooling air passage 760 corresponds to a vegetable compartment cooling air passage).

[0060]

When the concave portion 440 is used as the cooling air passage 760, a U-shaped (or concave) opening portion of the second air passage component 764 is arranged to open to the storage compartment side, and the first air passage component 762 as an air passage cover is arranged to cover the U-shaped opening portion of the second air passage component 764 so that the opening portion of the second air passage component 764 is closed by the first air passage component 762. With this, the cooling air passage 760 can be formed to have a substantially sealed space therein. The first air passage component 762 and the second air passage component 764 are each formed of a heat insulating member such as polystyrene foam and resin. The second air passage component 764 arranged in the concave portion 440 includes an air passage rear member 765 on its rear side, and air passage lateral members 766 on its lateral sides.

[0061]

The internal box 750 forming the concave portion 440 is arranged behind the rear member (air passage rear member 765) of the second air passage component 764. The vacuum heat insulating material 400 is bonded to a part of the internal box 750 corresponding to the rear wall 730 with the adhesive agent, and the convex portions 450 formed of the internal box 750 are arranged on the lateral sides with respect to the lateral members (air passage lateral members 766) of the second air passage component 764. The heat insulating material 701 such as urethane is arranged in the convex portions 450. Thus, the air passage rear member 765 and the air passage lateral members 766 of the second air passage component 764 are capable of securing the heat insulating performance even without heat insulating properties. Specifically, the vacuum heat insulating material 400 arranged in the rear wall 730 secures heat insulating performance on the rear side of the cooling air passage 760, and the heat insulating material 701 in the convex portions 450 secures heat insulating performance on the lateral sides of the cooling air passage 760. Thus, the air passage rear member 765 and the air passage lateral members 766 of the second air passage component 764 may be formed of the heat insulating material such as polystyrene foam, but even when the members are formed of a resin or metal material without heat insulating performance, the heat insulating performance of the cooling air passage 760 can be secured. As a result, the members of the second air passage component 764 may be formed of the heat insulating material such as polystyrene foam having heat insulating properties, but even when the members are formed of the resin or metal material without heat insulating performance, adhesion of dew and the like or dew condensation caused by generation of dew on, for example, the members of the cooling air passage 760 can be suppressed.

[0062]

Further, the first air passage component 762 is formed, for example, of the heat insulating member having heat insulating properties, such as polystyrene foam, or a resin. With this, dew condensation is suppressed so that dew and the like are not adhered or generated on the storage compartment side. In Fig. 4, the first air passage component 762 includes a projecting portion (extending portion) 763 having a width larger than a width in the right-and-left direction of the concave portion 440, or a width in the right-and-left direction of the U-shaped opening portion of the second air passage component 764. The projecting portion (extending portion) 763 closes the opening portion of the second air passage component 764 or the concave portion 440 into a substantially sealed state to form the cooling air passage 760. Further, the projecting portion (extending portion) 763 can be used to fix the first air passage component 762 in a removable manner to the convex portions 450 or the second air passage component 764. Note that, as long as the cooling air passage can be secured by closing the opening portion of the second air passage component 764, the first air passage component 762 need not necessarily close the concave portion 440, and only needs to close the opening portion of the second air passage component. However, when an opening portion of the concave portion 440 is closed, the first air passage component 762 is enhanced in mountability and design property.

[0063]

Note that, the cooling air passage components forming the cooling air passage 760 (such as first air passage component 762 or second air passage component 764) may be used also as reinforcing members for increasing the strength of the box body. When the box body strength or box body rigidity (specifically, torsional strength or bending strength) may be low, the first air passage component 762 or the second air passage component 764 may be used as the reinforcing member to increase the box body strength (box body rigidity). When the first air passage component or the second air passage component 764 is made of a resin, the component may have a predetermined thickness to such an extent that the box body strength can be secured. In order to reduce the thickness, the first air passage component or the second air passage component may be made of a metal having low heat conductivity instead of a resin (specifically, it is preferred that the metal be smaller in heat conductivity and greater in heat insulating performance than, for example, copper and aluminum). Further, the first air passage component 762 or the second air passage component 764 may include widthwise or vertical ribs so that the torsional strength and the bending strength are increased. When the strength or the rigidity of the heat insulating box body 700 does not matter, the second air passage component 764 may be omitted and the concave portion 440 may be used directly as a rear wall and lateral walls of the cooling air passage 760, whereas the first air passage component 762 may be arranged to cover the opening portion of the concave portion 440.

[0064]

When the concave portion 440 is used directly as the rear wall and the lateral walls of the cooling air passage 760, the second air passage component 764 need not be arranged. As a result, the heat insulating box body 700 and the refrigerator 1 are simplified in structure and reduced in cost. In this case, it is only necessary that the first air passage component 762 is arranged to cover the concave portion 440, and that the projecting portion (extending portion) 763 of the first air passage component 762 is fixed in a removable manner to the convex portions 450. When the projecting portion (extending portion) 763 is fixed directly to the convex portions 450, the strength of the box body is increased. When the first air passage component 762 is used as a cover for covering the concave portion 440, the concave portion 440 can be used as the cooling air passage 760. Note that, the rigidity of the first air passage component 762 may be increased by increasing a plate thickness thereof or by forming ribs thereon so that the first air passage component 762 is used as the reinforcing member. Also with this, the strength of the heat insulating box body can be increased.

[0065]

The cooling air passage 760 includes one or more cooling air supply ports (cooling air outlets) 768 through which the cooling air is to be supplied into the storage compartment (such as refrigerator compartment 2 and vegetable compartment 5). The one or more (at least one) cooling air supply ports (cooling air outlets) 768 are formed through the first air passage component 762 or the second air passage component 764 so that the insides of the storage compartments are efficiently cooled. Examples of the cooling air supply ports 768 include lateral air outlets through which the cooling air is to be sent to lateral sides in the storage compartment, front air outlets through which the cooling air is to be sent to the front, lateral front oblique air outlets capable of allowing the cooling air to be sent laterally and obliquely to the front, upward front oblique air outlets capable of allowing the cooling air to be sent upward and obliquely to the front, downward front oblique air outlets capable of allowing the cooling air to be sent downward and obliquely to the front, lateral obliquely upward air outlets capable of allowing the cooling air to be sent laterally and obliquely upward, or lateral obliquely downward air outlets capable of allowing the cooling air to be sent laterally and obliquely downward.

[0066]

In the example described in this embodiment, the vacuum heat insulating material 400 is arranged in the rear wall 730 of the heat insulating box body 700 or on the rear of the refrigerator 1. However, the vacuum heat insulating material 400 may be arranged in the lateral walls 790, the top wall 740, or the bottom wall 780 of the heat insulating box body 700, or in lateral surfaces, the top surface, or the bottom surface of the refrigerator 1. Further, the vacuum heat insulating material 400 may be arranged in the storage compartment door for covering the front opening of the storage compartment (such as refrigerator compartment door 7 and freezer compartment door 11). In this case, the heat insulating performance can be further enhanced.

[0067]

In Fig. 4, the cooling air supply ports (cooling air outlets) 768 are formed through the lateral surfaces of the cooling air passage 760 (lateral surfaces of the first air passage component 762 as a front cover). Around those cooling air supply ports 768, the projecting portion (extending portion) 763 of the first air passage component 762 is arranged on front-side end surfaces 451 of the convex portions 450. Note that, when the cooling air supply ports (cooling air outlets) 768 are formed through the air passage lateral members 766 of the second air passage component 764, the cooling air passage 760 is projected to the front side of the refrigerator 1 with respect to the front-side end surfaces 451 of the convex portions 450 by an amount corresponding to a size of an opening portion of each of the cooling air supply ports (cooling air outlets) 768. Thus, the front-side end surfaces 451 of the convex portions 450 are recessed to the depth side (rearward) with respect to a front-side end surface 769 of the first air passage component 762 as a cover. Concave parts 770 thus recessed to the depth side (spaces between the projecting portion (extending portion) 763 and the lateral walls 790) can be effectively used as housing spaces.

[0068]

In this embodiment, the front-side end surface 769 of the first air passage component 762 as a cover is formed to project to the storage compartment side with respect to the front-side end surfaces 451 of the convex portions 450. Thus, a difference in height (step portions 775) occurs. Those step portions 775 can be used to form the cooling air supply ports (cooling air outlets) 768. Further, when the step portions 775 are formed, the housing spaces for housing items to be stored, such as food, can be secured in the spaces 770 between lateral parts of the step portions 775 (lateral parts of the cooling air supply ports 768) and the lateral walls 790. In this way, when the first air passage component 762 includes the extending portion 763, the step portions 775 can be formed. When the cooling air supply ports (cooling air outlets) 768 are formed through the step portions 775, the items such as food to be housed or stored in the storage spaces that are the spaces 770 formed on lateral sides with respect to the step portions 775 can be efficiently cooled.

[0069]

(Use of Concave Portion as Cooling Air Passage (2))

In the example described above, the concave portion 440 is used as the cooling air passage 760, and the cooling air supply ports (cooling air outlets) 768 are formed through the step portions 775. Alternatively, the steps may be downsized as much as possible to increase the internal capacities of the storage compartments.

[0070]

Fig. 5 is a horizontal sectional view illustrating another refrigerator according to Embodiment 1 of the present invention. The refrigerator in the horizontal sectional view is cut in the plane perpendicular to the vertical direction of the refrigerator 1. In Fig. 5, the parts equivalent to those in Fig. 1 to Fig. 4 are denoted by the same reference symbols to omit description thereof.

[0071]

In Fig. 5, as in Fig. 4, the concave portion 440 is used as the cooling air passage 760.

Specifically, the concave portion 440 is formed of the lateral surfaces 452 of the convex portions 450 and the rear wall 730, and the vacuum heat insulating material 400 having a plate shape is arranged between the part of the internal box 750 corresponding to the inner surface (storage compartment side) of the rear wall 730 and the part of the external box 710 corresponding to the outer surface of the rear wall 730. Note that, although not shown, the vacuum heat insulating material 400 having a plate shape may be arranged also between the other parts of the internal box 750 corresponding to the inner surfaces (storage compartment side) of the lateral walls 790 and the other parts of the external box 710 corresponding to the outer surfaces of the lateral walls 790. The cooling air passage 760 formed in the rear wall 730 or the concave portion 440 includes the first air passage component 762 that is a designed cover member, and the second air passage component 764 having heat insulating properties and being arranged on the rear side (internal box 750 side) of the first air passage component 762. The cooling air passage 760 is arranged in the concave portion 440. The first air passage component 762 as the cover member or the second air passage component 764 includes the mount portions (engaging portions) to be, for example, fitted to or engaged with the mount portions (engaging portions) formed on the convex portions 450 or the rear wall 730 with the fixing members such as screws. With this, the first air passage component 762 or the second air passage component 764 is mounted to the convex portions 450 or the rear wall 730.

The cooling air passage 760 includes the first air passage component 762 as a cover that is arranged to cover the opening portion on the storage compartment side of the second air passage component 764 that is at least partially or entirely received in the concave portion 440, or to cover the opening portion on the storage compartment side of the concave portion 440, and includes the concave portion 440 or the second air passage component 764. The first air passage component 762 is fixed to or held on the front-side end surfaces 451 of the convex portions 450, or the air passage lateral members 766 of the second air passage component 764. In this embodiment, the step portions 775 formed of the extending portion

763 of the first air passage component 762 are small in size, and hence the cooling air supply ports 768 are difficult to form through the step portions 775 formed of lateral surfaces of the extending portion 763 of the first air passage component 762. Thus, the cooling air supply ports (cooling air outlets) 768 are formed only on a front side of the first air passage component 762. However, the projecting portion (extending portion) 763 of the first air passage component 762 can be reduced in thickness, and hence the step portions 775 can be downsized. As a result, the inside of the storage compartment can be extended in the depth direction by the downsizing amount of the step portions 775, and hence the housing capacity in the storage compartment can be increased.

[0072]

Note that, the first air passage component 762 as a cover may be formed into the plate shape as illustrated in Fig. 4 and Fig. 5, or may be formed into a curved-surface shape (such as circular-arc shape or arch shape) to project to the storage compartment side. The curved-surface shape of the first air passage component 762 has an advantage in that the openings of the cooling air supply ports 768 can be directed not only in the front surface direction in the storage compartment, but also in an oblique direction by forming the openings at curved surface parts. The degree of freedom in positioning the cooling air supply ports 768 is increased, and hence the inside of the storage compartment can be thoroughly cooled.

[0073]

The first air passage component 762 may be fixed to or held on the front-side end surfaces 451 of the convex portions 450 or the second air passage component 764, after the second air passage component 764 is fixed to or held on the concave portion 440. Alternatively, under a state in which the second air passage component 764 is fixed to or held on the first air passage component 762 integrally in advance, an assembly of the first air passage component 762 and the second air passage component 764 may be received or arranged in the concave portion 440, and the projecting portion (extending portion) 763 of the first air passage component 762 may be fixed to or held on the convex portions 450 (such as front-side end surfaces 451). With this, the second air passage component 764 under the state of being fixed to or held on the first air passage component 762 to form the cooling air passage 760 can be mounted to the convex portions 450 in the storage compartment, and hence not only assembly but also removal is facilitated (an assembly of the cooling air passage 760 can be formed of the first air passage component 762 and the second air passage component 764). As a result, the assembly of the cooling air passage 760 can be easily mounted in a removable manner to the inside of the storage compartment (specifically, to the convex portions 450).

[0074]

Further, in the concave portion 440 in which the adhesive agent as the first intermediate member intended mainly to perform bonding (including self-adhesive foam heat insulating material) is interposed between the concave portion 440 and the vacuum heat insulating material 400, the adhesive agent as the first intermediate member between the internal box 750 and the vacuum heat insulating material 400 (including self-adhesive foam heat insulating material) is small in thickness. Thus, when the cooling air passage 760 (such as first air passage component, second air passage component 764, or assembly of the first air passage component and the second air passage component) is mounted into the concave portion 440, the vacuum heat insulating material 400 may be damaged, for example, by fixing screws. However, in this embodiment, the cooling air passage 760 is mounted to the convex portions 450. Thus, the cooling air passage 760 need not be mounted into the concave portion 440 at a position of facing the vacuum heat insulating material 400, or in the internal box 750. As a result, the outer wrapping material of the vacuum heat insulating material 400 is not damaged. In this way, a heat insulating box body, a refrigerator, and a device, which are excellent in reliability and less liable to be deteriorated in heat insulating performance or degraded, can be provided.

[0075]

Note that, when the first air passage component 762 of the cooling air passage 760 is mounted to the convex portions 450 to cover the concave portion 440, the cooling air passage 760 can be formed without arranging the second air passage component 764. Thus, a heat insulating box body and a refrigerator, which are reduced in number of components, low-cost, and excellent in assembly efficiency and reliability, can be provided.

[0076]

(Use of Concave Portion as Cooling Air Passage (3))

Fig. 6 is a horizontal sectional view illustrating still another refrigerator according to Embodiment 1 of the present invention. The refrigerator in the horizontal sectional view is cut in the plane perpendicular to the vertical direction of the refrigerator 1. In Fig. 6, the parts equivalent to those in Fig. 1 to Fig. 5 are denoted by the same reference symbols to omit description thereof.

[0077]

In Fig. 6, the concave portion 440 is formed of the lateral surfaces 452 of the convex portions 450 and the rear wall 730, and the vacuum heat insulating material 400 having a plate shape is arranged between the part of the internal box 750 corresponding to the inner surface (storage compartment side) of the rear wall 730 and the part of the external box 710 corresponding to the outer surface of the rear wall 730. Note that, although not shown, the vacuum heat insulating material 400 having a plate shape is arranged also between the other parts of the internal box 750 corresponding to the inner surfaces (storage compartment side) of the lateral walls 790 and the other parts of the external box 710 corresponding to the outer surfaces of the lateral walls 790. The cooling air passage 760 formed in the rear wall 730 or the concave portion 440 includes the first air passage component 762 that is a designed cover member, and the second air passage component 764 having heat insulating properties and being arranged on the rear side (internal box

750 side) of the first air passage component 762. The cooling air passage 760 is arranged in the concave portion 440. The first air passage component 762 as the cover member or the second air passage component 764 includes the mount portions (engaging portions) to be, for example, fitted to or engaged with the mount portions (engaging portions) formed on the rear wall with the fixing members such as screws. With this, the first air passage component 762 or the second air passage component 764 is mounted to the rear wall 730. In Fig. 6, the spaces 770 are formed between the lateral portions (lateral surfaces) 766 of the cooling air passage 760 and the lateral surfaces (lateral parts) 452 of the convex portions 450, and those spaces 770 can be used as the storage spaces. Thus, the housing capacity for items to be housed in the storage compartment (such as refrigerator compartment 2) can be increased.

[0078]

In Fig. 6, the cross-sectional shape of the second air passage component 764 of the cooling air passage 760, which is orthogonal to a flow direction of the cooling air (such as vertical direction of the refrigerator 1), is a U-shape having an opening portion. In the storage compartment of the refrigerator 1, this U-shaped opening portion is arranged to open to the rear of the refrigerator 1 (arranged in the concave portion 440 in the rear surface of the storage compartment). The second air passage component 764 is pressed with the first air passage component 762 so that the U-shaped opening of the second air passage component 764 abuts against a part of the internal box 750 corresponding to the concave portion 440. In this state, the first air passage component 762 is fixed to or held on the convex portions 450. With this, the cooling air passage 760 is formed of the second air passage component 764 and the internal box 750. Note that, when the first air passage component 762 is formed of a member having a heat insulating function (such as polystyrene and porous member), the second air passage component 764 may be omitted. Thus, the cooling air passage 760 can be formed of the first air passage component 762 and the internal box. With this, a low-cost refrigerator and device can be provided. Note that, the cross-section of the second air passage component 764, which is orthogonal to the flow direction of the cooling air, has the U-shaped opening, but need not necessarily be formed into the U-shape as long as the cooling air passage can be formed. Specifically, the cross-sectional shape orthogonal to the flow direction of the cooling air may be an angular shape or an elliptical shape as long as the cooling air passage can be formed therein. The cross-sectional shape of the cooling air passage therein may also be an angular shape or an elliptical shape. When being formed into a circular shape or the elliptical shape, the cooling air passage is reduced in passage resistance and increased in efficiency. Further, a length in the depth direction in the elliptical shape, which is elongated in the width direction, can be set smaller than that in the circular shape. In this way, the amount of projection into the storage compartment can be reduced, and the housing capacity can be increased.

[0079]

Note that, in order to form the cooling air passage 760, the first air passage component 762 or the second air passage component 764 may directly be fixed to or held on the part of the internal box 750 corresponding to the concave portion 440. Alternatively, as illustrated in Fig. 4, the first air passage component 762 may include the projecting portion (extending portion) 763, and the projecting portion 763 may be extended to be longer than that in the case of Fig. 4 so that the projecting portion (extending portion) 763 can be fixed to the convex portions 450 over the spaces 770. In this case, depending on where to fix the projecting portion (extending portion) 763, housing capacities in the spaces 770 may be reduced by the projecting portion 763. As a countermeasure, the projecting portion (extending portion) 763 is extended (over the spaces 770) to a vicinity of the top wall 740 or the bottom wall 780 arranged at the top or bottom of the cooling air passage 760, the partition walls 24 for partitioning the storage compartments from each other, or the shelves 80, and is fixed to or held on the convex portions 450. With this, reduction of the housing capacities can be suppressed (a risk in that a tall item to be housed strikes against the projecting portion (extending portion) 763 so that the item cannot be housed can be reduced).

[0080]

Note that, the components of the cooling air passage 760 (first air passage component or second air passage component) may be directly fixed or held near the top wall 740 or the bottom wall 780 arranged at the top or bottom of the cooling air passage 760, near the partition walls 24 for partitioning the storage compartments from each other, or directly fixed to or held on the lateral walls 790 (specifically, when the projecting portion 763 is arranged at a substantial center in the vertical direction of the spaces 770 or below the substantial center and a tall item to be housed is housed in the spaces 770, the item to be housed may strike against the projecting portion 763 so that the item cannot be housed, and hence, the projecting portion 763 is arranged at positions where the projecting portion 763 is less liable to be an obstacle, specifically, near the top wall 740 (or bottom wall 780 or partition walls 24 for partitioning the storage compartments from each other), with the result that, even when the item to be housed is housed in the spaces 770, the projecting portion 763 is less liable to be an obstacle, and hence the housing capacities can be increased).

[0081]

Further, the first air passage component 762 as a cover for covering at least a part of the rear of the inside of the storage compartment may include an air passage cover portion for forming at least a part of the cooling air passage 760 or covering at least a part of the cooling air passage 760, a rear cover portion extended in the width direction (right-and-left direction or toward the lateral walls 790) from the air passage cover portion to cover at least a part of the rear wall 730 or the concave portion 440, and lateral cover portions connected to the rear cover portion or formed integrally with the rear cover portion to cover at least a part of the lateral walls 790. Further, the rear cover portion may be mounted, specifically, fixed to or held on the part of the internal box 750 corresponding to the rear wall

730, the concave portion 440, or the convex portions 450. Alternatively, the lateral cover portions may be mounted, specifically, fixed to or held on the part of the internal box 750 corresponding to the lateral walls 790 or the convex portions 450. With this, at least the parts of the rear wall 730, the lateral walls 790, and the convex portions 450 can be covered with the first air passage component 762 as a cover. As a result, the design properties can be enhanced, and the assembly efficiency can be enhanced.

[0082]

Further, the first air passage component 762 as a cover for covering at least a part of the rear of the inside of the storage compartment may include the air passage cover portion for forming at least a part of the cooling air passage 760 or covering at least a part of the cooling air passage 760, the rear cover portion extended in the width direction (right-and-left direction or toward the lateral walls 790) from the air passage cover portion to cover at least a part of the rear wall 730 or the concave portion 440, and an upper/lower wall cover portion connected to the air passage cover portion or formed integrally with the air passage cover portion to cover at least a part of the partition walls 24 arranged in the vertical direction of the rear wall 730 (including top wall 740 or bottom wall 780). Further, the rear cover portion may be mounted, specifically, fixed to or held on the part of the internal box 750 corresponding to the rear wall 730, the concave portion 440, or the convex portions 450. Alternatively, the upper/lower wall cover portion may be mounted, specifically, fixed to or held on parts of the internal box 750 corresponding to the partition walls 24 arranged in the vertical direction of the rear wall 730 (including top wall 740 or bottom wall 780). With this, at least the parts of the rear wall 730, the partition walls 24, the top wall 740, and the bottom wall 780 can be covered with the first air passage component 762 as a cover. As a result, the design properties can be enhanced, and the assembly efficiency can be enhanced.

[0083]

In the cooling air passage 760 and the components of the cooling air passage 760 (such as first air passage component or second air passage component), the one or more cooling air supply ports 768 through which the cooling air generated by the cooler 13 and caused to flow, for example, through the cooling air passage 760 is to be supplied into the storage compartments (such as refrigerator compartment 2, vegetable compartment 5, and freezer compartment 6) are formed through the lateral surfaces or a front surface of the cooling air passage 760. Those cooling air supply ports 768 are arranged at positions where housed items or stored items such as food in the storage compartment can be effectively cooled. The cooling air supply ports in the lateral surfaces and the cooling air supply ports in the front surface may be arranged at the same level in the vertical direction. However, when those cooling air supply ports are arranged at different levels, cooling can be performed from the different levels. With this, the housed items or stored items such as food can be thoroughly and efficiently cooled. Further, the cooling air supply ports 768 arranged in the lateral surfaces on the right and left (right lateral surface and left lateral surface) may also be arranged at the same level in the vertical direction. However, when those cooling air supply ports are arranged at different levels, cooling can be performed from the different levels. With this, the housed items or stored items such as food can be thoroughly and efficiently cooled.

[0084]

Note that, a width dimension of the vacuum heat insulating material 400, and a placement position thereof in the heat insulating box body or the refrigerator are the same as those in Fig. 4 and Fig. 5. Specifically, the width in the right-and-left direction of the vacuum heat insulating material 400 arranged in the rear wall 730 of the refrigerator 1 is set smaller than, for example, the width between the storage compartment inner walls 791 and 792 of the lateral walls 790 of the refrigerator 1. With this, the charging passages for the heat insulating material such as urethane to be charged through the charging ports 703 and 704 for the urethane heat insulating material, which are formed on the rear side of the refrigerator 1, are not closed.

[0085]

Note that, it is appropriate to arrange the vacuum heat insulating material 400 at a position where the vacuum heat insulating material 400 does not protrude outward with respect to the charging ports 703 and 704 for the heat insulating material such as urethane, which are formed at the left-and-right end portions on the rear of the refrigerator 1 (for example, at a position where the openings of the charging ports 703 and 704 are not closed, or a position where the heat insulating material such as urethane to flow into the heat insulating box body (specifically, into the lateral walls 790) through the openings of the charging ports 703 and 704 is not blocked or hindered from flowing, for example, into the lateral walls 790 or the rear wall 730). More specifically, the vacuum heat insulating material 400 is arranged at a position on the widthwise central side (inward) with respect to the charging ports on the left and right (left charging port 703 and right charging port 704), or a position where the vacuum heat insulating material 400 does not overlap with the charging ports 703 and 704 in the vertical direction. With this, the heat insulating material such as urethane to be charged into the heat insulating box body through the charging ports 703 and 704 (spaces 315 between the internal box 750 and the external box 710, specifically, the lateral walls 790 and the rear wall 730) is not blocked or hindered from being charged into the heat insulating box body (spaces 315 between the internal box 750 and the external box 710). Thus, deficiency in charging and deficiency in density of the heat insulating material are eliminated. As a result, a high-performance heat insulating box body and refrigerator, which are not deteriorated in heat insulating performance, can be provided.

[0086]

Note that, the concave portion 440 as a direct bonding part, in which the vacuum heat insulating material 400 and the internal box 750 are bonded directly to each other with the adhesive agent intended mainly to perform bonding (including self-adhesive foam heat insulating material), includes step portions 776 formed at reinforcing member interposed parts (such as convex portions 450) charged with the reinforcing member such as rigid urethane and projected by an amount corresponding to a height of projection of the convex portions 450. The concave portion 440 is recessed in the depth direction (rearward) with respect to the convex portions 450. In contrast, the convex portions 450 as the reinforcing member interposed parts are projected forward in the depth direction with respect to the concave portion 440 as the direct bonding part by an amount corresponding to the step portions 776. Further, the concave portion 440 as the direct bonding part, in which the vacuum heat insulating material 400 and the internal box 750 are bonded directly to each other with the adhesive agent such as the self-adhesive foam heat insulating material, includes steps corresponding to a height (thickness) of the cooling air passage 760. The concave portion 440 is recessed in the depth direction (rearward) with respect to the front-side end surface 769 of the cooling air passage 760. In contrast, the front-side end surface 769 of the cooling air passage 760 is projected forward in the depth direction with respect to the direct boding part by an amount corresponding to the steps.

[0087]

As described above, according to this embodiment, the heat insulating box body and devices such as a refrigerator, a cool box, and a showcase, each of which is formed of the internal box 750 and the external box 710, including the vacuum heat insulating material 400 arranged between the internal box 750 and the external box 710, include the direct bonding part (concave portion 440 in Fig. 6) in which the vacuum heat insulating material 400 arranged in the rear wall 730 in a compartment (such as storage compartment) is attached directly to the internal box 750 with the adhesive agent such as the self-adhesive foam heat insulating material, and the reinforcing member interposed parts (convex portions 450 in Fig. 6) in which the heat insulating material such as urethane is interposed as the reinforcing member for increasing the box body strength between the vacuum heat insulating material 400 and the internal box 750. Note that, the vacuum heat insulating material 400 and the external box 710 are attached directly to each other with the second adhesive agent such as a hot melt adhesive and a double-faced adhesive tape. The second adhesive agent such as a hot melt adhesive and a double-faced tape can be applied or attached in advance to the vacuum heat insulating material 400 side or the external box 710 side, and hence has an advantage in that the adhesive agent can be reduced in thickness. However, uneven application, uneven attachment, and the like may occur, and hence it is preferred that the self-adhesive foam heat insulating material be used between the vacuum heat insulating material 400 and the internal box 750.

[0088]

Further, in this embodiment, for example, the reinforcing member interposed parts (such as convex portions 450) and the direct bonding part (such as concave portion 440) are arranged at the same level in the width direction in the storage compartment. The reinforcing member interposed parts (such as convex portions 450) are arranged at the left-and-right end portions in the width direction in the storage compartment, and the direct bonding part (such as concave portion 440) is interposed between the reinforcing member interposed parts on the left and right in a manner of being sandwiched between the reinforcing member interposed parts on the left and right. With this, the convex portions 450 (reinforcing member interposed parts) are formed in the right-and-left direction on the rear of the storage compartment, and the concave portion 440 (direct bonding part) is formed between the convex portions 450. Note that, it is desired that the concave portion 440 and the convex portions 450 be formed over the entire range in the vertical direction in the storage compartment in view of securing the box body strength or the cooling air passage.

[0089]

In this way, at a position of facing the concave portion 440, the vacuum heat insulating material 400 and the external box 710 are directly held in contact with or abutment against each other through intermediation of the second adhesive agent.

Thus, the heat insulating material need not be arranged between the external box 710 and the vacuum heat insulating material 400, and hence the internal capacity of the storage compartment can be increased in comparison with that in the case where the heat insulating material is interposed. Further, at the direct bonding part (such as concave portion 440), the vacuum heat insulating material 400 and the internal box 750 are held in contact with or abutment against each other through intermediation of the adhesive foam adhesive agent. In this embodiment, at the part where the vacuum heat insulating material 400 is arranged (such as concave portion 440), the heat insulating performance and the strength are secured with the vacuum heat insulating material 400. Thus, the heat insulating material intended mainly to perform heat insulation need not be arranged between the internal box 750 and the vacuum heat insulating material 400, and hence the wall thickness can be reduced in comparison with that in the case where the heat insulating material is interposed mainly to perform heat insulation. Therefore, the internal capacity of the storage compartment can be increased. Note that, when the adhesive agent needs to have fluidity, for example, self-adhesive rigid urethane foam may be used and caused to flow in a two-phase state into the spaces 315, followed by foaming. Also in this way, bonding may be achieved.

[0090]

In this embodiment, the concave portion 440 can be used as the cooling air passage 760 through which the cooling air for cooling the inside of the storage compartment is to be sent. Thus, the concave portion 440 on the rear of the storage compartment, which is difficult to reach by a user, can be effectively used. Therefore, the housing capacity in the storage compartment can be efficiently used. Further, when the vacuum heat insulating material 400 having predetermined strength (bending strength or bending strength) is used, and when the convex portions 450 are formed continuously in the vertical direction with a predetermined width in the storage compartment (preferably to such an extent that the torsional strength or the bending strength can be secured), required strengths of the heat insulating box body 700 and the refrigerator 1 can be obtained, and torsional strength and bending strengths in the fore-and-aft direction and in the right-and-left direction can be secured. As a result, the heat insulating box body 700 and the refrigerator 1 that are excellent in reliability can be provided. Note that, as long as the required strengths of the heat insulating box body 700 and the refrigerator 1 are obtained and the torsional strength and the bending strengths in the fore-and-aft direction and in the right-and-left direction can be secured, the convex portions 450 need not be formed continuously in the vertical direction, and may be formed at a single position or intermittently at a plurality of positions.

[0091]

In this embodiment, on the left-and-right end portion sides (widthwise end portion sides) on the rear in the storage compartment, the convex portions 450 formed of the heat insulating material 701 such as urethane are arranged over the vertical direction. Due to the formation of the convex portions 450, the heat insulating box body 700 and the refrigerator 1 are improved in torsional strength and bending strength. With this, a risk in that the heat insulating box body 700 and the refrigerator 1 are deformed to incline the storage compartment doors (such as refrigerator compartment door 7 of a rotary type (hinge type)) arranged in the front of the storage compartments (such as refrigerator compartment 2), a risk in that, for example, one of the side-by-side doors (7A and 7B) on the left and right is inclined and displaced, and other risks can be eliminated. Thus, the storage compartment doors can be smoothly opened and closed. Further, the storage compartment doors on the left and right are not displaced so that excellent external appearance can be maintained. In addition, as for the pull-out doors, a risk in that the heat insulating box body 700 is deformed, for example, to cause inclination or mounting height asymmetry between the left and right of the rails for the pull-out cases, which are fixed to the inner walls 791 and 792 (lateral walls on the left and right) of the storage compartments (such as ice making compartment 3, switching compartment 4, vegetable compartment 5, and freezer compartment 6) can be eliminated. As a result, the cases can be smoothly pushed in and pulled out.

[0092]

Note that, in this embodiment, the vacuum heat insulating material 400 and the heat insulating material such as urethane, which forms the convex portions 450, each need to have predetermined strength. Thus, the vacuum heat insulating material 400 has a bending elastic modulus of 20 MPa or more, and the heat insulating material such as urethane, which forms the convex portions 450, has a bending elastic modulus of 13.0 MPa or more (preferably 15 MPa or more), and has a density of more than 60 kg/m^3 (preferably 62 kg/m^3 or more). Hitherto, the heat insulating material such as urethane is employed to obtain both the box body strength and the heat insulating performance. In view of securing the box body strength, the urethane heat insulating material needs to have a high bending elastic modulus. However, rigid urethane has such properties that, when the bending elastic modulus is increased, the density is increased, and when the density is increased, the heat insulating performance is deteriorated. Therefore, it is difficult to set the bending elastic modulus of urethane to approximately 10 MPa or more so as to obtain predetermined heat insulating performance. As a result, the thickness of urethane cannot be set, for example, to less than approximately 15 mm. Meanwhile, as the thickness of urethane is reduced, the wall thickness can be reduced, which leads to an advantage in that the internal capacity of the storage compartment can be increased. However, as the thickness of urethane is reduced so as to reduce the wall thickness, the density of urethane is increased, and the bending elastic modulus is also increased. With this, the box body strength can be increased. However, when the density is increased, the heat insulating performance is deteriorated. Thus, it is difficult to set the thickness of urethane to less than a predetermined value (specifically, to less than 15 mm).

[0093]

The vacuum heat insulating material 400 used in the present invention has a large bending elastic modulus of 20 MPa or more. Thus, at the part where the vacuum heat insulating material 400 is arranged (box body or walls), both the heat insulating performance and the strength can be secured with the vacuum heat insulating material 400. Also when the heat insulating material such as urethane is charged between the external box and the internal box, at the part where the vacuum heat insulating material is arranged, urethane need not be used as the heat insulating material intended mainly to perform heat insulation, and hence can be used as the adhesive agent. In this way, the heat insulating material such as urethane can be used as the adhesive agent for bonding the vacuum heat insulating material 400 and the internal box 750 to each other, or bonding the vacuum heat insulating material 400 and the external box 710 to each other. Thus, there are no problems even when the thickness of urethane is reduced to deteriorate the heat insulating performance of urethane. Note that, when a coverage of the vacuum heat insulating material 400 (ratio of the arrangement area of the vacuum heat insulating material 400 relative to the surface areas of the heat insulating box body 700 and the doors) or a charging rate of the vacuum heat insulating material 400 (ratio of a volume of the vacuum heat insulating material 400 relative to the spaces 315 between the external box 710 and the internal box 750) is set to a predetermined value or more (specifically, 40% or more), the heat insulating performance and the strength of the heat insulating box body 700 can also be secured even when the vacuum heat insulating material 400 is not partially arranged.

[0094]

Thus, as in this embodiment, at the part between the external box 710 and the internal box 750, such as the concave portion 440, where the vacuum heat insulating material 400 is arranged, when both the strength and the heat insulating performance of the heat insulating box body 700 are secured with the vacuum heat insulating material 400, the rigid urethane foam can be used between the vacuum heat insulating material 400 and the external box 710 or between the vacuum heat insulating material 400 and the internal box 750 as the adhesive agent intended mainly to perform bonding. Thus, the thickness of urethane can be reduced, and hence deterioration in heat insulating performance of urethane need not be taken into consideration. Therefore, even when the heat insulating performance of rigid urethane is deteriorated due to reduction in thickness of the rigid urethane foam, that is, reduction in wall thickness, the heat insulating performance of the box body is exerted by the vacuum heat insulating material 400. Thus, there are no problems. As a result, the internal capacity of the storage compartment can be increased through the reduction in thickness of urethane, that is, reduction in wall thickness. Note that, in any one of the space between the external box 710 and the vacuum heat insulating material 400 and the space between the internal box 750 and the vacuum heat insulating material 400, the wall thickness can be further reduced by using the second adhesive agent such as a hot melt adhesive and a double-faced tape. With this, the internal capacity of the storage compartment can be further increased.

[0095]

Note that, when the thickness of the rigid urethane foam to be used as the adhesive agent between the vacuum heat insulating material 400 and the external box 710 or between the vacuum heat insulating material 400 and the internal box 750 is set to a predetermined value or less, or smaller than the thickness of the vacuum heat insulating material 400, the wall thickness can be further reduced. Thus, the internal capacity of the storage compartment can be further increased. Further, when the thickness of the rigid urethane foam to be used mainly to perform bonding in any one of the space between the vacuum heat insulating material 400 and the external box 710 and the space between the vacuum heat insulating material 400 and the internal box 750 is set smaller than the thickness of the vacuum heat insulating material 400, there is an advantage in that the wall thickness can be reduced. When a sum of the thickness of the rigid urethane foam between the vacuum heat insulating material 400 and the external box 710 and the thickness of the rigid urethane foam between the vacuum heat insulating material 400 and the internal box 750 is set smaller than the thickness of the vacuum heat insulating material 400, the wall thickness can be further reduced. Thus, the internal capacity of the storage compartment can be further increased.

[0096]

In this embodiment, the rigid urethane foam is used as the adhesive agent between the vacuum heat insulating material 400 and the external box 710 or between the vacuum heat insulating material 400 and the internal box 750, and the thickness of urethane is reduced as much as possible. The same rigid urethane foam may be used not only between the vacuum heat insulating material 400 and the external box 710 or between the vacuum heat insulating material 400 and the internal box 750, but also at the parts to be charged only with urethane without the vacuum heat insulating material 400 (insides of the walls). The vacuum heat insulating material 400 is absent at the parts to be charged only with urethane without the vacuum heat insulating material 400 (such as insides of the walls or parts of the insides of the convex portions). Thus, the thickness of rigid urethane can be increased by an amount corresponding to the thickness of the vacuum heat insulating material 400, and hence a heat insulating thickness of urethane can also be increased. In this way, the thickness of urethane at the parts where the vacuum heat insulating material 400 is absent can be set larger than the thickness of urethane to be charged between the vacuum heat insulating material 400 and the external box 710 or between the vacuum heat insulating material 400 and the internal box 750. Thus, the density of urethane at the parts where the vacuum heat insulating material 400 is not arranged can be set lower than the density of urethane at the parts where the vacuum heat insulating material 400 is arranged. Therefore, the heat insulating performance of urethane can be enhanced at the parts where the vacuum heat insulating material 400 is not arranged. In this way, predetermined performance can be secured. Further, at the parts where the vacuum heat insulating material 400 is not arranged, the thickness of urethane can be increased, and hence the box body strength can also be increased. Note that, in this embodiment, in order to satisfy both the box body strength and the heat insulating performance, the coverage of the vacuum heat insulating material 400 (ratio of the arrangement area of the vacuum heat insulating material 400 relative to the surface areas of the heat insulating box body 700 and the doors) or the charging rate of the vacuum heat insulating material 400 (ratio of the volume of the vacuum heat insulating material 400 relative to the spaces 315 between the external box 710 and the internal box 750) is set a predetermined value or more.

[0097]

In this embodiment, the heat insulating performance and the box body strength are secured with the vacuum heat insulating material 400. Thus, the urethane heat insulating material to be used may be reduced in thickness and increased in strength to have the bending elastic modulus of 13.0 MPa or more (preferably 15 MPa or more). Further, the urethane heat insulating material to be used may be increased also in density to more than 60 kg/m^3 (preferably 62 kg/m^3 or more). Thus, urethane can be reduced in thickness, and hence the heat insulating box body 700 can also be reduced in wall thickness. Note that, when the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member is excessively high, there may arise problems of, for example, quality degradation, performance deterioration, and cost increase, specifically, (1) cost may be increased due to increase in injection amount of urethane, (2) leakage of urethane may occur due to increase in injection pressure of urethane, (3) a force of close contact or an adhesive force between urethane and a box body deformation suppressing die set, a box body pressing member, or the like may be increased due to increase in foaming pressure at the time of foaming of urethane, with the result that the box body deformation suppressing die set, the box body pressing member, or the like may be difficult to pull out of the box body (difficult to take out of the box body), and (4) the heat insulating performance may be abruptly deteriorated due to the increase in density of urethane. As a countermeasure, the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member (density after foaming as for the foam heat insulating material) is set to preferably 100 kg/m^3 or less (more preferably 90 kg/m^3 or less).

[0098]

(Cooling Air Passage in Convex Portions)

In the example described above, the concave portion 440 (space on the storage compartment side in the internal box 750) is used as the cooling air passage 760. However, the cooling air passage 760 may be formed in each of the convex portions 450 (spaces between the internal box 750 and the external box 710). Alternatively, the cooling air passage 760 may be additionally formed instead of the convex portions 450. Fig. 7 is a horizontal sectional view illustrating yet another refrigerator according to Embodiment 1 of the present invention. The refrigerator in the horizontal sectional view is cut in the plane perpendicular to the vertical direction of the refrigerator 1. In Fig. 7, the parts equivalent to those in Fig. 1 to Fig. 6 are denoted by the same reference symbols to omit description thereof.

[0099]

In Fig. 7, the concave portion 440 is formed of the lateral surfaces 452 of the convex portions 450 and the rear wall 730, and the vacuum heat insulating material 400 having a plate shape is arranged between the part of the internal box 750 corresponding to the inner surface (storage compartment side) of the rear wall 730 and the part of the external box 710 corresponding to the outer surface of the rear wall 730. Note that, although not shown, the vacuum heat insulating material 400 having a plate shape may be arranged also between the other parts of the internal box 750 corresponding to the inner surfaces (storage compartment side) of the lateral walls 790 and the other parts of the external box 710 corresponding to the outer surfaces of the lateral walls 790. The cooling air passages 760 formed through the convex portions 450 include the first air passage component 762 that is a designed cover member, and the second air passage components 764 having heat insulating properties and being arranged on a rear side (external box 710 side) of the first air passage component 762. The cooling air passages 760 are formed through the convex portions 450. The first air passage component 762 as the cover member or each of the second air passage components 764 includes the mount portions (engaging portions) to be, for example, fitted to or engaged with the mount portions (engaging portions) formed on the rear wall 730 or the lateral walls 790 with the fixing members such as screws. With this, the first air passage component 762 or the second air passage component 764 is fixed to the rear wall 730 or the lateral walls 790.

Note that, one, two, or more convex portions 450 each having the cooling air passage 760 formed therethrough are formed on the widthwise end portion sides on the rear in the storage compartment. The cooling air passage 760 is formed of the second air passage components 764 each formed into a U-shape in cross-section or a substantially rectangular shape in cross-section (or formed of the second air passage components 764 and the vacuum heat insulating material 400), and the convex portions 450 are formed of the second air passage components 764 and the internal box 750 arranged to cover the storage compartment sides of the second air passage components 764. In other words, the cooling air passages 760 are interposed between the vacuum heat insulating material 400 and the internal box 750. The cooling air passages 760 each include the one or more cooling air supply ports 768 through which the cooling air is to be supplied into the storage compartment.

[0100]

Note that, when the cross-sectional shape of the second air passage component 764 is a U-shape having an opening portion, this opening portion is arranged to open to the vacuum heat insulating material 400 side. The cooling air passages 760 are each formed by closing this U-shaped opening portion with the vacuum heat insulating material 400. However, the U-shaped opening portion need not necessarily be arranged to open to the vacuum heat insulating material

400 side, and may be arranged to open to the lateral wall 790 side or to the storage compartment side and closed with the heat insulating material such as polystyrene foam. Also with this, the cooling air passages 760 can be formed. Further, the outer cross-sectional shape of the second air passage component 764 may include any other shape such as a rectangular shape, a circular shape (circular pipe shape), or an elliptical shape as long as the cooling air passage 760 is formed therein. However, the circular shape and the elliptical shape have an advantage in that the passage resistance can be reduced. In comparison with the circular shape, the elliptical shape elongated in the width direction has an advantage in that a height can be reduced. Thus, an effective capacity can be increased, and hence high usability can be achieved. When the outer cross-sectional shape of the second air passage component 764 is a shape having no opening portions other than the cooling air supply ports 768, such as the rectangular shape, the circular shape (circular pipe shape), or the elliptical shape, the cooling air passages 760 may each be formed only of the second air passage component 764.

[0101]

Note that, when the second air passage component 764 of each of the cooling air passages 760 is formed of a member having a cross-sectional shape with predetermined torsional strength or predetermined bending strength (such as U-shape or rectangular, circular (circular-pipe), or elliptical outer shape in cross-section), the convex portions 450 are increased in strength with the cooling air passages 760 formed through the convex portions 450. Thus, the box body strength can be increased. Note that, when the second air passage component 764 is formed of a member having a U-shape in cross-section and the box body is twisted or bent so that the U-shaped opening portion may be expanded or narrowed to cause deficiency in strength, it is appropriate to use a separate member (such as plate-like member, bar-like member, and rib member) to connect ends of the opening portion of the second air passage component 764 so that the opening portion is not expanded or narrowed, and to close the opening portion so that the strength is secured.

[0102]

As described above, in this embodiment, instead of charging the heat insulating material 701 into the convex portions 450, the cooling air passages 760 are formed to function as reinforcing members. Thus, according to this embodiment, the heat insulating box body and devices such as the refrigerator, each of which is formed of the internal box 750 and the external box 710, including the vacuum heat insulating material 400 arranged between the internal box 750 and the external box 710, include the direct bonding part (concave portion 440 in Fig. 7) in which the vacuum heat insulating material 400 on the rear in the storage compartment is attached directly to the internal box 750, for example, with the adhesive agent, and the reinforcing member interposed parts (convex portions 450) in which the cooling air passages 760 are interposed as the reinforcing members for increasing the box body strength between the vacuum heat insulating material 400 and the internal box 750. The reinforcing member interposed parts (convex portions 450) are arranged at the corner portions between the rear wall 730 and the lateral walls 790. Note that, the vacuum heat insulating material 400 and the external box 710 are attached directly to each other with the second adhesive agent such as a hot melt adhesive and a double-faced tape.

[0103]

Note that, the self-adhesive rigid urethane foam may be used as the adhesive agent being the first intermediate member between the vacuum heat insulating material 400 and the internal box 750. When the rigid urethane foam is used as the adhesive agent, the rigid urethane foam need not function as the heat insulating material. Thus, an adhesive agent thickness can be reduced when urethane is used as the adhesive agent. In this case, it is preferred that the thickness of urethane be smaller than the thickness of the vacuum heat insulating material 400, specifically, approximately 11 mm or less. As the adhesive agent thickness is reduced, the wall thickness can be reduced, which leads to the advantage in that the internal capacity of the storage compartment can be increased. Specifically, it is preferred that the adhesive agent thickness be less than 10 mm, more specifically, approximately 6 mm or less. When the adhesive agent thickness is less than 1 mm, concavo-convex portions on the surface of the vacuum heat insulating material 400 partially hinder bonding, which may cause such quality degradation that the internal box 750 peels off from the vacuum heat insulating material 400. Thus, when urethane is used as the adhesive agent, it is preferred that the adhesive agent thickness be 3 mm or more. Further, when the rigid urethane foam is used as the adhesive agent in view of securing the strength, it is preferred that the density thereof be more than 60 kg/m^3. Note that, in order to increase the box body strength, it is preferred that the vacuum heat insulating material 400 have the bending elastic modulus of 13 MPa or more, and that the heat insulating material 701 to be charged into the convex portions 450 have the bending elastic modulus of 13 MPa or more and the density of more than 60 kg/m^3. Note that, when the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member is excessively high, there may arise problems of, for example, quality degradation, performance deterioration, and cost increase, specifically, (1) cost may be increased due to increase in injection amount of urethane, (2) leakage of urethane may occur due to increase in injection pressure of urethane, (3) a force of close contact or an adhesive force between urethane and a box body deformation suppressing die set, a box body pressing member, or the like may be increased due to increase in foaming pressure at the time of foaming of urethane, with the result that the box body deformation suppressing die set, the box body pressing member, or the like may be difficult to pull out of the box body (difficult to take out of the box body), and (4) the heat insulating performance may be abruptly deteriorated due to the increase in density of urethane. As a countermeasure, the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member (density after foaming as for the foam heat insulating material) is set to preferably 100 kg/m^3 or less (more preferably 90 kg/m^3 or less).

[0104]

(Use of Concave Portion as Cooling Air Passage (4))

Next, with reference to Fig. 8 to Fig. 10, description is made of a structure of yet another refrigerator according to Embodiment 1 of the present invention. Fig. 8 is a horizontal sectional view illustrating yet another refrigerator according to Embodiment 1 of the present invention. The refrigerator in the horizontal sectional view is cut in the plane perpendicular to the vertical direction of the refrigerator 1 (the same applies to Fig. 4 to Fig. 7). Fig. 9 is a front view illustrating the refrigerator 1 according to Embodiment 1 of the present invention as viewed from the front side in a state in which the front opening-and-closing doors of the refrigerator 1 are removed, and Fig. 10 is a sectional side view illustrating the refrigerator 1 according to Embodiment 1 of the present invention. In Fig. 8 to Fig. 10, the parts equivalent to those in Fig. 1 to Fig. 7 are denoted by the same reference symbols to omit description thereof.

[0105]

In Fig. 8, the convex portions 450 are each formed into a substantially triangular shape, and the lateral surfaces of the convex portions 450 correspond to oblique sides 456. In each of the convex portions 450, a rear wall-side end portion 798 as one end is connected to the rear wall 730, and a lateral wall-side end portion 797 as another end is connected to the lateral wall 790. The concave portion 440 is formed of the oblique sides 456 corresponding to the lateral surfaces of the convex portions 450 and the rear wall 730, and the vacuum heat insulating material 400 having a plate shape is arranged between the part of the internal box 750 corresponding to the inner surface (storage compartment side) of the rear wall 730 and the part of the external box 710 corresponding to the outer surface of the rear wall 730. Note that, although not shown, the vacuum heat insulating material 400 having a plate shape may be arranged also between the other parts of the internal box 750 corresponding to the inner surfaces (storage compartment side) of the lateral walls 790 and the other parts of the external box 710 corresponding to the outer surfaces of the lateral walls 790. The cooling air passage 760 formed in the rear wall 730 or the concave portion 440 includes the first air passage component 762 that is a designed cover member, and the second air passage component 764 having heat insulating properties and being arranged on the rear side (internal box 750 side) of the first air passage component 762. The cooling air passage 760 is arranged in the concave portion 440. The first air passage component 762 as the cover member or the second air passage component 764 includes the mount portions (engaging portions) to be, for example, fitted to or engaged with the mount portions (engaging portions) formed on the convex portions 450 or the rear wall 730 with the fixing members such as screws. With this, the first air passage component 762 or the second air passage component 764 is mounted to the convex portions 450 or the rear wall 730.

The concave portion 440 is formed on the rear in the storage compartment, and a part in the width direction of the concave portion 440 (for example, substantially central portion in the width direction) is used as the cooling air passage 760. The cooling air passage 760 may be used as the refrigerator compartment cooling air passage 50 through which the cooling air is to be supplied into the refrigerator compartment 2, specifically, as a cooling air passage through which the cooling air is to be supplied into the electrostatic atomizing device (misting device) 200 or the mist is to be supplied from the electrostatic atomizing device 200 into the refrigerator compartment as a storage compartment together with the cooling air. Further, the cooling air passage 760 includes the second air passage component 764 formed at the substantially central portion of the concave portion 440, and the first air passage component 762 as a cover arranged to cover the second air passage component 764. The first air passage component 762 is formed into a U-shape having an opening portion in cross-section, and includes a front surface portion 761 and lateral surface portions 767.

[0106]

The lateral surface portions of the first air passage component 762 (such as air passage cover) are arranged to be held in contact at least partially with fixing protruding portions 910 as protruding portions of the internal box 750, which are projected to the storage compartment side in the concave portion 440. The lateral surface portions or the front surface portion is fixed to or held on the fixing protruding portions 910. In this embodiment, at least parts of inner lateral surfaces of the lateral surface portions of the first air passage component 762 are held in contact with outer lateral surfaces of the protruding portions 910, and the first air passage component 762 is fixed or held with screws, a hooking structure, a fitting structure, or the like. With this, the cooling air passage 760 is formed. Note that, the first air passage component 762, which is formed into a U-shape in cross-section in this case, may be formed into a substantially semicircular shape, a curved surface shape (arch shape), or a substantially V-shape. Further, the first air passage component 762 only needs to be fixed to or held on, for example, the protruding portions 910, the internal box (wall surface) 750 forming the storage compartment, the shelves 80, and the partition walls (such as rear wall 730, lateral walls 790, top wall 740, bottom wall 780, and partition walls 24 between the storage compartments). In addition, the first air passage component 762 may be formed into any shape as long as the cooling air passage 760 can be formed therein.

[0107]

The cooling air passage 760 is connected to the cooler room 131 through intermediation of the refrigerator compartment damper 55 as the airflow rate control unit, and the cooling air generated by the cooler 13 arranged in the cooler room 131 is sent by the cooling air circulation fan (internal fan) 14, which is arranged in the cooler room 131, into the cooling air passage 760 as the refrigerator compartment cooling air passage 50 through the air passage 16 and the refrigerator compartment damper 55 as the airflow rate control unit. The cooling air sent into the cooling air passage 760 is supplied into the storage compartments (such as refrigerator compartment 2) through the cooling air supply ports 768 formed through the first air passage component 762, the second air passage component 764, or the fixing protruding portions 910.

[0108]

In this embodiment, the one or more (at least one) cooling air supply ports (cooling air outlets) 768 leading to the inside of the storage compartment are formed through the front surface portion or the lateral surface portions of the first air passage component 762. When the second air passage component 764 is arranged, the one or more (at least one) cooling air supply ports (cooling air outlets) 768 are formed through a front surface portion, lateral surface portions, or a rear surface portion of the second air passage component 764. In Fig. 8, the cooling air supply port 768 is formed at the front surface portion of the first air passage component 762 to penetrate the front surface portion of the second air passage component 764. However, when the cooling air supply ports 768 are formed at the lateral surface portions of the first air passage component 762 to communicate (or penetrate) the lateral surface portions of the second air passage component 764, the cooling air can be supplied not only through the front surface portion but also through the lateral sides into the storage compartment. Thus, the cooling air can be supplied thoroughly and efficiently. Note that, the cooling air supply port of the first air passage component 762 and the cooling air supply port of the second air passage component 764 need not necessarily be formed at the same position (position where the cooling air supply ports are communicated therebetween), and may be formed at different positions (positions where the cooling air supply ports are not communicated therebetween). Specifically, the cooling air supply port of the first air passage component 762 may be formed in the front, and the cooling air supply port of the second air passage component may be formed at a part that is vertically displaced from the position of the cooling air supply port of the first air passage component (front surface portion and lateral surface portion), or at a position that is different in right-and-left direction therefrom at the same level (lateral surface portion).

[0109]

The front-side end surface 769 of the front surface portion 761 of the first air passage component 762 and the concave portion 440 (rear wall of the storage compartment) are different in height from each other on the storage compartment side (in front direction of the refrigerator 1), and steps (step portions 775) are formed therebetween by an amount corresponding to the difference in height. When the cooling air supply port 768 (such as opening or cutout) is not formed through the step portions 775 (specifically, lateral surface portions 767 of the first air passage component 762 as a member for forming an outer shell of the cooling air passage 760, or protruding portions 910), the front-side end surface 769 of the first air passage component 762 can be downsized (a thickness (height) of projection to the interior side (storage compartment side) can be reduced) by an amount corresponding to the opening or the cutout of the cooling air supply port 768. Thus, the amount of projection of the step portions 775 into the interior side can be reduced. As a result, the inside of the storage compartment can be extended in the depth direction by the downsizing amount of the step portions 775, and hence the housing capacity in the storage compartment can be increased.

[0110]

Note that, the protruding portions 910 are formed in at least two positions in the width direction (right protruding portion and left protruding portion as viewed from the front opening of the refrigerator 1). A space between the protruding portions 910 on the right and left corresponds to a second concave portion 441, and the second concave portion 441 has a vertical groove shape. The protruding portions 910 are formed continuously or intermittently over the vertical direction by projecting a part of the internal box on the rear of the storage compartment, which forms the concave portion 440, toward the storage compartment side (specifically, the protruding portions 910 are formed in at least two positions to extend substantially parallel to each other in the vertical direction so that the groove shape (second concave portion 441) is formed therebetween). Note that, the protruding portions 910 may be formed separately from the internal box 750.

[0111]

Further, through concavo-convex fitting, or by using a hooking structure, screws, or the like, an inner surface side of the lateral surface portions 767 of the first air passage component 762 is held on or fixed to outer surfaces of the protruding portions 910 forming the second concave portion 441 therebetween (outer lateral surfaces of the protruding portions 910 forming the groove shape therebetween). Specifically, concavo-convex fitting structures for holding or fixing the first air passage component 762 through the concavo-convex fitting, or fixing members (or holding unit) including projecting hooking portions to be hooked to concave portions or convex portions so as to hold or fix the first air passage component 762 are provided to the first air passage component 762 and the protruding portions 910. With this, the first air passage component 762 is fixed to or held on the protruding portions 910 forming the second concave portion 441 therebetween (more specifically, the hooking portions are formed on the first air passage component 762, and the concave portions or the convex portions are formed on the protruding portions 910 at positions of facing the hooking portions so that the first air passage component 762 is fixed to or held on the protruding portions 910 with a simple structure for lightly pressing the first air passage component 762 against the protruding portions 910 forming the second concave portion 441 therebetween).

[0112]

In this embodiment, for example, as described above, there is formed a space surrounded by the at least two protruding portions 910 formed over the vertical direction at the substantially widthwise (right-and-left direction) central portion on the rear of the refrigerator 1, the second concave portion (groove shape) 441 formed on the storage compartment side of the rear wall 730, and the first air passage component 762 (such as U-shaped member having a U-shape or curved surface member having an arch shape) (space formed over the vertical direction at the substantially widthwise central portion of the refrigerator 1). The space surrounded by the second concave portion 441 and the first air passage component 762 may be used as the cooling air passage 760. Alternatively, as illustrated in Fig. 8, the second air passage component 764 may be received in the space surrounded by the second concave portion 441 and the first air passage component 762 so that the second air passage component 764 is used as the cooling air passage 760. Note that, the protruding portions 910 or the lateral surface portions 767 of the first air passage component 762 need not necessarily be continuous over the vertical direction as long as the air passage and the cooling air supply ports 768 capable of allowing the cooling air in the air passage to be supplied therethrough into the storage compartment (such as refrigerator compartment 2) can be formed.

[0113]

The plurality of protruding portions 910 may be formed intermittently over the vertical direction of the refrigerator 1 so that protrusion-free portions without protruding portions, which are formed between the plurality of protruding portions formed intermittently over the vertical direction (such as cutout parts formed, for example, by intermittently cutting out the vertical protruding portions), are used as the cooling air supply ports 768 leading to the inside of the storage compartment. In this case, the protrusion-free portions between the plurality of protruding portions formed over the vertical direction in the first air passage component 762 (intermittent cutout parts formed in the vertical protruding portions) may be closed to form the air passage, or the second air passage component 764 may be used to form the air passage. Alternatively, the protruding portions 910 may be used only as fixing portions or holding portions for fixing or holding the first air passage component 762. When the space surrounded by the first air passage component 762 and the second concave portion 441 formed of the two protruding portions 910 arranged on the right and left over the vertical direction of the refrigerator 1 (space formed over the vertical direction of the refrigerator 1) is used directly as the cooling air passage 760, it is preferred that the first air passage component 762 or the protruding portions 910 be formed of a member having heat insulating performance, such as the heat insulating material, so as to prevent dew condensation or increase in temperature of the cooling air in the cooling air passage 760. In this case, it is appropriate to mold the protruding portions 910 to project from the internal box 750 so that the urethane heat insulating material is charged therein.

[0114]

The space surrounded by the first air passage component 762 and the second concave portion 441 formed of the two protruding portions 910 arranged over the vertical direction of the refrigerator 1 (space formed over the vertical direction of the refrigerator 1) may be used directly as the cooling air passage 760. In this space, the second air passage component 764 may be arranged to form the cooling air passage 760. By arranging the second air passage component 764, the second air passage component 764 can be formed of the heat insulating material such as polystyrene foam, and hence the first air passage component 762 or the protruding portions 910 need not necessarily be formed of the member having heat insulating performance, such as the heat insulating material. As a result, the first air passage component 762 or the protruding portions 910 can be simplified in structure. Further, the second air passage component 764 can be formed, for example, of a heat insulating material to be easily processed, such as polystyrene foam and resins. Thus, the second air passage component 764 can be processed or molded to have various cross-sectional shapes (outer cross-sectional shapes) such as a circular shape, an elliptical shape, or a polygonal shape (specifically, triangular shape, quadrangular shape, or hexagonal shape). Further, the air passage can also be formed easily into a cross-sectional shape reduced in air passage resistances such as pressure loss and passage loss in the air passage (specifically, circular shape, elliptical shape elongated in the width direction, or the like). Thus, a heat insulating box body, a refrigerator, and a device, which are excellent in efficiency, can be provided.

[0115]

Under a state in which the second air passage component 764 is fixed to or held on the two protruding portions 910 (may be two or more protruding portions 910) arranged in the width direction, the second air passage component 764 is arranged in the space surrounded by the first air passage component 762 and the second concave portion 441 formed of the internal box 750 and the two protruding portions 910 arranged in the width direction of the refrigerator 1 (the two protruding portions 910 are formed continuously or intermittently over the longitudinal direction) (space formed over the vertical direction of the refrigerator 1). The second air passage component 764 has such an air passage structure that the cooling air passage 760 is formed therein. The air passage in the second air passage component 764 is formed to have an outer cross-sectional shape such as a circular shape, an elliptical shape, or a polygonal shape (specifically, triangular shape, quadrangular shape, or hexagonal shape) so that the cooling air passage 760 is formed therein. The second air passage component may be formed into any shape as long as the cooling air passage 760 can be formed therein. Note that, the cross-sectional shape of the component having the air passage formed therein, such as the first air passage component 962 or the second air passage component 764, refers to a cross-sectional shape in a direction substantially orthogonal to the flow direction of the air or the cooling air.

[0116]

Note that, examples of the outer cross-sectional shape of the cooling air passage 760 to be formed in the second air passage component 764 include a circular shape, an elliptical shape, or a polygonal shape (specifically, triangular shape, quadrangular shape, or hexagonal shape), and the outer cross-sectional shape of the cooling air passage 760 only needs to be equivalent or similar to the cross-sectional shape of the second air passage component 764. However, the outer cross-sectional shape of the cooling air passage 760 may be different from the cross-sectional shape of the second air passage component 764. Specifically, when the outer cross-sectional shape of the second air passage component 764 is a substantially quadrangular shape, the outer cross-sectional shape of the cooling air passage 760 may be a substantially circular shape, an elliptical shape, or a substantially triangular shape. In this way, there are no problems even when the outer cross-sectional shapes are different from each other. However, in the cross-section of the air passage in the second air passage component 764, higher efficiency can be achieved as the passage resistance is lower when the air (cooling air) is caused to flow. Thus, the circular shape and the elliptical shape are preferred to the angular shape, the triangular shape, and other shapes. Further, in comparison with the circular shape, the elliptical shape elongated in the width direction has an advantage in that a height at the time of placement (height of projection into the storage compartment) can be reduced. Thus, a depth dimension in the storage compartment can be increased, and hence high usability can be achieved. In this way, the second air passage component 764 only needs to be capable of forming the cooling air passage therein. Specifically, the cross-sectional shape orthogonal to the flow direction of the cooling air may be, for example, an angular shape or an elliptical shape as long as the cooling air passage 760 can be formed therein. The cross-sectional shape of the cooling air passage 760 therein may also be, for example, an angular shape or an elliptical shape. When being formed into a circular shape or the elliptical shape, the cooling air passage 760 is reduced in passage resistance and increased in efficiency. Further, the length in the depth direction in the elliptical shape, which is elongated in the width direction, can be set smaller than that in the circular shape. In this way, the amount of projection into the storage compartment can be reduced, and the housing capacity can be increased (when the cross-sectional shape of the second air passage component 764 or the cross-sectional shape of the cooling air passage 760 is the elliptical shape, it is preferred that the length in the width direction (major axis direction) be set larger than that in the depth direction (minor axis direction)). Further, when the second air passage component 764 is formed by assembling two, three, or more segments into a single air passage component, there is an advantage in that the second air passage component 764 can be easily processed and assembled. When the cross-sectional shape of the second air passage component 764 or the cross-sectional shape of the cooling air passage 760 is the elliptical shape and the second air passage component 764 is divided into segments, division of the second air passage component 764 into two segments in major axis cross-section provides an advantage in that the processability and the assembly efficiency can be increased.

[0117]

The cooling air (air), which is generated by the cooler 13 as a heat exchanger arranged in the cooler room 131, is caused to flow into the cooling air passage 760, which is formed, for example, in the second air passage component 764, through the cooling air passage 16, the refrigerator compartment damper 55, and the like, and then is supplied into the storage compartment through the cooling air supply ports 768. Further, the space surrounded by the second concave portion 441 and the first air passage component 762 is used as the cooling air passage 760. In this embodiment, the space to be used as the cooling air passage 760 is formed over the vertical direction at the substantially widthwise central portion on the rear of the refrigerator 1. As viewed from the front (front surface) of the refrigerator, the space is formed at one position substantially at the center in the width direction (right-and-left direction) of the refrigerator 1, but need not necessarily be formed at the one position. The space may be formed at two or more positions in the width direction (right-and-left direction) of the refrigerator 1. Further, the space need not necessarily be formed substantially at the central portion, and may be formed on the end side in the width direction.

[0118]

When the space to be used as the cooling air passage 760 is formed at two or more positions, the cooling air passage through which the cooling air generated by the cooler 13 as the heat exchanger in the cooler room 131 is to be supplied into the storage compartments (such as refrigerator compartment 2, vegetable compartment 5, switching compartment 4, and chilled compartments 2X and 2Y), and a mist air passage through which the mist generated by the misting device 200 is to be supplied into the storage compartments (such as refrigerator compartment 2, vegetable compartment 5, switching compartment 4, and chilled compartments 2X and 2Y) need not necessarily be used in common, and may be partitioned from each other. When the air passages are formed independently of each other, cooling air supply (ON/OFF of the cooling air supply or control of a cooling airflow rate) and mist supply (ON/OFF of the mist supply or control of a mist supply rate) can be controlled independently of each other, for example, by the airflow rate control unit. As a matter of course, there are no problems also when the cooling air passage and the mist air passage are used in common.

[0119]

When the second air passage component 764 is arranged, it is appropriate that the second air passage component 764 be fixed to or held on the first air passage component 762. Alternatively, the second air passage component 764 may be held on or fixed to, for example, the protruding portions 910, the internal box 750, the shelves 80, the partition walls 24, or surfaces of the walls (such as rear wall 730, top wall 740, and bottom wall 780). When the second air passage component 764 is fixed to or held on the first air passage component 762 so that the first air passage component 762 and the second air passage component 764 are formed integrally with each other into an air passage assembly, the first air passage component 762 and the second air passage component 764 can be easily mounted to the heat insulating box body 700 or the refrigerator 1, and can also be removed easily. Note that, when the assembly can be formed into such a shape that the second air passage component 764 forms the independent air passages, the second air passage component 764 can be used as the air passage assembly. Thus, the air passage assembly can be removably mounted to the insides of the storage compartments (specifically, protruding portions 910, concave portion 440, second concave portion 441, first air passage component 762, internal box 750, or shelves 80). Further, the cooling air passage 760 need not be formed with the internal box 750 to face the vacuum heat insulating material 400 (part of the internal box corresponding to the concave portion 440 or the second concave portion 441), and hence is simplified in structure. As a result, a low-cost heat insulating box body, refrigerator, and device can be provided.

[0120]

Further, when the first air passage component 762 or the air passage assembly (second air passage component 764 or assembly of the first air passage component 762 and the second air passage component 764) is mounted, for example, to the protruding portions 910, the first air passage component 762, or the shelves 80 in the insides of the storage compartments, the first air passage component 762 or the air passage assembly need not be mounted directly to the internal box 750 at the position of facing the vacuum heat insulating material 400 (concave portion 440 or second concave portion 441). Thus, at the time of mounting the cooling air passage 760, the internal box 750 can be suppressed, for example, from being deformed, flawed, or cracked. As a result, the internal box is suppressed from damaging, for example, the outer wrapping material of the vacuum heat insulating material 400. In this way, a heat insulating box body, a refrigerator, and a device, which are excellent in reliability and less liable to be deteriorated in heat insulating performance or degraded, can be provided.

[0121]

Note that, when the first air passage component 762 of the cooling air passage 760 is formed to cover the concave portion 440 or the second concave portion 441, the cooling air passage 760 can be formed without arranging the second air passage component 764. Thus, a heat insulating box body and a refrigerator, which are reduced in number of components, low-cost, and excellent in assembly efficiency and reliability, can be provided. In this case, it is appropriate that the first air passage component 762 be fixed to or held on, for example, the convex portions 450, the shelves 80, the partition walls 24, or the surfaces of the walls (rear wall 730, lateral walls 790, top wall 740, and bottom wall 780).

[0122]

As viewed from the front side (front surface side) of the refrigerator 1, the convex portion 450 is formed in at least one position (one or more positions) at the corner portions in the width direction on the rear of the storage compartment (end portions on the left and right in the width direction, or end portions in the width direction). In order to increase the box body strength (box body rigidity) such as the torsional strength, the bending strength, or compression strength of the box body, the heat insulating material 701 such as rigid urethane foam is charged and formed between the internal box 750 and the external box 710. In the concave portion 440 or the second concave portion 441, the box body strength is secured by setting the strength of the vacuum heat insulating material 400 to a predetermined value or more (specifically, setting the bending elastic modulus thereof to 20 MPa or more). Thus, the adhesive agent as the first intermediate member intended mainly to perform bonding (such as adhesive foam heat insulating material) is charged between the vacuum heat insulating material 400 and the internal box 750. With the adhesive agent as the first intermediate member, the vacuum heat insulating material 400 and the internal box 750 are bonded, fixed, or firmly attached to each other. Note that, the rigid urethane foam may be used as the adhesive agent being the first intermediate member. In this case, urethane used as the adhesive agent is not used as the heat insulating material intended mainly to perform heat insulation. Thus, urethane can be reduced in thickness. In other words, when urethane is used as the first intermediate member between the vacuum heat insulating material 400 and the internal box 750, urethane need not have high heat insulating performance, and hence may be thin as long as urethane has a predetermined thickness with bonding strength or fixing strength secured to obtain rigidity and strength to such an extent that the heat insulating box body is prevented from being unnecessarily deformed or distorted at the time of bonding. The predetermined thickness in the case where the rigid urethane foam as the first intermediate member is used as the adhesive agent is preferably approximately 11 mm or less (specifically, less than 10 mm), more preferably approximately 6 mm or less. Further, as long as an adhesive force (adhesion performance) of the adhesive agent can be satisfied, the predetermined thickness is preferably as small as possible, specifically, 1 mm or more, preferably approximately 3 mm or more.

[0123]

The horizontal cross-section of the refrigerator 1 is illustrated in Fig. 4 to Fig. 8. At both the end portions in the width direction of the refrigerator 1, the convex portions 450 are formed as projecting portions projecting toward the inside of the storage compartment (front side of the refrigerator 1). In Fig. 4 to Fig. 7, the cross-sectional shape of each of the convex portions 450 (cross-sectional shape of each of the projecting portions except the parts corresponding to the lateral walls 790 and the rear wall in the horizontal cross-section of the refrigerator 1) is the angular shape (rectangular shape). Meanwhile, in Fig. 8, the cross-sectional shape of each of the convex portions 450 (cross-sectional shape of each of the parts projected from the lateral walls 790 and the rear wall 730 into the storage compartment in the horizontal cross-section of the refrigerator 1) is the substantially triangular shape. One end of the oblique side 456 of the triangular shape is connected to the predetermined part (lateral wall-side end portion) 797 on the inner surface of the lateral wall 790, and another end of the oblique side 456 is connected to the predetermined part (rear wall-side end portion) 798 on the inner surface of the rear wall 730. In other words, the one end of the oblique side 456 of the substantially triangular shape is connected to the predetermined part (lateral wall-side end portion) 797 on the inner surface of the lateral wall 790, and the another end is connected to the predetermined part (rear wall-side end portion) 798 on the inner surface of the rear wall 730. Thus, the oblique side portion 456 of the convex portion 450 is projected from the rear wall-side end portion 798 and the lateral wall-side end portion 797 to the compartment interior side. In other words, in the cross-sectional shape of the convex portion 450, the part corresponding to the oblique side 456 of the substantially triangular shape is formed, for example, into a substantially straight shape, a curved shape, or an arch shape over a range of from the predetermined part 797 on the lateral wall 790 to the predetermined part 798 on the rear wall 730 in the internal box 750 in the storage compartment.

[0124]

Thus, when the cross-sectional shape of each of the convex portions 450 is the substantially triangular shape, it is appropriate to set a length of the oblique side 456 of the substantially triangular shape to an extent that predetermined strength is obtained. Unlike the case where the cross-sectional shape of each of the convex portions 450 is the angular shape, the convex portions 450 do not include the corner portions in the case of the substantially triangular shape. Thus, a volume corresponding to the amount of projection into the storage compartment can be reduced. Therefore, the internal capacity of the storage compartment can be increased. In addition, when the convex portions 450 do not include the corner portions, the design properties are also enhanced.

[0125]

Further, in this embodiment, the plurality of protruding portions 910 are formed continuously or intermittently over the vertical direction in the storage compartment to project toward the storage compartment side (front surface side of the refrigerator 1) so that the groove shape (second concave portion) 441 is formed therebetween. With this, the box body strength can be increased. Note that, when the convex portions are each formed into the substantially triangular shape, the concave portion 440, which is formed between the two convex portions 450 on the left and right at the corner portions between the lateral walls 790 on the left and right and the rear wall 730, falls within a range between the predetermined parts 798 on the rear wall (part represented by "W" in Fig. 8), to which the oblique sides 456 of the convex portions 450 on the left and right are respectively connected.

[0126]

In Fig. 4 to Fig. 8, the width in the right-and-left direction of the vacuum heat insulating material 400 arranged in the rear wall 730 of the refrigerator 1 is set substantially equal to the width between the inner walls of the storage compartment (such as refrigerator compartment 2, vegetable compartment 5, and freezer compartment 6) (substantially equal to the distance (length) between the lateral walls 790 on the left and right of the storage compartment). With this, the foam heat insulating material such as urethane can be smoothly charged into the lateral walls 790 through the charging ports 703 and 704 for urethane and the like. Further, the charging ports 703 and 704 through which the foam heat insulating material such as urethane is to be charged into the spaces 315 between the internal box 750 and the external box 710 are not overlapped with the vacuum heat insulating material 400 (the charging ports 703 and 704 are not closed by the vacuum heat insulating material 400). With this, at the time of injecting the foam heat insulating material such as urethane, the vacuum heat insulating material 400 is prevented from closing the charging ports 703 and 704 so that the foam heat insulating material is not hindered from flowing into the lateral walls 790, the top wall 740, the bottom wall 780, and the partition walls 24.

[0127]

Further, in Fig. 4 to Fig. 8, the convex portions 450, which function as the reinforcing members for maintaining or increasing the box body strength, are each used also as an accommodating portion for accommodating, for example, the pipe 720 or the refrigerant pipe 725. Note that, the protruding portions 910 in Fig. 8, which form the second concave portion 441 therebetween, may each be used as the accommodating portion for accommodating, for example, the pipe 720 or the refrigerant pipe 725, or as the reinforcing member by charging the foam heat insulating material or the like. One of the convex portion 450 and the protruding portion 910 may be used as the accommodating portion for accommodating, for example, the pipe 720 or the refrigerant pipe 725, or both the convex portion 450 and the protruding portion 910 may be used as the accommodating portion for accommodating, for example, the pipe 720 or the refrigerant pipe 725. In this way, when the convex portion 450 or the protruding portion 910 is used as the accommodating portion for accommodating, for example, the pipe 720 or the refrigerant pipe 725, or used as the box body reinforcing portion, the accommodating portion for accommodating, for example, the pipe 720 or the refrigerant pipe 725 need not be additionally arranged. With this, a heat insulating box body, a refrigerator, a device, and the like, which are simple in structure, low-cost, and excellent in strength, can be provided.

[0128]

The convex portions 450 are formed at the corner portions on the end sides in the width direction on the rear of the storage compartment (at the corner on one side or the corners on both sides). The one end of each of the convex portions 450 in the width direction of the storage compartment is connected to the predetermined part (lateral wall depthwise end portion 797) on the lateral wall 790 of the storage compartment, and the another end in the width direction thereof is connected to the predetermined part (rear wall widthwise end portion 798) on the rear wall 730, where the convex portion 450 is overlapped with the vacuum heat insulating material 400 by the predetermined length X in the width direction. The foam heat insulating material such as rigid urethane is charged into the convex portions 450. In this way, when the convex portion 450 is extended to a position where the convex portion 450 is partially overlapped with the vacuum heat insulating material 400 in the width direction of the vacuum heat insulating material 400 (position of the overlapping length X), the vacuum heat insulating material 400 is formed integrally with urethane in the lateral wall 790 through intermediation of urethane in the convex portion 450. With this, the lateral walls 790 and the rear wall 730 are formed firmly integrally with the vacuum heat insulating material 400 and rigid urethane. As a result, the strength of the box body 700 is increased. This structure can be easily obtained by charging and foaming the rigid urethane foam not only in the lateral wall 790 but also in the space between the vacuum heat insulating material 400 and the internal box 750. Note that, the convex portions 450 are formed at the corner portions as the reinforcing members by molding the internal box 750 into an angular shape, a rectangular shape, a substantially triangular shape, a circular-arc shape, or an arch shape in cross-section so that the internal box 750 is projected into the storage compartment, and by charging or placing, for example, the rigid urethane foam between the internal box 750 and the external box 710 that form the convex portions 450 therebetween. Further, the filler to be charged into the spaces between the external box 710 and the internal box 750, such as urethane, is determined in consideration of, for example, the heat insulating performance of the heat insulating box body 700 at the parts where the vacuum heat insulating material 400 is arranged and the parts where the vacuum heat insulating material 400 is not arranged, the bonding strengths of the internal box 750, the vacuum heat insulating material 400, and the external box 710, and the strength (rigidity) of the heat insulating box body 700. In this embodiment, the rigid urethane foam is used as the filler.

[0129]

The one end on the rear wall 730 side of each of the convex portions 450 as high-strength portions (reinforcing portions) is formed to overlap with the vacuum heat insulating material 400 by the predetermined length (overlapping length) X. Thus, the vacuum heat insulating material 400 and the internal box 750 are firmly bonded to each other with the rigid urethane foam charged into the convex portions 450, and the vacuum heat insulating material 400 is firmly connected also to the lateral walls 790 through intermediation of urethane. Further, the convex portions 450 projected into the storage compartment are formed at the corner portions in the width direction on the rear of the storage compartment. With this, even when the rigid urethane foam is reduced in thickness at the concave portion 440 corresponding to the part where the vacuum heat insulating material 400 is arranged, deterioration in heat insulating performance can be suppressed.

Further, the box body strength is increased by the convex portions 450 and the vacuum heat insulating material 400. In addition, also on the wall surfaces in which the vacuum heat insulating material 400 is not arranged (such as lateral walls 790 and partition walls 24), when the arrangement area or the arrangement volume of the vacuum heat insulating material is increased (the coverage or the charging rate of the vacuum heat insulating material is increased), the heat insulating performance of the heat insulating box body can be secured also on the wall surfaces in which the vacuum heat insulating material 400 is not arranged. Further, the convex portions 450 are extended to the positions where the convex portions 450 are overlapped with the vacuum heat insulating material 400 in the width direction, and hence the vacuum heat insulating material 400, the lateral walls 790, and the concave portions (440 and 441) on the rear wall can be formed (or molded) integrally with each other. Thus, the box body strength can be increased.

[0130]

Further, the pipe 720 accommodating the lead wires such as the control wires and the power wires and the refrigerant pipe 725 may be arranged through the convex portions 450. In this case, the box body strength is increased by the convex portions 450, and in addition, the pipe 720 and the refrigerant pipe 725 can also be used as the reinforcing members for increasing the box body strength. Thus, additional reinforcing components for increasing the box body strength can be omitted to reduce cost. In addition, the heat insulating box body 700 can be reinforced, and hence can be increased in box body strength. Further, the reinforcing members may be arranged through the convex portions 450, and hence the design properties are enhanced. Thus, a heat insulating box body and a refrigerator, which are low-cost and excellent in reliability and design property, can be provided.

[0131]

Note that, as the predetermined widthwise overlapping length X between the convex portion 450 and the vacuum heat insulating material 400 is increased, a length (or firm-attachment area) that allows rigid urethane in the convex portion 450 and the vacuum heat insulating material 400 to be firmly attached to (or held on) each other is increased. With this, the box body strength can be increased. However, when the predetermined length X is excessively large, the amount of projection of the convex portion 450 into the storage compartment (volume of projection into the storage compartment) is increased. As a result, the internal capacity of the storage compartment is reduced, and hence the predetermined length X is preferably 200 mm or less, more preferably 180 mm or less. Meanwhile, when the predetermined widthwise overlapping length X between the convex portion 450 and the vacuum heat insulating material 400 is excessively small, the vacuum heat insulating material 400 and rigid urethane in the convex portion 450 cannot be firmly attached to each other sufficiently. As a result, the box body strength is reduced. Specifically, when the overlapping length X between the filler such as rigid urethane and the vacuum heat insulating material 400 is less than 30 mm, heat leakage along the surface of the vacuum heat insulating material 400 is increased. Specifically, when the length X of the part where the filler such as rigid urethane is overlapped with the vacuum heat insulating material 400 is less than 30 mm, heat leakage by heat bridge from a surface on the internal box 750 side (storage compartment side) to a surface on the external box 710 side (rear side) of the vacuum heat insulating material 400 is increased. As a result, the heat insulating performance is deteriorated. For this reason, the length X is preferably 30 mm or more, more preferably 40 mm or more. Thus, the overlapping length X between the vacuum heat insulating material 400 and the convex portion 450 is preferably 30 mm or more (more preferably 40 mm or more) at a lower limit thereof, and 200 mm or less (more preferably 180 mm or less) at an upper limit thereof. In other words, the overlapping length X is preferably approximately 1/3 or less of the distance between the lateral walls 790 of the heat insulating box body 700 (distance between the storage compartment inner walls 791 and 792) (assuming that an outer width of the refrigerator 1 is approximately 600 mm and the thickness of each of the lateral walls 790 is 30 mm, the distance between the inner walls of the lateral walls 790 is approximately 540 mm, and hence the overlapping length X is preferably 1/3 or less of 540 mm, that is, approximately 180 mm or less).

[0132]

In the example described in this embodiment, the vacuum heat insulating material 400 is arranged in the rear wall, but may be arranged in the lateral walls 790, or may be arranged both in the rear wall and the lateral walls 790. In this case, also on the lateral wall side, for the same reason as that for the rear wall side, the overlapping length between the vacuum heat insulating material 400 and the convex portion 450 is preferably 30 mm or more (more preferably 40 mm or more) at a lower limit thereof, and 200 mm or less (more preferably 180 mm or less) at an upper limit thereof. (The overlapping length between the vacuum heat insulating material 400 and the convex portion 450 is desirably set to a first predetermined value or more (for example, 30 mm or more, preferably 40 mm or more) and a second predetermined value or less (for example, approximately 1/3 or less of the width of the vacuum heat insulating material 400) relative to the width of the vacuum heat insulating material 400. When the first predetermined value is less than 30 mm, the length X of the overlapping part between the filler such as rigid urethane and the vacuum heat insulating material 400 is reduced to increase the heat leakage by the heat bridge from the surface on the internal box side (storage compartment side) to the surface on the external box side (rear side) of the vacuum heat insulating material 400. As a result, the heat insulating performance is deteriorated. In addition, the overlapping length between the convex portion and the vacuum heat insulating material 400 is excessively small, and hence the box body strength is reduced. For those reasons, the first predetermined value is preferably 30 mm or more (more preferably 40 mm or more). Further, when the second predetermined value exceeds 1/3 of the width of the vacuum heat insulating material 400, the width of the concave portion 440 or the second concave portion 441 is reduced. As a result, a predetermined size of the cooling air passage 760 cannot be secured. For this reason, the second predetermined value is preferably 1/3 or less of the width of the vacuum heat insulating material 400.)

[0133]

Note that, the vacuum heat insulating material 400 may be arranged in the top wall 740, the bottom wall 780, or the partition walls 24 for partitioning the storage compartments from each other, and the convex portions 450 may be formed at the corner portions. An overlapping length between the vacuum heat insulating material 400 and the convex portion formed at the corner portion between the rear wall 730 and the top wall 740, an overlapping length between the vacuum heat insulating material 400 and the convex portion formed at the corner portion between the rear wall 730 and the bottom wall 780, an overlapping length between the vacuum heat insulating material 400 and the convex portion formed at the corner portion between the rear wall 730 and the partition wall 24, or an overlapping length between the vacuum heat insulating material 400 and the convex portion formed at the corner portion between the lateral wall 790 and the top wall 740 is preferably, as described above, 30 mm or more (more preferably 40 mm or more) at a lower limit thereof, and 200 mm or less (more preferably 180 mm or less) at an upper limit thereof.

[0134]

As described above, the widthwise length X of the overlapping part between the one end of the convex portion 450 as a high-strength portion and the vacuum heat insulating material 400 is set within the predetermined range. With this, without impairing the box body strength or the heat insulating performance, the concave portion 440 formed between the convex portions 450 on the left and right, or the space 770 formed between the convex portion 450 and the second concave portion (space 770 between the protruding portion 910 and the convex portion 450) can be enlarged. Thus, while securing predetermined box body strength and predetermined heat insulating performance, the compartment internal capacity can be increased. With this, the spaces 770 as stored item housing spaces for food and the like can be enlarged, and hence the internal housing capacity of the storage compartment can be increased. In this way, a user-friendly refrigerator and device can be provided.

[0135]

In this embodiment, the vacuum heat insulating material 400 is arranged also in the front opening-and-closing door of the storage compartment (such as refrigerator compartment door 7). The vacuum heat insulating material 400 is attached directly to a door inner plate and a door outer plate of a door outer shell with the adhesive agent. In this case, rigid urethane may be used as the adhesive agent. In this case, urethane is not used as the heat insulating material, and hence need not have high heat insulating performance as long as urethane has a predetermined thickness with predetermined bonding strength secured at the time of bonding. The predetermined thickness of the adhesive agent is preferably approximately 11 mm or less, more preferably approximately 6 mm or less. Further, as long as the adhesive force (adhesion performance) of the adhesive agent can be satisfied, the predetermined thickness is preferably as small as possible, specifically, 1 mm or more, preferably approximately 3 mm or more. Note that, the strength of the refrigerator compartment door 7 (specifically, torsional strength or bending strength) is secured with the strength (rigidity) of the vacuum heat insulating material 400, and hence the door strength need not be secured with the foam heat insulating material unlike the related art. Therefore, as described above, urethane may be used as the adhesive material as long as the predetermined thickness of the adhesive agent can be secured. Thus, a thickness of the door can be reduced. As a result, the compartment internal capacity can be increased in accordance therewith. Note that, also when a glass plate member is arranged on the front side of the storage compartment doors 7, 8, 9, 10, and 11 such as the refrigerator compartment door 7, and the adhesive agent (such as rigid urethane foam) is used as the intermediate member between the glass plate member and the vacuum heat insulating material, the predetermined thickness of the adhesive agent is preferably approximately 11 mm or less (specifically, less than 10 mm), more preferably approximately 6 mm or less. Further, as long as the adhesive force (adhesion performance) of the adhesive agent can be satisfied, the predetermined thickness is preferably as small as possible, specifically, 1 mm or more, preferably approximately 3 mm or more.

[0136]

Note that, as in the cases of Fig. 4 to Fig. 7, the first air passage component 762 as a cover member for covering at least a part of the rear of the inside of the storage compartment or the second concave portion 441 may include the air passage cover portion for forming at least a part of the cooling air passage 760 or covering at least a part of the cooling air passage 760, the rear cover portion extended in the width direction (right-and-left direction or toward the lateral walls 790) from the air passage cover portion to cover at least a part of the rear wall 730 or the concave portion 440, and the lateral cover portions connected to the rear cover portion or formed integrally with the rear cover portion to cover at least a part of the lateral walls 790. Further, the rear cover portion may be mounted, specifically, fixed to or held on the part of the internal box 750 corresponding to the rear wall 730, the concave portion 440, or the convex portions 450. Alternatively, the lateral cover portions may be mounted, specifically, fixed to or held on the part of the internal box 750 corresponding to the lateral walls 790 or the convex portions 450. With this, at least the parts of the rear wall 730, the lateral walls 790, and the convex portions 450 can be covered with the first air passage component 762 as a cover. As a result, the design properties can be enhanced, and the assembly efficiency can be enhanced.

[0137]

Further, the first air passage component 762 as a cover member for covering at least a part of the rear of the inside of the storage compartment may include the air passage cover portion for forming at least a part of the cooling air passage 760 or covering at least a part of the cooling air passage 760, the rear cover portion extended in the width direction (right-and-left direction or toward the lateral walls 790) from the air passage cover portion to cover at least a part of the rear wall 730 or the concave portion 440, and an upper/lower wall cover portion connected to the air passage cover portion or formed integrally with the air passage cover portion in a manner of being extended forward from an upper end portion or a lower end portion of the rear wall 730 to cover at least a part of the partition walls 24 arranged in the vertical direction of the rear wall 730 (including top wall 740 or bottom wall 780). Further, the rear cover portion may be mounted, specifically, fixed to or held on the part of the internal box 750 corresponding to the rear wall 730, the concave portion 440, or the convex portions 450. Alternatively, the upper/lower wall cover portion may be mounted, specifically, fixed to or held on the parts of the internal box 750 corresponding to the partition walls 24 arranged in the vertical direction of the rear wall 730 (including top wall 740 or bottom wall 780). With this, at least the parts of the rear wall 730, the partition walls 24, the top wall 730, and the bottom wall 780 can be covered with the first air passage component 762 as a cover. As a result, the design properties can be enhanced, and the assembly efficiency can be enhanced.

[0138]

In Fig. 9 and Fig. 10, in the uppermost stage of the refrigerator 1, the refrigerator compartment 2 is arranged as a side-by-side (or open-and-close type) storage compartment. Under the refrigerator compartment 2, the ice making compartment 3 and the switching compartment 4 are arranged as storage compartments parallel to each other on the left and right. In the lowermost stage of the refrigerator 1, the vegetable compartment 5 is arranged as a storage compartment, and the freezer compartment 6 is arranged as a storage compartment above the vegetable compartment 5. The freezer compartment 6 is arranged under the ice making compartment 3 and the switching compartment 4 arranged parallel to each other on the left and right, and above the vegetable compartment 5. In other words, the arrangement of the storage compartments is of what is called a mid-freezer type in which the freezer compartment 6 is arranged between the vegetable compartment 5 and each of the ice making compartment 3 and the switching compartment 4 arranged parallel to each other on the left and right.

[0139]

The inside of the refrigerator compartment 2 as a storage compartment serves as a stored item housing space 21 for housing items to be stored (such as food and drink). In the stored item housing space 21, the plurality of shelves 80, which are made of a resin or glass, are arranged so that the stored items are put thereon. On a lower side of the stored item housing space 21 (below the internal shelve in the lowermost stage), there are arranged the substantially sealed containers 2X and 2Y to be used respectively as the chilled compartment 2Y that is controlled to fall within a chilled temperature range of from approximately +3 degrees C to -3 degrees C, and the vegetable compartment 2X that is controlled to fall within a vegetable compartment temperature range, specifically, maintained within a range of from approximately +3 degrees C to +5 degrees C. The substantially sealed containers 2X and 2Y may each be used as an egg compartment for storing eggs. Further, the substantially sealed containers 2X and 2Y each have, for example, a pull-out structure so that the stored items can be taken in and out by pulling out the containers.

[0140]

The structures of the substantially sealed containers 2X and 2Y are formed by providing removable lids to upper surface opening portions of containers each opened on its upper side. Those lids may be arranged on the container side, or may be arranged on the shelf 80 or a partition wall arranged above the containers. Alternatively, the shelf and the partition wall themselves above the containers may be used also as the lids.

[0141]

This embodiment employs the mid-freezer type in which the freezer compartment 6 is arranged between the vegetable compartment 5 and each of the ice making compartment 3 and the switching compartment 4 arranged parallel to each other on the left and right. With this, the low-temperature compartments (such as ice making compartment 3, switching compartment 4, and freezer compartment 6) are arranged close to each other, and hence the heat insulating materials need not be arranged between those low-temperature compartments. Further, heat leakage is reduced. Thus, an energy-efficient refrigerator can be provided at low cost.

[0142]

Further, similarly to Fig. 1, in the front-side opening portion of the refrigerator compartment 2 as a storage compartment, there is arranged the side-by-side refrigerator compartment door 7 that can be freely opened and closed. The side-by-side refrigerator compartment door 7 includes two doors of the left refrigerator compartment door 7A and the right refrigerator compartment door 7B. As a matter of course, a single rotary door may be employed instead of the side-by-side doors. For other storage compartments, specifically, the ice making compartment 3, the switching compartment 4, the vegetable compartment 5, and the freezer compartment 6, there are respectively arranged the pull-out type ice making compartment door 8 capable of freely opening and closing the opening portion of the ice making compartment 3, the pull-out type switching compartment door 9 capable of freely opening and closing the opening portion of the switching compartment 4, the pull-out type vegetable compartment door 10 capable of freely opening and closing the opening portion of the vegetable compartment 5, and the pull-out type freezer compartment door 11 capable of freely opening and closing the opening portion of the freezer compartment 6.

[0143]

Further, the operation switches for performing, for example, temperature setting in the storage compartments (compartment selection switch 60a, temperature range changeover switch 60b, instant freezing switch 60c, ice making changeover switch 60d, mist supply switch 60e, and other functional switches (such as eco-mode switch, advice switch for offering energy-saving advice, and Internet setting/connection switch for establishing connection to the Internet and performing setting thereof)) and the operation panel 60 for displaying temperature information such as internal temperatures and preset temperatures are installed to any one of the left refrigerator compartment door 7A and the right refrigerator compartment door 7B on the left and right of the refrigerator compartment 2 as a storage compartment. Operation information from the operation switches, information to be displayed on the liquid crystal display unit, information of temperatures in the storage compartments, and other information are controlled by the controller 30 including the control board having the microcomputer and the like mounted thereto. The controller 30 is arranged in a control board room 31 on an upper portion on the rear of the refrigerator (refrigerator compartment rear wall) or a top surface of the refrigerator (such as refrigerator compartment upper wall or top wall).

[0144]

Further, the controller 30 includes a transmitting-and-receiving unit such as an antenna. The transmitting-and-receiving unit is provided to the controller (control board) 30, the control board room 31, the upper portion of the refrigerator 1 (preferably near the controller 30 or in the control board room 31), the rear surface of the refrigerator 1 (preferably near the controller 30 or in the control board room 31), or the lateral surface of the refrigerator 1 (preferably near the controller 30 or in the control board room 31). With this, via infrared connection, wireless connection, or wired connection (such as connection via lamp lines, Internet link connection, local area network (LAN) connection, or universal serial bus (USB) connection), the controller 30 is capable of transmitting and receiving device information to and from external devices arranged on the outside of the refrigerator 1. Note that, examples of the devices external to the refrigerator 1 include an external server, a mobile terminal (such as mobile phone, personal digital assistant, or mobile personal computer), and external devices of other types (such as air conditioner, television set, other refrigerator, hot water supplier, illumination device, or washing machine). Further, examples of the device information include device information of the refrigerator 1 (such as internal temperature, power consumption, operation history, total operating time, operation information of the compressor (ON, OFF, rotation speed, and electric current information)), information other than that of the refrigerator 1 (such as weather forecast, disaster information (including earthquake information)), and information of operating conditions of other devices connected to the network, power consumption of those devices, and the like.

[0145]

Specifically, the refrigerator 1 includes a time measuring unit for measuring an operating time, and a storage unit for storing the measured operating time or the total operating time. Information of a standard use period (standard use time) preset as device information and information of the total operating time are transmitted to an external server (such as cloud server). With this, when a proportion (ratio) of an actual total operating period (total operating time) relative to the standard use period and the actual total operating period (total operating time) relative to the standard use period exceed a predetermined ratio that is set in advance, a message for prompting replacement purchase can be received and displayed, for example, on the operation panel 60 and the mobile terminal or announced by voice. Further, also in the external devices, when the proportion (ratio) of the actual total operating period (total operating time) relative to the standard use period and the actual total operating period (total operating time) relative to the standard use period exceed the predetermined ratio that is set in advance, the message for prompting replacement purchase can be received and displayed, for example, on the operation panel 60 and the mobile terminal or announced by voice.

[0146]

Further, the transmitting-and-receiving unit enables transmission and reception of information of external environment (such as weather forecast, disaster information, earthquake information, and temperature information), information of the external devices (such as information of operating conditions of other external devices and information of power consumption of those devices), and electric power. Thus, by receiving information from the server and the external devices, energy-efficient control can be performed, or the information of the other devices can be displayed. In addition, by operating the operation panel 60 installed to the front opening-and-closing door of the refrigerator 1 or the external mobile terminal, the information of the refrigerator 1 can be transmitted to the external server or the other devices. Further, the information can be received from the external server or the other devices and displayed, for example, on the operation panel 60 and the mobile terminal, and the devices such as the refrigerator can be operated.

[0147]

Further, in the devices such as the refrigerator and the showcase, when the insides of the storage compartments are cooled to a predetermined temperature (specifically, to -18 degrees C in the case of the freezer compartment) and then operations of the compressor 12 and the cooling air circulation fan 14 are stopped, temperatures in the storage compartments are increased along with the elapse of time. Thus, when the time measuring unit and a temperature measuring unit are provided, information of the temperatures in the storage compartments, such as degrees of temperature increase in the storage compartments with respect to an elapsed time period under predetermined conditions such as a state in which the operation of the compressor 12 or the cooling air circulation fan 14 is stopped after the temperatures in the storage compartments are lowered to a predetermined temperature prior to start of use by a user, specifically, at the time of shipment from a factory, or a state in which the dampers 15 and 55 are closed, or differences between temperatures in the storage compartments at the start of measurement (predetermined temperatures) and temperatures in the storage compartments after a predetermined time period (for example, 10 minutes) can be stored in advance as initial temperature information in the storage unit of the controller 30. When this information is transmitted as the device information from the storage unit of the controller 30 to, for example, the external server and stored in the external server, it can be determined whether or not the heat insulating performance has been deteriorated or abnormality has occurred. In this way, the message for prompting the user to make replacement purchase can be displayed, for example, on the mobile terminal or a display device in the operation panel 60.

[0148]

Specifically, the information of the temperatures in the storage compartments, such as the degrees of temperature increase in the storage compartments with respect to an elapsed time period under the predetermined conditions such as the state in which the operation of the compressor 12 or the cooling air circulation fan 14 is stopped after the temperatures in the storage compartments are lowered to a predetermined temperature prior to the start of use by the user, specifically, at the time of shipment from a factory, or the state in which the switching compartment dampers 15 and 55 are closed (degrees of initial temperature increase), or the differences between the temperatures in the storage compartments at the start of measurement (predetermined temperatures) and the temperatures in the storage compartments after a predetermined time period (for example, 10 minutes) (differences from initial temperatures) is stored in advance as initial temperature information of each of the storage compartments in the storage unit of the controller 30. After the start of use by the user, this information is transmitted as the device information to the external devices such as the server and stored in the external devices. Then, the degrees of temperature increase or the differences of the temperatures in the storage compartments are periodically measured under the same conditions as the initial conditions, and are transmitted to the external devices such as the external server as the device information. When a result of comparison between the device information and the initial temperature information in the external device such as the server falls within a tolerance, a main body of the device such as the refrigerator receives a signal indicating "NO ABNORMALITY." When the result of the comparison between the device information and the initial temperature information falls out of the tolerance, the main body of the device such as the refrigerator or the mobile terminal receives a signal indicating "ABNORMALITY OCCURRED." After receiving the signal, the main body of the device or the mobile terminal may display a message for notifying the abnormality such as the deterioration in heat insulating performance, or the message for prompting replacement purchase.

[0149]

Further, electric power can be supplied by operating the operation panel 60 installed to the front opening-and-closing door of the refrigerator 1 or the external mobile terminal. Alternatively, electric power can be automatically supplied to the external devices by the controller 30 of the refrigerator 1. Still alternatively, electric power can be supplied by switching to electric power supply from external power sources (devices capable of supplying electric power, such as a photovoltaic power generator, a rechargeable battery, and a fuel cell) or electric power supply from the external devices. In particular, even when electric power supply to the refrigerator 1 is stopped due to a power failure or the like, electric power can be supplied to the refrigerator 1 by switching the power source from the lamp line to the external power source through operation of the mobile terminal, the personal computer, or the like. Thus, when the refrigerator 1 (or device connected to the network) includes connection terminals connectable to mobile devices such as the mobile phone and the mobile terminal, the personal computer, and the like, the mobile devices such as the mobile phone and the mobile terminal, the personal computer, and the like can be recharged. Further, the information of the other devices and the external information, which are stored in the mobile devices such as the mobile phone and the mobile terminal, the personal computer, and the like, can be displayed or operated.

In addition, when the refrigerator 1 includes a body portion formed of the internal box 750 and the external box 710 with the housing spaces (such as storage compartments 2, 3, 4, 5, and 6) each having the opening portion formed on the front side, and the doors (such as 7, 8. 9, 10, and 11) for closing the opening portions formed on the front side of the housing spaces in a freely openable and closable manner, the transmitting-and-receiving unit capable of transmitting and receiving information such as the temperature information and device control information, and transmitting electric power may be provided to each of the body portion and the doors so that the information and the electric power can be transmitted and received between the body portion and the doors via wireless connection or infrared connection. In this way, the doors and the body portion need not be connected to each other in a wired manner. With this, at the time of transporting the refrigerator, for example, into a room through a narrow entrance (such as hall of a house with a narrow frontage), the doors can be removed from the body portion. In this way, the refrigerator can be installed to the house with a narrow frontage. Further, also at the time of shipment from a factory, the doors and the body portion can be packaged separately from each other. With this, weight reduction can be achieved so that the doors and the body portion can be easily transported. In addition, even when the doors and the body portion are separate from each other, electric power can be transmitted and received between the doors and the body portion. With this, an operation power source of the operation panel provided on the front side of the door can be secured. Further, device information, and operation signals and control signals of the devices can be transmitted and received between the doors and the body portion. Thus, by operating the operation panel of the door, activation, stoppage, and other operations of controlling devices in the body portion (such as compressor 12, fan 14, and dampers 15 and 55) can be performed.

[0150]

The compressor 12 is arranged in the machine room 1A formed in the lowermost portion on the rear (or upper portion on the rear) of the refrigerator 1. The refrigerator 1 includes the refrigeration cycle. The compressor 12, which is arranged in the machine room 1A, serves as one of the components of the refrigeration cycle, specifically, has the function to compress refrigerant in the refrigeration cycle. The refrigerant compressed by the compressor 12 is condensed by the condensor (not shown). Under the condensed state, the refrigerant is decompressed by the capillary tube (not shown) or the expansion valve (not shown) as the decompression device. The cooler 13, which serves as another of the components of the refrigeration cycle of the refrigerator, is arranged in the cooler room 131 formed in the rear wall of the refrigerator compartment 2, the ice making compartment 3, the switching compartment 4, the vegetable compartment 5, or the freezer compartment 6. The refrigerant decompressed by the decompression device is evaporated by the cooler 13, and gas around the cooler 13 is cooled by the endothermic effect at the time of the evaporation. The cooling air circulation fan (internal fan) 14, which is arranged near the cooler 13 in the cooler room 131, is configured to send the cooling air generated by cooling around the cooler 13 to each of the compartments as the plurality of storage compartments of the refrigerator 1 (refrigerator compartment 2, ice making compartment 3, switching compartment 4, vegetable compartment 5, and freezer compartment 6) through the cooling air passages (such as cooling air passage 16 or refrigerator compartment cooling air passage 50 or 760).

[0151]

Further, similarly to Fig. 1, the defrost heater 150 as the defrosting unit for defrosting the cooler 13 is arranged under the cooler 13 arranged in the cooler room 131. Above the defrost heater 150, the heater roof 151 is arranged between the cooler 13 and the defrost heater 150 so that defrost water does not directly drop from the cooler 13 onto the defrost heater 150.

[0152]

Note that, examples of the defrost heater 150 may include an inlaid heater that is integrally assembled into the cooler 13. Further, the glass tube heater and the inlaid heater may be used together. The defrost water generated around the cooler 13 or the defrost water that has dropped onto the heater roof 151 drops in the cooler room 131 and is drained to the outside of the refrigerator (such as evaporating dish arranged in the machine room 1A) through a defrost water drain port 155 that is formed on a lower side in the cooler room 131.

[0153]

The switching compartment damper 15 as the airflow rate control unit is configured, for example, to control the rate of the cooling air to be sent into the switching compartment 4 as a storage compartment by the cooling air circulation fan 14, to control the temperature in the switching compartment 4 to a predetermined temperature, and to switch the preset temperature of the switching compartment 4. The cooling air generated by cooling around the cooler 13 is sent into the switching compartment 4 through the cooling air passage 16. Further, the cooling air passage 16 is arranged on the downstream side in the switching compartment damper 15.

[0154]

Further, the refrigerator compartment damper 55 as the airflow rate control unit is also configured, for example, to control the rate of the cooling air to be sent into the refrigerator compartment 2 as a storage compartment by the cooling air circulation fan 14, to control the temperature in the refrigerator compartment 2 to a predetermined temperature, and to change the preset temperature of the refrigerator compartment 2. The cooling air generated by cooling around the cooler 13 is sent into the refrigerator compartment 2 through the cooling air passage 16 and the cooling air passage 50 or 760.

[0155]

Of the storage compartments, for example, the switching compartment 4 is a compartment (storage compartment) in which the temperature in the storage compartment can be selected from a plurality of levels between the freezing temperature range (-17 degrees C or less) and the vegetable compartment temperature range (3 degrees C to 10 degrees C). The temperature in the storage compartment is selected or switched by operating the operation panel 60 installed to any one of the left refrigerator compartment door 7A and the right refrigerator compartment door 7B of the refrigerator 1, or operating the external mobile terminal.

[0156]

Further, the switching compartment thermistor 19 (equivalent to that of Fig. 3) as the first temperature detecting unit for detecting the air temperature in the switching compartment 4 is installed, for example, on the depth-side wall surface of the switching compartment 4. The thermopile 22 (or infrared sensor, equivalent to that of Fig. 3) as the second temperature detecting unit for directly detecting the surface temperatures of stored items put in the switching compartment 4 as a storage compartment is installed, for example, on the ceiling surface (central portion, front surface portion, rear surface portion, or the like) of the switching compartment 4. The controller 30 controls the switching compartment damper 15 to open and close in accordance with the temperature detected by the switching compartment thermistor 19 as the first temperature detecting unit (or temperature detected by the thermopile 22) so that the temperature in the switching compartment 4 is adjusted to fall within a selected temperature range, or to fall within a preset temperature range. Further, the temperatures of food items as stored items in the switching compartment 4 are detected directly by the thermopile 22 as the second temperature detecting unit.

[0157]

(Misting Device 200)

The electrostatic atomizing device 200 as the misting device 200 for supplying mist into a storage compartment is arranged in the partition wall 51 (rear wall 730, or first air passage component 762 as the air passage cover) on the depth side (rear side) of the storage compartment (such as refrigerator compartment 2), a partition wall behind a container rear wall of the substantially sealed container (such as substantially sealed container 2X or 2Y) arranged on the lower portion of the stored item housing space 21 in the storage compartment (such as refrigerator compartment 2)), or a rear partition wall or the upper partition wall 24 of the storage compartment (such as vegetable compartment 5).

[0158]

The misting device 200 includes at least a discharge electrode. Water is supplied to the discharge electrode, or the discharge electrode is controlled to generate water, and then voltage is applied to the discharge electrode. In this way, mist is generated by the discharge electrode. In order to supply water to the discharge electrode, a radiation unit may be cooled to generate dew condensation water around the discharge electrode that is thermally connected to the radiation unit. Alternatively, when the radiation unit and the discharge electrode are not thermally connected to each other, the dew condensation water to be generated by cooling the radiation unit may be supplied to the discharge electrode (the discharge electrode may serve also as an endothermic unit, and in this case, the radiation unit is thermally connected to the discharge electrode, and the dew condensation water may be generated around the discharge electrode by cooling the radiation unit). Still alternatively, the misting device 200 may include at least the discharge electrode and an electrode holding portion for holding or accommodating the discharge electrode, and mist may be generated by applying voltage to the discharge electrode. When a water supply unit for supplying water to the discharge electrode is arranged, mist may be generated by supplying water from the water supply unit to the discharge electrode, and then applying voltage to the discharge electrode. Note that, examples of the water supply unit include a water storage tank capable of storing water, and a heat exchanger (such as cooler 13). When the cooler 13 serves as the water supply unit, defrost water to be generated by the cooler 13 may be received and accumulated in a container 152 arranged in the cooler room 131, and the water in the container may be supplied to the discharge electrode, for example, by a capillary phenomenon. Note that, mist can be stably generated by using a counter electrode, but the counter electrode need not necessarily be arranged and aerial discharge may be performed.

[0159]

Note that, the discharge electrode is arranged in the storage compartment (such as refrigerator compartment 2). When the cooling air passage is formed through the partition wall having the misting device 200 installed therein, it is appropriate that the radiation unit be arranged in direct contact with an air passage wall of the cooling air passage (such as cooling air passage 16, 50, or 760) formed through the partition wall (rear surface, upper surface, lower surface, or lateral surface) of the storage compartment, or in indirect contact therewith through intermediation of a heat conduction member, or be arranged to project into the cooling air passage through the air passage wall. With this, the radiation unit is cooled by cooling air in the cooling air passage, and dew condensation water is generated around the discharge electrode that is thermally connected to the radiation unit. Then, voltage is applied to the discharge electrode to generate mist.

[0160]

The radiation unit may be cooled by using cooling air in another adjacent storage compartment (such as freezer compartment 6) that is arranged on an opposite side of a storage compartment (such as vegetable compartment 5), in which the misting device 200 is arranged, with respect to the partition wall of the storage compartment (upper surface, lower surface, or lateral surface). In this case, it is appropriate that the radiation unit be arranged on the storage compartment side so as to be held in contact with the bottom wall or the upper wall of the another storage compartment (such as freezer compartment). (The misting device 200 may be arranged in any compartment as long as the compartment is a storage compartment. Specifically, the misting device 200 may be arranged in any storage compartment or container such as the refrigerator compartment 2, the vegetable compartment 5, or the chilled compartment 2X or 2Y. When the misting device 200 is arranged in the rear wall, the misting device 200 may be arranged in a partition wall as a part of the rear wall arranged between the storage compartment and the cooler room. (The misting device 200 may be arranged on a high-temperature storage compartment side of a partition plate between two adjacent storage compartments that are different in temperature (for example, between the vegetable compartment 5 as a storage compartment on a high-temperature side and the freezer compartment 6 as an adjacent storage compartment on a low-temperature side). One end of the radiation unit (end portion on the opposite side of the discharge electrode) may be arranged in contact with a partition plate of another storage compartment so that the radiation unit is cooled by using low-temperature cooling air in the storage compartment on the low-temperature side (by using a temperature difference between the storage compartment on the high-temperature side and the storage compartment on the low-temperature side).)

[0161]

As illustrated in Fig. 10, the vacuum heat insulating materials 400 are arranged in the rear surface, the upper surface, and the bottom surface of the refrigerator 1. Further, although not shown, the vacuum heat insulating materials 400 are arranged also in the lateral walls, the partition walls 24, and the doors. As described with reference to Fig. 8, at least within the range of the concave portion 440, the vacuum heat insulating material 400 arranged in the rear surface is attached directly to the external box 710 and the internal box 750 with the foam heat insulating material as the adhesive agent intended mainly to perform bonding. As the adhesive agent, it is appropriate to use adhesive rigid urethane foam. When the rigid urethane foam is used, through appropriate adjustment of free foam density, the rigid urethane foam can be charged thoroughly and uniformly even in narrow passages (such as space between the vacuum heat insulating material 400 and the internal box 750). Further, the rigid urethane foam can perform bonding even in the narrow passages, and hence is suited to use as the adhesive agent. For this reason, the rigid urethane foam is used as the adhesive agent.

[0162]

When the rigid urethane foam is used for the main purpose as the adhesive agent, deterioration in heat insulating performance due to reduction in thickness of the rigid urethane foam need not be taken into consideration. Thus, the thickness of the rigid urethane foam can be reduced to a predetermined thickness or smaller. As a result, the wall surface (such as rear wall) can be reduced in thickness, and the internal capacity of the storage compartment can be increased. The predetermined thickness of the rigid urethane foam to be used as the adhesive agent is preferably approximately 11 mm or less (for example, preferably less than 10 mm), more preferably approximately 6 mm or less. Further, as long as the adhesive force (adhesion performance) of the adhesive agent can be satisfied, the thickness is preferably as small as possible, specifically, approximately a predetermined thickness or larger (for example, 1 mm or more, preferably 3 mm). For example, when the thickness is set to less than 1 mm, surface roughness of the vacuum heat insulating material 400 (concavo-convex portions of the outer wrapping material) cannot be eliminated by the thickness of the adhesive agent. The convex portions on the surface of the vacuum heat insulating material 400 are held in direct contact with the internal box 750, and hence bonding cannot be partially performed. As a result, the bonding strength may be deteriorated. In this way, when the rigid urethane foam is used as the adhesive material and is excessively thin, the bonding strength may be deteriorated, and hence the predetermined thickness or larger is preferred.

[0163]

As a matter of course, when the rigid urethane foam is used as the adhesive agent, the heat insulating performance can be obtained to some extent, that is, the heat insulating performance of the heat insulating material can be obtained though the heat insulating performance is inferior to that of the vacuum heat insulating material 400. Specifically, when the rigid urethane foam is used as the adhesive agent at the time of bonding the vacuum heat insulating material 400 to, for example, the external box 710 or the internal box 750, not only the heat insulating effect by the vacuum heat insulating material 400 but also the heat insulating effect by urethane can be obtained. Further, at the parts between the internal box 750 and the external box 710 where the vacuum heat insulating material 400 is not arranged, the thickness of the rigid urethane foam can be increased by an amount corresponding to absence of the vacuum heat insulating material 400. Thus, the heat insulating performance can be enhanced. Further, the self-adhesive rigid urethane foam can be used as the adhesive agent between the internal box 750 and the external box 710. With this, the box body strength of the heat insulating box body 700 can be increased, and the heat insulating performance can also be enhanced.

[0164]

The cooling air generated by the cooler 13 arranged in the cooler room 131 is sent by the cooling air circulation fan 14 to flow through the cooling air passage 16, the refrigerator compartment damper 55 as the airflow rate control unit, and the refrigerator compartment cooling air passage 760 formed in the second air passage component, to thereby be supplied into the refrigerator compartment 2 (also into the substantially sealed containers 2X and 2Y) through the cooling air supply ports 768 formed through the first air passage component 762. After cooling the inside of the refrigerator compartment 2 as a storage compartment, the cooling air is returned into the cooler room 131 through a refrigerator-compartment returning air passage 410. A part of the cooling air in this refrigerator-compartment returning air passage 410 may be supplied into the vegetable compartment 5. In this case, after cooling the inside of the vegetable compartment 5, the cooling air is returned into the cooler room 131 through a vegetable-compartment returning air 430. The vegetable compartment 5 may be cooled by the returning cooling air that is supplied under a state of being increased in temperature as a result of cooling other storage compartments such as the refrigerator compartment 2 and the switching compartment 4, or may be cooled directly by the cooling air generated by the cooler 13 in the cooler room 131.

[0165]

Through the operation of the cooling air circulation fan 14, the cooling air is supplied into the ice making compartment 3 or the switching compartment 4 from the cooler 13 arranged in the cooler room 131 through the cooling air passage 16, the switching compartment damper 15 as an airflow rate control device, and a switching-compartment cooling air passage 17, and is returned into the cooler room 131 through an ice making-compartment returning air passage (not shown) or a switching-compartment returning air passage (not shown). The cooling air is supplied into the freezer compartment 6 from the cooler 13 arranged in the cooler room 131 through the cooling air passage 16 and a freezer-compartment cooling air passage 18, and is returned into the cooler room 131 through a freezer-compartment returning air passage 420.

[0166]

Note that, the misting device 200 for supplying mist into the storage compartment may be energized or stopped simultaneously with, at a different timing from, or in conjunction with ON or OFF of the cooling air circulation fan 14. Further, when supplying mist into the plurality of storage compartments, mist supply may be switched between first storage compartments (such as vegetable compartment 5 and refrigerator compartment 2) and second storage compartments (such as refrigerator compartment 2, freezer compartment 6, vegetable compartment 5, and switching compartment 4) by using damper devices (such as switching compartment damper 15, refrigerator compartment damper 55, vegetable compartment damper, and freezer compartment damper). Specifically, in a case where the misting device 200 is arranged to be at least partially received in a concave portion of an upper partition wall of the first storage compartment (such as vegetable compartment) and a mist supply air passage communicating to this concave portion is formed through the same partition wall, when the vegetable compartment damper is opened, mist in the concave portion is supplied into the second storage compartment (such as refrigerator compartment) through the mist supply air passage in the partition wall, a first cooling air passage (such as vegetable-compartment returning air passage), the cooler room, and a second cooling air passage. When the vegetable compartment damper is closed, the cooling air is not supplied into the vegetable compartment. Thus, it is appropriate to cause the mist in the concave portion to be supplied into the first storage compartment (such as vegetable compartment) by gravity. In this case, the cooling air passage 760 formed on the rear of the refrigerator compartment 2 may serve as the second cooling air passage. Further, the mist supply into the first storage compartment and the mist supply into the second storage compartment may be switched in conjunction with opening and closing of the damper devices, or in conjunction with ON and OFF of the cooling air circulation fan 14 instead of the damper devices.

[0167]

Further, cooling air containing mist by being mixed with the cooling air in the concave portion may be supplied into the first storage compartment, and a part of the cooling air containing the mist, which is supplied into the first storage compartment, may be returned into the cooler room through the air passage (such as returning air passage to the cooler room) formed through the partition wall (such as upper partition wall and lateral partition wall). Then, the cooling air containing the mist may be supplied into the second storage compartment through the cooler room.) The air passage, which is formed through the partition wall, may be formed of a cover that is arranged to cover the concave portion for receiving at least a part or entirety of the misting device 200 (atomizing device), formed of a separate member, or may be formed in an inside of the partition wall. Note that, it is appropriate to form at least one of a cooling air inlet or a cooling air outlet through the cover.

[0168]

(Wide Gap Semiconductor)

The controller 30, which is arranged in the control board room 31, includes semiconductor components such as a switching element and a diode element. Wide band gap semiconductors are used at least as a part of the semiconductor components of an inverter drive circuit and the like. Further, the controller 30 may include only the semiconductor components (may include only the wide band gap semiconductors), or may include not only the semiconductor components but also, for example, control-related components (for example, at least one of a transformer, a relay, a converter, a power source reactor, a capacitor, or a current detecting component).

[0169]

In this embodiment, the wide band gap semiconductors are used as the semiconductor components to be mounted to the controller 30 (such as semiconductors for the inverter drive circuit for driving and controlling, for example, the compressor 12, the compressor cooling fan, and the cooling air circulation fan 14). Hitherto, as the semiconductor components to be mounted to the controller 30, such as the components of the inverter drive circuit, silicon (Si)-based semiconductors have been generally used. In this embodiment, the wide band gap semiconductors are used instead. The wide band gap semiconductors are made of, for example, silicon carbide (SiC), gallium nitride (GaN), diamond, aluminum gallium nitride (AlGaN).

[0170]

The wide band gap semiconductors (such as silicon carbide SiC, gallium nitride, and gallium nitride (GaN)) have the following two advantages over the silicon (Si) semiconductors. The first advantage is that the wide band gap semiconductors are small in element loss, and can be operated under high temperature. Si generates a large amount of heat, and semiconductor performance is deteriorated and operational difficulties occur at temperatures of from approximately 100 degrees C to 200 degrees C. Therefore, heat radiation fins (radiator) need to be provided so as to further radiate heat via the air. Thus, the capacity of accommodating the fins to be mounted and heat radiation spaces need to be secured. Meanwhile, elements of the wide band gap semiconductors (such as SiC) are small in switching loss and excellent in energy efficiency, and performance deterioration is less liable to occur at temperatures up to approximately 300 degrees C. Thus, the elements of the wide band gap semiconductors can be used in a high-temperature atmosphere such as the machine room 1A. Further, the performance deterioration is less liable to occur at the temperatures up to approximately 300 degrees C, and hence there is an advantage in that the heat radiation fins can be omitted or considerably downsized (reduced in height or size).

[0171]

The second advantage is that devices being the semiconductor components can be reduced in thickness. The wide band gap semiconductors (such as SiC and GaN) have high breakdown field intensity, and hence have high semiconductor withstand voltage (have withstand voltage approximately ten times as high as that of silicon (Si)). Thus, the semiconductor devices can be reduced in thickness (thinned) to approximately 1/10. In this embodiment, the wide band bap semiconductors having such characteristics are used, and hence the components of the inverter drive circuit can be significantly reduced in size and height, and can be used irrespective of heat radiation environment. Thus, a refrigerator having a high degree of freedom in design, a small size, and excellent quality in high-temperature environment can be provided.

[0172]

The wide band gap semiconductors, which have high breakdown electrolytic intensity and high withstand voltage, are used as the semiconductor components to be mounted to the controller 30, such as the components of the inverter drive circuit. Thus, the semiconductor components can be reduced in thickness and size (to approximately 1/10 of silicon). Further, the wide band gap semiconductors can be operated even at a high temperature of 300 degrees C, and hence the heat radiation fins (radiator) for cooling the semiconductor components can be significantly downsized. In this way, in this embodiment, the wide band gap semiconductors are used as the semiconductor components being the components of the inverter drive circuit having a radiator that is significantly larger in height in the related art than, for example, other control-related components under a state in which the radiator is mounted to the controller 30. With this, a total size or height of the radiator and the components of the inverter drive circuit (vertical or horizontal width) can be significantly reduced (reduced in height and size). Thus, heights of the semiconductor components under the state of being mounted to the controller 30 can be reduced to be equivalent to or smaller than heights of the other control-related components (such as power source reactor, capacitor, transformer, or current detecting component).

[0173]

Note that, also at the part where the control board room 31 is arranged, it is appropriate to attach the vacuum heat insulating material 400 directly to the external box 710 or the control board room 31 with the adhesive agent, and to charge rigid urethane foam as the adhesive agent between the vacuum heat insulating material 400 and the internal box 750 so as to be set to a predetermined thickness (for example, to 1 mm or more, preferably 3 mm or more, and 11 mm or less, preferably 6 mm or less).

[0174]

Further, in the structure of this embodiment, the control board room 31 is arranged at the top of the refrigerator 1, and heat insulation therearound is performed by the vacuum heat insulating material 400. When the wide band gap semiconductors are used as the semiconductor components being the components of the inverter drive circuit or the like, there are no problems even when the periphery of the control board room 31 is covered with the vacuum heat insulating material 400 or the urethane heat insulating material and the inside of the control board room 31 enters high-temperature environment. Further, when the wide band gap semiconductors are used as the semiconductor components being the components of the inverter drive circuit or the like, the control board room 31 may be arranged in the machine room 1A that enters high-temperature environment. In comparison with the related-art Si semiconductors, the wide band gap semiconductor is less liable to cause malfunction and is operable even in high-temperature environment. Thus, there are no problems even when the control board room 31 is covered with the heat insulating material. Further, also when the control board room 31 is arranged in the machine room 1A that enters high-temperature environment, heat insulation need not be performed so as not to increase the temperature in the control board room 31 by arranging the heat insulating material or the like around the control board room 31. Thus, the specifications of the control board room can be simplified so that a low-cost compressor and device can be provided. Further, heat insulation of the control board room 31 need not be performed, and hence the control board room 31 can be downsized, specifically, reduced in height (or in width or depth) by an amount corresponding to the thickness of the heat insulating material. Thus, when the vacuum heat insulating material 400 and the control board room 31, and the vacuum heat insulating material 400 and the internal box 750 are bonded directly to each other with the adhesive agent, urethane need not be charged as the heat insulating material. As a result, the wall surface in which the control board room 31 is arranged (such as upper wall and rear wall), can be reduced in wall surface thickness, and in accordance therewith, the internal capacity of the storage compartment (compartment internal capacity) can be increased.

[0175]

Further, the control board room 31 can be installed in spaces around the compressor 12 (such as a space above or aside of (or spaces around) a terminal box of the compressor 12) unlike the related art in which the control board room 31 cannot be installed in those spaces. Thus, the degree of freedom in installing the control board room 31 (degree of freedom in design) is increased. In this way, a refrigerator and a device such as an air-conditioning device, in which the space, for example, in the machine room 1A can be effectively used, can be provided.

[0176]

(Use of Defrost Heater and Defrost Water)

The compressor 12 is arranged in the machine room 1A formed in the lowermost portion on the rear (or uppermost portion on the rear) of the refrigerator 1. The refrigerator 1 includes the refrigeration cycle. The compressor 12, which is arranged in the machine room 1A, serves as one of the components of the refrigeration cycle, specifically, has the function to compress refrigerant in the refrigeration cycle. The refrigerant compressed by the compressor 12 is condensed by the condensor (not shown). Under the condensed state, the refrigerant is decompressed by the capillary tube (not shown) or the expansion valve (not shown) as the decompression device. The cooler 13, which serves as another of the components of the refrigeration cycle of the refrigerator, is arranged in the cooler room 131. The refrigerant decompressed by the decompression device is evaporated by the cooler 13, and gas around the cooler 13 is cooled by the endothermic effect at the time of the evaporation. The cooling air circulation fan 14, which is arranged near the cooler 13 in the cooler room 131, is configured to send the cooling air generated by cooling around the cooler 13 to each of the compartments as the storage compartments of the refrigerator 1 (refrigerator compartment 2, ice making compartment 3, switching compartment 4, vegetable compartment 5, and freezer compartment 6) through the cooling air passages (such as switching compartment cooling air passage 16 or refrigerator compartment cooling air passage 50).

[0177]

The defrost heater 150 as the defrosting unit for defrosting the cooler 13 (such as defrosting glass tube heater, specifically, carbon heater using, in a silica glass tube, carbon fibers for emitting light having a wavelength of from 0.2 μm to 4 μm, which is transmitted through the silica glass tube) is arranged under the cooler 13 arranged in the cooler room 131. Above the defrost heater 150, the heater roof 151 is arranged between the cooler 13 and the defrost heater 150 so that defrost water does not directly drop from the cooler 13 onto the defrost heater 150. When a black medium heater such as the carbon heater is used as the defrost heater 150, frost over the cooler 13 can be efficiently molten by radiant heat transfer. Thus, the surface temperature thereof can be set to a low temperature (approximately 70 degrees C to 80 degrees C). With this, even when flammable refrigerant (such as isobutane being hydrocarbon refrigerant) is used as refrigerant to be used in the refrigeration cycle and refrigerant leakage and the like occur, a risk of ignition can be reduced. Further, the frost over the cooler 13 can be more efficiently molten by radiant heat transfer in comparison with that by a nichrome wire heater, and hence the frost formed over the cooler 13 is gradually molten and is less liable to drop in a cluster at once. Thus, noise of the frost to drop onto the heater roof 151 can be reduced. In this way, a refrigerator excellent in quietness and defrosting efficiency can be provided.

[0178]

Note that, examples of the defrost heater 150 may include an inlaid heater that is integrally assembled into the cooler 13. Further, the glass tube heater and the inlaid heater may be used together. The defrost water generated around the cooler 13 or the defrost water that has dropped onto the heater roof 151 drops in the cooler room and is drained to the outside of the refrigerator (such as evaporating dish arranged in the machine room 1A) through the defrost water drain port 155 via a defrost water receiving portion 154 that is formed on a lower side in the cooler room 131.

[0179]

Further, when two coolers (evaporators), that is, a freezer compartment cooler and a refrigerator compartment cooler are arranged, an evaporating temperature can be set relatively higher in the refrigerator compartment cooler than in the freezer compartment cooler. Thus, the frost is less liable to be formed around the cooler. For this reason, the defrost heater 150 can be omitted, and hence the heater roof 151 can also be omitted. As a result, the defrost water to be generated by the cooler 13 drops, in the cooler room, directly onto the defrost water receiving portion 154 that is formed on the lower portion in the cooler room 131, and is drained to the outside of the refrigerator through the defrost water drain port 155 (such as evaporating dish arranged in the machine room 1A).

[0180]

When the two coolers (evaporators), that is, the freezer compartment cooler and the refrigerator compartment cooler are arranged, the refrigerator compartment cooler is arranged in a storage compartment rear surface on the rear of the lower portion of the refrigerator compartment 2 (substantially sealed containers 2X and 2Y), or in a rear surface of the vegetable compartment 5. Thus, it is appropriate to arrange the misting device 200, for example, in a rear wall of the stored item housing space in the refrigerator compartment 2, a storage compartment rear wall behind a rear surface of the substantially sealed containers 2X and 2Y, or in the rear wall of the vegetable compartment 5. Defrost water generated by the refrigerator compartment cooler can be used as water supply means for the misting device 200, and it is appropriate that a container for receiving and accumulating the defrost water generated by the refrigerator compartment cooler be arranged instead of the heater roof 151 arranged below the cooler 13 in the cooler room 131. In this case, when water overflows from a water drain port container arranged in an upper portion of the container, the overflowed water is drained to the outside of the refrigerator through the defrost water drain port 155, thereby eliminating the need to treat the water overflowing from the water drain port arranged in the upper portion of the container. Thus, it is appropriate that the container be arranged in the cooler room 131 at a position below the refrigerator compartment cooler and above the defrost water drain port 155. Further, when the discharge electrode of the misting device 200 is arranged at a position above the container and at a level equivalent to that of the refrigerator compartment cooler (position on the front surface side of the cooler), or at a position between the refrigerator compartment cooler and the container, there is an advantage in that a water supply route at the time of supplying the water in the container to the discharge electrode, for example, by a capillary phenomenon can be shortened.

[0181]

As illustrated in Fig. 10, the misting device 200 is arranged to be at least partially received in the concave portion of the upper wall (upper partition wall 24) of the vegetable compartment 5 arranged adjacently below the freezer compartment 6. Cooling air in another storage compartment (freezer compartment 6) arranged adjacently above a storage compartment (vegetable compartment 5), in which the misting device 200 is arranged, may be used for generating dew condensation water around the radiation unit. This dew condensation water may be used so that the discharge electrode is caused to generate mist through voltage application.

[0182]

In Fig. 9 and Fig. 10, a storage compartment interior illumination device 900 is arranged, for example, in the top wall (upper wall) 740 as an inner wall of the refrigerator compartment 2 as a storage compartment. The storage compartment interior illumination device 900 includes a plurality of LEDs. Note that, the illumination device 900 may be arranged in the lateral wall 790, the bottom wall 780, or the partition wall 24 in the storage compartment. The plurality of LEDs of the illumination device 900 are arranged on the front surface side of the refrigerator 1 with respect to front edges of the shelves 80, and hence are allowed to thoroughly illuminate the inside of the storage compartment from the upper side to the lower side without being blocked by the shelves 80. An optical axis of at least one of the plurality of LEDs of the illumination device 900 is arranged such that door pockets provided to the storage compartment door (such as refrigerator compartment door 7) can be illuminated when the storage compartment door (such as refrigerator compartment door 7) is opened. Thus, even when the periphery of the refrigerator 1 is dim, for example, during nighttime, not only the inside of the storage compartment but also the door pockets can be illuminated. In this way, a user-friendly refrigerator can be provided.

[0183]

In the example described above, the cooling air passage 760 to be formed on the storage compartment rear wall 730 is formed of a separate component (such as first air passage component 762) that is separate from the internal box 750 forming the concave portion 440. The first air passage component 762 may be molded or formed integrally with the internal box 750. In this case, it is appropriate that the internal box at the substantially central position in the width direction (right-and-left direction) of the concave portion 440 formed in the part of the internal box 750 corresponding to the rear wall 730 be formed into a projecting portion having a circular-arc shape (or arch shape or U-shape) in cross-section over the vertical direction so that the projecting portion is molded to project toward the inside of the storage compartment and used instead of the first air passage component 762. Alternatively, a space between the projecting portion obtained by forming the internal box into a circular-arc shape (or arch shape or U-shape) and the vacuum heat insulating material 400 may be used as the cooling air passage 760. When the cooling air passage 760 is difficult to form only with the circular-arc projecting portion and the vacuum heat insulating material 400, it is appropriate to arrange the second air passage component 764 having, for example, an elliptical shape in cross-section in the space between the projecting portion and the vacuum heat insulating material 400. In this way, when the internal box 750 is used instead of the first air passage component 762, the first air passage component 762 can be omitted. Thus, the first air passage component need not be assembled, for example, to the internal box 750, and hence the assembly efficiency can be improved. As a result, a heat insulating box body, a refrigerator, and a device, which are reduced in number of components, low-cost, and excellent in design property, can be provided.

[0184]

(Other Heat Insulating Box Body and Refrigerator)

Fig. 11 is a front sectional view illustrating the heat insulating box body according to Embodiment 1 of the present invention. Fig. 12 is a rear view illustrating the heat insulating box body. Further, Fig. 13 is a perspective view illustrating the heat insulating box body as viewed from the front surface side. Fig. 14 is another perspective view illustrating the heat insulating box body as viewed from the rear surface side (rear side). Further, Fig. 22 is a rear view illustrating another heat insulating box body. The parts equivalent to those in Fig. 1 to Fig. 10 are denoted by the same reference symbols to omit description thereof. Note that, actually, the vacuum heat insulating materials 400 are arranged in the wall internal spaces 315 to be formed between the external box 710 and the internal box 750. However, in Fig. 12, for ease of understanding of the shape of the vacuum heat insulating materials 400 arranged in the rear wall of the refrigerator 1, the vacuum heat insulating materials 400 are illustrated transparently through the rear surface of the external box 710 (in other words, the vacuum heat insulating materials 400 are indicated by the solid lines). Further, rails 755 are not illustrated in Fig. 13.

[0185]

The refrigerator 1 includes the heat insulating box body 700 formed of the external box 710 made, for example, of a metal, and the internal box 750 made, for example, of a resin. Further, the rigid urethane foam and/or the vacuum heat insulating materials 400 is/are arranged (charged) as the heat insulating material in the wall internal spaces 315 to be formed between the external box 710 and the internal box 750 (specifically, in the top surface, the right and left lateral surfaces, the rear surface, and the bottom surface portion of the refrigerator 1 or the heat insulating box body 700).

[0186]

The heat insulating box body 700 of the refrigerator 1 according to Embodiment 1 is formed into such a bottomed angular cylindrical shape (substantially rectangular parallelepiped shape) that the top side, the bottom side, and the lateral sides are closed, and the front surface portion is opened to form an opening portion. Further, the heat insulating box body 700 is partitioned, for example, by the plurality of (two in Fig. 11) partition walls 24 into the plurality of storage compartments (such as refrigerator compartment 2, ice making compartment 3, switching compartment 4, vegetable compartment 5, and freezer compartment 6). Sheet metal covers 34 each formed of a sheet metal (having a thickness of, for example, 0.5 mm or more) are fixed to the front surface sides of those partition walls 24 with the fixing members such as screws. Those sheet metal covers 34 are fastened to the heat insulating box body 700 with the screws and the like so that the partition walls 24 are mounted to the heat insulating box body 700. In this way, when the partition walls 24 are mounted to the heat insulating box body 700 by using the sheet metal covers 34, the strength of the heat insulating box body 700 can be increased.

[0187]

Further, in the refrigerator 1 or the heat insulating box body 700 according to this embodiment, in the storage compartments such as the refrigerator compartment 2, the vegetable compartment 5, and the freezer compartment 6, the rail portions 755 (such as rails or rail holding portions) for supporting the shelves 80 or the pull-out type storage compartments (such as pull-out doors or pull-out cases) that are set in the storage compartment are formed on the lateral walls 790.

[0188]

The heat insulating box body 700 structured as described above is manufactured, for example, as follows. First, the vacuum heat insulating materials 400 are fixed to the external box 710 by bonding with the second adhesive agent in advance. Then, the external box 710 and the internal box 750 are fixed to each other with a jig, by bonding, or the like, for example, under a state in which the wall internal spaces 315 (spaces formed between the external box 710 and the internal box 750) are formed. After that, as illustrated in Fig. 14, with the rear surface side of the heat insulating box body 700 facing up, a liquid raw material of rigid urethane foam is injected through the plurality of injection ports 703 and 704 for urethane and the like, which are formed at the widthwise end portions on the rear surface side, and then integral foaming is performed in the spaces 315. In this way, the insides of the wall internal spaces 315 are charged with the rigid urethane foam.

[0189]

In this embodiment, at the parts where the vacuum heat insulating materials 400 are arranged (such as concave portion 440, second concave portion 441, lateral walls 790, or doors (7, 8, 9, 10, and 11)), urethane is used not mainly as the heat insulating material, but mainly as the adhesive agent. Specifically, at the parts where the vacuum heat insulating materials 400 are arranged, the heat insulating performance is secured by setting the coverage or the charging rate of the vacuum heat insulating materials 400 to a predetermined value or more. More specifically, in a part or entirety of the range of the concave portion 440, for example, rigid urethane to be applied or charged into the space between the vacuum heat insulating materials 400 and the internal box 750 is used as the adhesive agent intended mainly to exert the bonding function. Thus, the adhesive agent to be applied or charged into the spaces 315 between the vacuum heat insulating materials 400 and the internal box 750 (or external box 710) in the wall (rear wall 730 of the refrigerator 1) only needs to satisfy the adhesive force (bonding strength and adhesion performance) of the adhesive agent. Further, quality failure such as bonding failure (peeling or deformation) due to the adhesive agent only needs to be prevented at the time of applying the product. For this reason, the predetermined thickness of the adhesive agent is preferably small, specifically, approximately 11 mm or less (for example, preferably less than 10 mm), preferably approximately 6 mm or less.

[0190]

Further, in order to satisfy the adhesive force (adhesion performance) of the adhesive agent and secure the box body strength at the time of bonding by the predetermined value or more, an adhesive thickness of the adhesive agent needs to be equal to or larger than a predetermined thickness, desirably 1 mm or more. Note that, even when concavo-convex portions are formed on the surface of the vacuum heat insulating materials 400 or on the surface of the internal box 750 (or external box 710), it is preferred that the adhesive agent be propagated substantially all over the spaces 315 between the vacuum heat insulating materials 400 and the internal box 750 (or external box 710) even over the regions corresponding to the concavo-convex portions, for example, by applying or charging the adhesive agent substantially all over the spaces between the vacuum heat insulating materials 400 and the internal box (or external box). Thus, the adhesive thickness is preferably approximately 3 mm or more.

[0191]

Note that, when the vacuum heat insulating materials 400 are arranged not only in the concave portion 440 formed in the rear wall, but also in other parts in the rear wall 730, or the lateral walls 790, the top wall 740, the bottom wall 780, or the partition walls 24, at the parts facing the vacuum heat insulating materials 400, the vacuum heat insulating materials 400 and the surfaces of the walls (such as those of the internal box 750, the external box 710, or the partition walls 24) may be bonded directly to each other as in the concave portion 440 as long as the predetermined thickness of the adhesive agent can be secured in the wall internal spaces 315. Thus, the predetermined thickness of the adhesive agent is preferably approximately 11 mm or less (for example, preferably less than 10 mm), more preferably approximately 6 mm or less, and preferably approximately 1 mm or more, more preferably approximately 3 mm or more.

[0192]

Note that, on the rear surface side of the heat insulating box body 700, the injection ports 703 and 704 are formed so as to allow the liquid raw material of the foam heat insulating material such as urethane to be charged therethrough. Thus, in the spaces 315 in the heat insulating box body 700 (space between the external box 710 and the internal box 750), the rigid urethane foam needs to be charged through the injection ports 703 and 704 at positions of facing the injection ports 703 and 704, and hence the vacuum heat insulating materials 400 are difficult to arrange at those positions (when the vacuum heat insulating materials 400 interfere with the injection ports 703 and 704, the injection of the liquid raw material of urethane is difficult). As a countermeasure, in this embodiment, on the rear surface side of the heat insulating box body 700, as illustrated in Fig. 12, the vacuum heat insulating materials 400 are arranged at parts excluding the parts to face the injection ports 703 and 704 (the cutout portions (openings or cutouts) 33 are formed at parts of the vacuum heat insulating materials 400 to face the injection ports 703 and 704 so that the vacuum heat insulating materials 400 do not interfere with the injection ports 703 and 704). Specifically, the vacuum heat insulating materials 400 to be used are cut out at the parts to face the injection ports 703 and 704, and the vacuum heat insulating materials 400 are arranged such that the cutout portions 33 come to the parts to face the injection ports 703 and 704. In this way, urethane is not hindered from being charged or flowing.

[0193]

Further, the vacuum heat insulating material 400 to be arranged on the rear surface side of the heat insulating box body 700 need not be, for example, a single piece, and may be formed of an array of a plurality of (for example, two or three) segments each having, at the parts to face the injection ports 703 and 704, the cutout portions 33 such as cutouts and openings having a size substantially equivalent to or larger than that of the injection ports 703 and 704. Note that, the vacuum heat insulating material 400 need not be divided, and may be formed of the single piece. The vacuum heat insulating material 400 may be formed of the single piece as long as the vacuum heat insulating material 400 has the cutouts or the openings so that urethane to be charged through the injection ports 703 and

704 is not suppressed or hindered from being charged or flowing to target parts in the heat insulating box body 700.

[0194]

In this embodiment, the vacuum heat insulating material 400 has the cutout portion 33 formed in at least one corner portion out of four corner portions of a substantially rectangular shape, and the cutout portion 33 is arranged to face the injection port 703 or 704. The cutout portion 33 is formed in the corner portion at the position where the cutout portion 33 faces the injection port 703 or 704 under the state in which the vacuum heat insulating material 400 is placed in the heat insulating box body 700. The cutout portion 33 formed in the corner portion of the vacuum heat insulating material 400 is arranged at the part to face the injection port 703 or 704 so that the vacuum heat insulating material 400 and the injection port 703 or 704 do not interfere with each other. With this arrangement, the arrangement areas of the vacuum heat insulating materials 400 can be increased, and the vacuum heat insulating materials 400 can be arranged so as not to overlap with the injection ports 703 and 704 (the injection of the liquid raw material of the rigid urethane foam is not hindered by the vacuum heat insulating materials 400). Thus, the ratio of the arrangement areas (coverage) of the vacuum heat insulating materials relative to the outer surface area of the heat insulating box body or the rear wall of the heat insulating box body can be increased. Further, a proportion of the volumes of the vacuum heat insulating materials (charging rate of the vacuum heat insulating materials) relative to volumes of the spaces between the external box and the internal box forming the box body can also be increased. With this, the refrigerator or the heat insulating box body can be enhanced in heat insulating performance. When the vacuum heat insulating materials 400 are arranged in this way, the heat insulating box body 700 or the refrigerator 1, which is excellent in heat insulating performance and is capable of securing the box body strength, can be provided. Note that, when the vacuum heat insulating materials 400 do not have the cutout portions 33, it is appropriate that the vacuum heat insulating materials 400 be arranged so as not to overlap with the injection ports 703 and 704 (the vacuum heat insulating materials 400 be arranged at such positions that the vacuum heat insulating materials 400 do not interfere with the injection ports 703 and 704).

[0195]

Note that, it is desired that the injection ports 703 and 704 be positioned between the external box 710 and the internal box 750, at which the lateral walls 790 are formed.

[0196]

Further, the positions where the injection ports 703 and 704 are formed are merely an example, and the injection ports 703 and 704 may be formed as appropriate in accordance with the shape of the heat insulating box body 700, in other words, the shape of the wall internal spaces 315 to be formed between the external box 710 and the internal box 750. Thus, the injection ports 703 and 704 may be formed at positions on any one of the side surfaces (such as right lateral surface, left lateral surface, front surface, rear surface, top surface, or bottom surface) in accordance with the shape of the heat insulating box body 700 or the refrigerator 1.

[0197]

Fig. 22 is a rear view illustrating another heat insulating box body 700 according to the embodiment of the present invention. The parts equivalent to those in Fig. 1 to Fig. 14 are denoted by the same reference symbols to omit description thereof. In Fig. 22, as in Fig. 12, for ease of understanding of the shape of the vacuum heat insulating material 400 arranged in the rear wall 730 of the refrigerator 1, the vacuum heat insulating material 400 is illustrated transparently through the rear surface of the external box 710 (in other words, the vacuum heat insulating material 400 is indicated by the solid lines).

[0198]

In Fig. 22, the charging ports (injection ports) 703 and 704, which are formed on the rear surface side of the heat insulating box body 700 and allow, for example, the rigid urethane foam to be charged or injected therethrough, are formed at four positions near four corners (near four corner portions) of a rear wall part excluding the machine room 1A arranged on a lower portion on the rear or an upper portion on the rear of the heat insulating box body 700. The charging ports (injection ports) 703 and 704 are each arranged at a position away from a left edge or a right edge of the box body 700 by a predetermined distance (widthwise inner end portion position) Y1 in the width direction, and away from an upper edge, a lower edge, or an end portion of the machine room 1A by a predetermined distance (vertical inner end portion position) Y2 in the vertical direction. Note that, when a thickness (wall thickness) of each of the lateral walls 790 is represented by T1 mm, and a widthwise length of each of the charging ports (diameter of circle) is represented by r1, the predetermined distance (widthwise inner end portion position) Y1 in the width direction of the injection ports 703 and 704 is preferably T1+r1 or less so that, when the filler such as urethane is charged through the charging ports (injection ports) 703 and 704, the filler such as urethane is caused to smoothly flow into the lateral walls 790. Specifically, assuming that the thickness of each of the lateral walls 790 is approximately 20 mm to 50 mm, the diameter r1 of each of the charging ports 703 and 704 is approximately 25 mm to 50 mm, and the charging ports 703 and 704 are each arranged away from an end portion of the lateral wall 790 by a predetermined distance T01 mm or larger (specifically, 10 mm or more), the predetermined distance Y1 is T01+r1 or more and T1+r1 or less. Therefore, the predetermined distance Y1 is preferably approximately 35 mm or more and 80 mm or less.

[0199]

Further, when a thickness (wall thickness) of the top wall, the bottom wall, or the heat insulating partition wall for partitioning the machine room and the storage compartment from each other is represented by T2 mm, and a vertical length of each of the charging ports (diameter of circle) is represented by r2, the predetermined distance Y2 (vertical inner end portion position) in the vertical direction of the injection ports 703 and 704 is preferably T2+r2 or less so that, when the filler such as urethane is charged through the charging ports (injection ports) 703 and 704, the filler such as urethane is caused to smoothly flow into the top wall, the bottom wall, or the partition wall. The thickness of the top wall, the bottom wall, or the partition wall is approximately 20 mm to 50 mm, and the diameter r2 of each of the charging ports 703 and 704 is approximately 25 mm to 50 mm. Thus, assuming that the charging ports 703 and 704 are each arranged away from the end portion of the wall surface by a predetermined distance T02 mm or more (specifically, 10 mm or more), the predetermined distance Y2 is T02+r2 or more and T2+r2 or less. Thus, the predetermined distance Y2 is preferably 35 m or more and 80 mm or less.

Note that, the predetermined distance T01 (or T02) corresponds to such a distance that the injection ports 703 and 704 can be processed at the time of executing a process of drilling the injection ports 703 and 704 in the external box 710 (specifically, such a distance that the injection ports do not interfere with outer plates forming outer walls of the lateral walls 790, or the injection ports 703 and 704 are not fractured or deformed at the time of processing the injection ports 703 and 704), or corresponds to such a distance that flow of the heat insulating material such as urethane or the adhesive agent is not blocked (specifically, such a distance that flow of a liquid raw material of urethane and the like is not hindered by the outer plates forming the outer walls of the lateral walls 790, or the flow of the liquid raw material of urethane and the like is not hindered by the vacuum heat insulating materials arranged on the outer wall sides in the lateral walls 790). With regard to the predetermined distances T01 and T02, on a premise that a plate thickness of each of the outer plates forming the outer walls of the lateral walls 790 is, for example, approximately 0.6 mm to 3 mm, and that the thickness of each of the vacuum heat insulating materials arranged on the outer wall sides in the lateral walls 790 is 11 mm or less (specifically, preferably less than 10 mm, and hence 9.5

mm), the thickness (9.5 mm) of each of the vacuum heat insulating materials is larger than the plate thickness (from 0.6 mm to 3 mm). Thus, the predetermined distance T01 (or T02) only needs to be 9.5 mm or more, which is the thickness of each of the vacuum heat insulating materials. In this case, the predetermined distance T01 (or T02) only needs to be 9.5 mm or more, but in consideration of a margin, the predetermined distance T01 (or T02) is preferably 10 mm or 10 mm or more.

[0200]

Note that, when the convex portions 450 are formed to project into the compartment side (inside of the storage compartment) as illustrated in Fig. 8, the filler is smoothly charged as long as the charging ports 703 and 704 are formed within the ranges in which the convex portions 450 are respectively formed (ranges between the predetermined parts 797 and 798 of each of the oblique sides 456 of the substantially triangular shapes of the convex portions 450, which are connected to the rear wall 730 or the lateral wall 790. Thus, when a widthwise length of each of the convex portions 450 is represented by "A" (widthwise convex portion length "A"), the predetermined distance Y1 is preferably T01+r1 or more and T1+A or less. When a vertical length of each of the convex portions 450 is represented by "B" (vertical convex portion length "B"), the predetermined distance Y2 is preferably T02+r2 or more and T2+B or less. Therefore, assuming that the length A of each of the convex portions 450 is, for example, 180 mm to 200 mm, the predetermined distance Y1 may be 250 mm or less (preferably approximately 230 mm or less). With this distance, even when the charged filler such as urethane strikes against the oblique sides 456 of the convex portions 450 (which may have a circular-arc shape), inclinations of the oblique sides allow the filler to be smoothly injected, for example, into the lateral walls 790 or the top wall 740. Thus, there are no problems.

As described above, the box body according to this embodiment is formed of the external box 710 and the internal box 750, and at least has the rear wall 730 and the lateral walls 790. The storage compartments 2, 3, 4, 5, 6, and 7 each having the opening portion formed on the front side are formed in the box body. The vacuum heat insulating material 400 is arranged on the external box side in the rear wall 730. The injection ports 703 and 704 are formed at the end portions in the width direction or the end portions in the vertical direction of the rear wall 730, for injecting the liquid raw material of the heat insulating material being the intermediate member into the rear wall 730. The injection ports 703 and 704 are formed through the rear wall excluding the machine room 1A in the upper portion or the lower portion on the rear of the box body (at the four corners of the rear wall excluding the machine room 1A in Fig. 22, or on left-and-right end sides of the rear wall excluding the machine room 1A in Fig. 12). The vacuum heat insulating materials 400 include the cutout portions 33 such as cutouts or openings, which are formed at the parts to face the injection ports 703 and 704 so that the vacuum heat insulating materials 400 do not interfere with the injection ports 703 and 704. When the thickness of the heat insulating material is set to 11 mm or less (preferably less than 10 mm in consideration of, for example, variation and the concavo-convex portions on the surfaces of the vacuum heat insulating materials), the ratio of the arrangement areas (coverage) of the vacuum heat insulating materials relative to the outer surface area of the heat insulating box body or the rear wall of the heat insulating box body can be increased. Further, the proportion of the volumes of the vacuum heat insulating materials (charging rate of the vacuum heat insulating materials) relative to the volumes of the spaces between the external box and the internal box forming the box body can also be increased. With this, the refrigerator or the heat insulating box body can be enhanced in heat insulating performance.

Further, when the density of the heat insulating material is set to more than 60 kg/m^3, the strength (rigidity) of the box body is increased. With this, a refrigerator excellent in reliability can be provided. Note that, when the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member is excessively high, there arise problems of, for example, quality degradation, performance deterioration, and cost increase, specifically, (1) cost may be increased due to increase in injection amount of urethane, (2) leakage of urethane may occur due to increase in injection pressure of urethane, (3) a force of close contact or an adhesive force between urethane and a box body deformation suppressing die set, a box body pressing member, or the like may be increased due to increase in foaming pressure at the time of foaming of urethane, with the result that the box body deformation suppressing die set, the box body pressing member, or the like may be difficult to pull out of the box body (difficult to take out of the box body), and (4) the heat insulating performance may be abruptly deteriorated due to the increase in density of urethane. As a countermeasure, the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member (density after foaming as for the foam heat insulating material) is set to preferably 100 kg/m^3 or less (more preferably 90 kg/m^3 or less).

Still further, when the ratio of "Thickness of Heat Insulating Material/(Thickness of the Heat Insulating Material+Thickness of the Vacuum Heat Insulating Material)" is set to 0.3 or less, the wall thickness of the box body can be reduced, and in addition, both the box body strength and the heat insulating performance can be enhanced. Thus, a heat insulating box body, a refrigerator, and a device, which are large in internal capacity of the compartments (such as storage compartments) and excellent in strength and heat insulating performance, can be provided. Further, the bending elastic modulus of the rigid urethane foam can be increased. Thus, even when the rigid urethane foam is reduced in thickness, the strength can be increased. Therefore, even when the wall thickness is reduced, the box body strength can be increased. In addition, the composite heat conductivity of the wall formed of the composite member including the vacuum heat insulating material 400 and the rigid urethane foam can be reduced. Thus, even when the wall thickness is reduced, the heat insulating performance can be enhanced.

Yet further, when the heat insulating material is the rigid urethane foam, the bending elastic modulus of the rigid urethane foam is set to 15 MPa or more and 150 MPa or less, and the bending elastic modulus of the vacuum heat insulating material 400 is set to 20 MPa or more, the bending elastic modulus of the rigid urethane foam being the intermediate member can be increased. Thus, even when the rigid urethane foam is reduced in thickness, the strength can be increased. Further, the rigidity of the vacuum heat insulating material is increased, and hence the box body strength is increased.

Yet further, the vacuum heat insulating materials are arranged at least in the lateral walls 790 and the rear wall 730, and the ratio of the arrangement areas of the vacuum heat insulating materials 400 relative to the outer surface areas of the rear wall 730 and the lateral walls 790 is set to 70% or more. With this, a heat insulating box body, a refrigerator, and a device, which are small in deformation amount of the box body and excellent in strength, rigidity, and heat insulating performance, can be provided.

Yet further, the proportion of the volumes of the vacuum heat insulating materials relative to the volumes of the spaces between the external box and the internal box forming the box body is set to 40% or more. With this, a heat insulating box body, a refrigerator, and a device, which are small in deformation amount of the box body and excellent in strength, rigidity, and heat insulating performance, can be provided.

Yet further, the vacuum heat insulating materials each have a substantially quadrangular plate shape, and the cutout portions 33 are formed at the parts to face the injection ports 703 and 704, specifically, of the four corner portions (four corners) of the substantially quadrangular shape, at least at corner portions at which the injection ports 703 and 704 are formed so that the vacuum heat insulating materials do not interfere with the injection ports 703 and 704. Thus, at the time of being charged through the charging ports (injection ports) 703 and 704, the filler such as urethane smoothly flows through the lateral walls, the top wall, the bottom wall, or the partition walls. When the injection ports 703 and 704 are formed at the four corners of the rear wall excluding the machine room 1A, it is appropriate that the cutout portions 33 of the vacuum heat insulating materials 400 be also formed at the four corners to face the injection ports 703 and 704 (four corner portions of the vacuum heat insulating material 400 having the substantially quadrangular shape).

[0201]

(Rail Members on Lateral Walls)

Next, description is made of a case where the rail portions (such as rails or rail mount portions) 755 for supporting the shelves 80 or the pull-out type storage compartments (such as pull-out doors or pull-out cases) are formed on the lateral walls 790.

[0202]

Fig. 24 is a main-part sectional view illustrating a vicinity of the rail mount portion of the refrigerator according to the embodiment of the present invention. Fig. 25 is a main-part sectional view illustrating a vicinity of another rail mount portion of the refrigerator according to the embodiment of the present invention. Fig. 26 is a main-part sectional view illustrating a vicinity of still another rail mount portion of the refrigerator according to the embodiment of the present invention. Fig. 27 is a main-part sectional view illustrating a vicinity of yet another rail mount portion of the refrigerator according to the embodiment of the present invention. In Fig. 24 to Fig. 27, the parts equivalent to those in Fig. 1 to Fig. 14 are denoted by the same reference symbols to omit description thereof. Further, in Fig. 24 to Fig. 27, the equivalent parts are denoted by the same reference symbols, and hence description thereof is made with reference to one of those figures to omit description with reference to the other figures.

[0203]

In Fig. 24, an average thickness of the wall thickness of the lateral wall 790 excluding a local protrusion or concavity is set to 20 mm or more and 40 mm or less. In the storage compartment such as the refrigerator compartment 2, the vegetable compartment 5, or the freezer compartment 6, the rail portion (such as rail member mount portion or rail holding portion) 755 for supporting the shelf 80 or the pull-out type storage compartment (such as pull-out door or pull-out case), which is installed in the storage compartment, is formed into, for example, an internal-box concave portion 717 having a concave shape or an internal-box convex portion having a convex shape in the internal box 750. A rail support portion 820 for a rail member 810 is fixed to the internal box 750, a reinforcing member 731, or the heat insulating material 701 such as urethane with the rail fixing member 735 such as a screw. Thus, when, on the lateral wall 790, a thickness of the heat insulating material 701 such as rigid urethane foam as a third intermediate member to be charged between the vacuum heat insulating material 400 and the internal box 750 is set equal to or smaller than a predetermined thickness (approximately 11 mm or less, preferably less than 10 mm, more preferably approximately 6 mm or less) so that the wall thickness is reduced to increase the internal capacity of the storage compartment, there is a risk in that the fixing member such as a screw for fixing or holding the rail member or the reinforcing member damages or tears the outer wrapping material of the vacuum heat insulating material 400.

[0204]

Note that, when the fixing member 735 such as a screw is shortened so as not to damage the vacuum heat insulating material 400, the fixing strength or holding strength for fixing or holding the rail member 810 is reduced. As a result, when a case 520, the shelf 80, or the like is set to the rail member 810, and the item to be stored is housed therein or put thereon, there is a risk in that the fixing member 735 is disengaged from the internal box 750 due to weight of, for example, the stored item, the case 520, or the shelf 80. Further, when the case 520 is, for example, a pull-out case having two-step rails, which needs to be pulled out by a large amount, there is a risk in that, when the case 520 or the like is set to the rail member 810, the rail portion 755 is deformed due to the weight of, for example, the stored item or the case 520, to thereby disable the pull-out case 520 from being smoothly pulled out at a mounting part of the internal box 750, which is located at a position of facing the rail member 810 or the reinforcing member 731. Further, in order to secure the strength, the length of the fixing member 735 such a screw to be inserted and fixed in the heat insulating material 701 such as urethane (length of threaded portion) is difficult to set to less than approximately 10 mm. Normally, a length of approximately 15 mm or more is secured. Thus, the thickness of the rigid urethane foam 701 as the third intermediate member between the vacuum heat insulating material 400 and the internal box 750 has been difficult to set to approximately 15 mm or less (preferably 11 mm or less (more specifically, preferably less than 10 mm)). In particular, hitherto, in order to secure the heat insulating performance, urethane has been used in a range of a low density of 60 kg/m3 or less. Thus, a large amount of voids is formed in urethane, and hence the strength of holding the fixing member such as a screw is small. As a result, the fixing member such as a screw needs to be long.

[0205]

In the embodiment of the present invention, on the lateral walls 790 of the heat insulating box body 700 or the refrigerator 1, the rail portion (such as rail mount portion or rail holding portion) 755 for supporting the shelf 80 or the pull-out case (such as pull-out type storage compartment, door of the storage compartment, or pull-out case) 520, which is installed in the compartment (such as storage compartment), is formed in the internal box 750. The vacuum heat insulating material 400 is arranged between the internal box 750 and the external box 710 at a part facing the rail portion 755 of the internal box 750. When the vacuum heat insulating material 400 is arranged between the internal box 750 and the external box 710 at the part facing the rail portion 755 of the internal box 750, it is appropriate to provide the fixing member 735 such as a screw not through the lateral wall 790 but through the partition wall 24 as a lower surface of the compartment, the partition wall (upper wall) 24 as an upper surface of the compartment, the top wall 740, or the bottom wall 780. In this case, the fixing member is provided through the bottom wall 780, the partition wall 24 as the lower surface, the partition wall 24 as the upper surface, or the top wall 740 near the lateral wall 790. Thus, when the vacuum heat insulating material is arranged also in the bottom wall 780, the partition wall 24 as the lower surface, the top wall 740, or the partition wall 24 as the upper surface, it is appropriate to arrange the vacuum heat insulating material 400, for example, so as not to be overlapped with the part where the fixing member 735 is provided, or so as to be cut out at the part where the fixing member 735 is provided. With this, the vacuum heat insulating material 400 can be arranged in the lateral wall 790, and the wall thickness can be reduced.

[0206]

Further, in the embodiment of the present invention, even when the length of the fixing member 735 (length of threaded portion) such as a screw inserted into the heat insulating material 701 such as urethane to be used as the third intermediate member is set to approximately less than 10 mm, as long as urethane is used as the third intermediate member in a range of a density of more than 60 kg/m^3, the amount of the voids in urethane is smaller than that in a case where the density is less than 60 kg/m^3. Thus, urethane for holding the fixing member 735 such as a screw is increased in strength, and hence the fixing member 735 is increased in holding strength. In this case, the plate-like reinforcing member (screw fixing portion) 731 made of a resin or a metal may be arranged between the vacuum heat insulating material 400 and the internal box 750 so that the fixing member 735 is inserted into the screw fixing portion 731 for fixing. A thickness of the reinforcing member 731 is not particularly limited as long as the fixing member 735 such as a screw can be held or fixed. Specifically, the thickness is set approximately to 2 mm or more and 10 mm or less. Also in this case, when the density of urethane as the third intermediate member is set to more than 60 kg/m^3, the holding strength of the reinforcing member (screw fixing portion) 731 in the heat insulating material 701 such as urethane can be increased. Thus, for example, deformation of the rail portion 755 and the fixing member 735 in the internal box 750 can be suppressed, and displacement of the reinforcing member 731 in the heat insulating material 701 such as urethane can also be suppressed. In particular, in the two-step rail structure in which the storage compartment is pulled out in two steps, the fixing or holding strength of the fixing member needs to be great. However, when the density of urethane is set to more than 60 kg/m^3, the two-step rail structure can be used without problems. Further, even when the thickness of the heat insulating material 701 such as urethane is set to 11 mm or less (specifically, less than 10 mm), preferably 6 mm or less, and the length of the threaded portion of the fixing member 735 such as a screw is set to 10 mm or less, a length of projection of the threaded portion into the heat insulating material 701 such as urethane is reduced by an amount corresponding to a thickness of the internal box 750 (for example, 1 mm to 2 mm) at a part to which the screw 735 is fixed (rail portion 755), or by an amount corresponding to the thickness of the reinforcing member 731 (for example, approximately 1 mm to 8 mm). With this, the vacuum heat insulating material 400 is not damaged or torn by the screw 735.

[0207]

Specifically, on the lateral wall 790 in which the vacuum heat insulating material 400 is arranged between the internal box 750 and the external box 710 and the rail member 810 for the pull-out type storage compartment is fixed, the thickness of the lateral wall 790 is set to 40 mm or less, and a thickness of the foam heat insulating material (such as rigid urethane foam) 701 at the part facing the rail portion (rail mount portion) 755 to which the rail member 810 is mounted is set to 11 mm or less (preferably less than 10 mm in consideration of, for example, variation and the concavo-convex portions on the surface of the vacuum heat insulating material), a ratio expressed by "Thickness of Foam Heat Insulating Material/(Thickness of Foam Heat Insulating Material+Thickness of Vacuum Heat

Insulating Material)" is set to 0.3 or less, and the density of the rigid urethane foam is set to more than 60 kg/m3. With this, the fixing member 735 such as a screw is suppressed from being disengaged, or the holding strength or the fixing strength of the fixing member 735 such as a screw is increased. Thus, deformation and the like of the rail portion 755 do not occur, and hence the case 520 or the like can be smoothly pushed in and pulled out. Further, the rail portion (rail mount portion) 755 to which the fixing member 735 such as a screw is mounted, or the internal box 750 is not damaged. As a result, the reliability is enhanced.

[0208]

The rail member 810 is fixed to or held on the opening-and-closing door 7, 8, 9, 10, or 11 of the storage compartment 2, 3, 4, 5, or 6, and includes an upper rail 811 as a movable rail to be pulled out in conjunction with opening of the opening-and-closing door, a lower rail 812 as a fixed rail fixed to the lateral wall 790 of the storage compartment, an intermediate rail 813 arranged between the upper rail 811 and the lower rail 812, the rail support portion 820 fixed to the lower rail 812 with a rail support portion fixing member 836 such as a screw or welding, a case support portion 830 fixed to the upper rail 811 with a case support portion fixing member 835 such as a screw or welding, and a plurality of bearings 815 as rotary support members for supporting engagement between the intermediate rail 813, the upper rail 811, and the lower rail 812. The rail support portion 820 is fixed with the rail fixing member 735 such as a screw to the rail portion 755 of the internal box 750 corresponding to the lateral wall 790 of the storage compartment 2, 3, 4, 5, or 6. Further, the case support portion 830 supports the case 520 arranged in the storage compartment 2, 3, 4, 5, or 6 so as to cause the case 520 to be moved in the fore-and-aft direction in conjunction with movement of the upper rail 811 as the movable rail in the fore-and-aft direction (the case 520 is pushed in and pulled out in the fore-and-aft direction by being moved in the fore-and-aft direction in conjunction with the movement of the upper rail 811). Further, the intermediate rail 813 is moved in the fore-and-aft direction in conjunction with the movement of the upper rail 811 in the fore-and-aft direction. Thus, the case 520 in the storage compartment 2, 3, 4, 5, or 6 is moved frontward and rearward together with the upper rail 811 in synchronization with pulling-out of the storage compartment door 7, 8, 9, 10, or 11 in the fore-and-aft direction with respect to the refrigerator 1. Under a state in which the storage compartment door is fully opened, the case 520 can be freely removed in an upward direction.

[0209]

Note that, the lower rail 812 and the rail support portion 820 may be formed integrally with each other. Specifically, the lower rail 812 and the rail support portion 820 may be fixed integrally to each other in advance through welding or the like. In this case, a screw as the rail support portion fixing member 836 can be omitted, and hence the assembly efficiency can be improved. Alternatively, a part of the lower rail 812 may be used as the rail support portion 820. In this case, the welding, the screw, or the like may be omitted, and hence a rail member and a refrigerator, which are low-cost and excellent in assembly efficiency, can be provided.

[0210]

The rail fixing member 735 enables the rail support portion 820 of the rail member 810 to be fixed to or held on the rail portion 755 of the internal box 750 corresponding to the lateral wall 790 of each of the storage compartments. Note that, the rail member 810 has a certain size, and hence protrudes (projects) to the storage compartment side under a state of being mounted to the storage compartment side of the rail portion 755. In order to reduce the amount of protrusion (amount of projection) into the storage compartment, it is preferred that the rail portion 755 be recessed from the storage compartment side toward the external box 710. For this reason, the rail portion 755 of the internal box 750 is formed into a shape recessed toward the external box 710. With this, the internal-box concave portion 717 is formed. In this way, when the rail member 810 is mounted from the storage compartment side into the internal-box concave portion

717 formed by recessing the rail portion 755 toward the external box 710, the internal capacity of the storage compartment and the capacity of the case 520 can be increased.

[0211]

On the external box 710 side (side opposite to the storage compartment side) of the rail portion 755 of the internal box 750, the reinforcing member 731 is arranged between the rail portion 755 and the vacuum heat insulating material 400, and the heat insulating material 701 as the third intermediate member, such as urethane, is charged between the reinforcing member 731 and the vacuum heat insulating material 400. The reinforcing member 731 is fixed to or held on the rail portion 755 in substantially close contact by using the heat insulating material 701 such as urethane. Between the rail portion 755 of the internal box 750 and the external box 710, the rail portion 755, the reinforcing member 731, the heat insulating material 701 such as urethane, the vacuum heat insulating material 400, and the external box 710 are arranged in the stated order from the internal box 750 side. Note that, in this embodiment, the heat insulating material 701 such as urethane is charged between the internal box 750 and the vacuum heat insulating material 400, but the adhesive agent may be used as the third intermediate member instead of the heat insulating material 701 because the heat insulating performance and the box body strength are secured by the vacuum heat insulating material 400. In this case, rigid urethane foam that is a self-adhesive foam heat insulating material may be used as the adhesive agent. Note that, the external box 710 and the vacuum heat insulating material 400 are fixed to each other with the second adhesive agent as the second intermediate member, such as a hot melt adhesive or a double-faced tape.

[0212]

Note that, a thickness Q of the heat insulating material 701 such as urethane, which is charged between the vacuum heat insulating material 400 and the internal box 750, is preferably set to approximately 15 mm or more (preferably

13 mm or more), but is preferably set to 11 mm or less. Further, a thickness P of the heat insulating material 701 such as urethane, which is charged between the vacuum heat insulating material 400 and the rail portion 755 of the internal box 750, is set to 11 mm or less (preferably less than 10 mm in consideration of, for example, variation and the concavo-convex portions on the surface of the vacuum heat insulating material). Thus, a bending elastic modulus of the heat insulating material 701 such as urethane can be increased, and the box body 700 or the refrigerator 1 can be increased in strength. Still further, a thickness R of the heat insulating material 701 such as urethane, which is charged between the reinforcing member 731 and the vacuum heat insulating material 400, is set smaller than the predetermined thickness P by an amount corresponding to the thickness of the reinforcing member. Specifically, the thickness R is set to 8 mm or less when the thickness of the reinforcing member is set to 2 mm, and the thickness R is set to approximately 6 mm or less when the thickness of the reinforcing member is set to 4 mm. Thus, the strength can be further increased. In addition, the density of the heat insulating material 701 such as urethane is set to more than 60 kg/m^3, and hence the fixing member 735 such as a screw is increased in holding strength or fixing strength. As a result, the screw is suppressed from being loosened, disengaged, or dropped off. Further, the reinforcing member 731 is increased in holding strength or fixing strength, and hence not only occurrence of displacement of the reinforcing member 731, but also deformation of the screw and deformation of the rail portion 755 of the internal box 750 due to the displacement can be suppressed. As a result, a refrigerator and a device, which are excellent in reliability, can be provided. Note that, when the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member is excessively high, there arise problems of, for example, quality degradation, performance deterioration, and cost increase, specifically, (1) cost may be increased due to increase in injection amount of urethane, (2) leakage of urethane from the box body or the like may occur due to increase in injection

pressure of urethane, (3) a force of close contact or an adhesive force between urethane and a box body deformation suppressing die set, a box body pressing member, or the like may be increased due to increase in foaming pressure at the time of foaming of urethane, with the result that the box body deformation suppressing die set, the box body pressing member, or the like may be difficult to pull out of the box body (difficult to take out of the box body), and (4) the heat insulating performance may be abruptly deteriorated due to the increase in density of urethane. As a countermeasure, the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member is set to preferably 100 kg/m^3 or less (more preferably 90 kg/m^3 or less).

[0213]

In Fig. 25, the reinforcing member 731 is made of a metal or a resin, and includes a plate-like reinforcing member body portion 734 to which the fixing member 735 is fixed, a plate-like upper reinforcing-member extending portion 732 formed to extend substantially in a horizontal direction at an upper end or an upper portion of the reinforcing member body portion 734, and a plate-like lower reinforcing-member extending portion 733 formed to extend substantially in the horizontal direction at a lower end or a lower portion of the reinforcing member body portion 734. The reinforcing member body portion 734, the upper reinforcing-member extending portion 732, and the lower reinforcing-member extending portion 733 are formed integrally with each other (assembled integrally to each other), or molded integrally with each other.

[0214]

The reinforcing member 731 is bonded to the external box 710 side of the internal-box concave portion 717 formed in the rail portion 755 of the internal box 750 with the second adhesive agent such as a double-faced tape or a hot melt adhesive. Then, the heat insulating material 701 such as urethane is charged. In this way, the reinforcing member 731 is fixed to or held on the rail portion 755 of the internal box 750. The reinforcing member 731 is formed into such a U-shape in cross-section that the upper reinforcing-member extending portion 732 and the lower reinforcing-member extending portion 733 are extended in the same direction from end surfaces of the reinforcing member body portion 734. The reinforcing member 731 is arranged on the external box 710 side of the internal-box concave portion 717 in such a positional relationship that the reinforcing member body portion 734 is arranged to fit to a bottom surface portion (concave portion) of the internal-box concave portion 717, and that the upper reinforcing-member extending portion 732 is placed to face an upper concave-portion step portion 718 of the internal-box concave portion 717. Further, the lower reinforcing-member extending portion 733 is arranged to face a lower concave-portion step portion 719 of the internal-box concave portion 717. With this, the upper reinforcing-member extending portion 732 or the lower reinforcing-member extending portion 733 of the reinforcing member 731 can be easily positioned with respect to the internal box 750. Further, the reinforcing member 731 can be mounted to the internal-box concave portion 717 to cover the internal-box concave portion 717 from the external box 710 side, and hence the reinforcing member 731 can be easily positioned or mounted with respect to the internal box 750. In addition, the strength of the internal-box concave portion 717 is increased. Note that, as long as any one of the upper reinforcing-member extending portion 732 and the lower reinforcing-member extending portion 733 is formed or molded, the reinforcing member 731 can be positioned with the upper reinforcing-member extending portion 732 and the upper concave-portion step portion 718, or the lower reinforcing-member extending portion 733 and the lower concave-portion step portion 719. Thus, any one of those extending portions may be omitted (it is only necessary to form any one of those extending portions).

[0215]

Further, in Fig. 25, the rail support portion 820 is formed by welding integrally with the lower rail 812 as the fixed rail of the rail member 810, and hence the rail member 810 can be easily assembled to the rail portion 755 of the internal box 750.

Further, the rail member 810 is placed on the lower concave-portion step portion 719 as a rail-member placing portion of the internal-box concave portion 717 through intermediation of the rail support portion 820 or the lower rail 812 as the fixed rail. With this, the rail member 810 is positioned so as not to move downward. Further, on an upper surface side of the lower concave-portion step portion 719, a fixing portion at which the rail support portion 820 is fixed or held with a screw or the like is arranged. The rail support portion 820 is fixed to or held on the fixing portion (movement suppressing portion) so that the rail support portion 820 or the rail member 810 is suppressed from moving upward or sideways.

[0216]

The rail member 810 is placed on the lower concave-portion step portion 719 as the rail-member placing portion, and hence the rail support portion 820 supporting the rail member 810 is suppressed from being deformed downward due to weight of the case 520. Thus, the door or the case 520 can be smoothly pushed in and pulled out. Note that, the case 520 is a container opened on its top and including a case bottom wall and four case lateral walls that are formed at a draft angle for the sake of production efficiency. Thus, the case lateral walls of the case 520 are each inclined from top to bottom toward a central axis of the case 520. In other words, the case 520 is formed to be narrower at a lower end than at an upper end.

[0217]

Thus, a gap (length) between the case 520 and the lateral wall 790 is larger at the lower end of the case 520 than at the upper end thereof. Therefore, when the case 520 is supported with the rail member 810, it is preferred that the rail member 810 be supported on a lower side in a height direction of the case 520 because the case 520 can be increased in capacity. When the case 520 is supported with the rail member 810 (such as case support portion 830) at a position at a height of 1/2 or less, preferably 1/3 or less of a height of the case 520, the case can be further increased in width. Thus, the case 520 can be increased in capacity. In this case, a case step portion 525 may be formed on the case lateral wall of the case 520 so that the case support portion 830 of the rail member 810 supports the case step portion 525. With this, the case 520 can be easily supported. Further, a vicinity of the lower end in the height direction of the case 520 (specifically, position at the height of 1/2 or less, preferably 1/3 or less of the height of the case 520) may be supported. When a lowermost end, that is, a back surface of the case bottom wall is supported, the case step portion 525 need not be formed in the case 520. Thus, the case 520 can be easily manufactured.

[0218]

When the density of the heat insulating material 701 such as urethane (specifically, rigid urethane foam), which is charged between the vacuum heat insulating material 400 (or external box 710) and the internal box 750 in which the lower concave-portion step portion 719 as a rail member placing portion is formed, is set to more than 60 kg/m^3, there is an advantage in that the lower concave-portion step portion 719 as the rail member placing portion is increased in strength. With this, even when heavy items are housed in the case 520, deformation and the like of the lower concave-portion step portion 719 as the rail member placing portion on which the rail member 810 is to be placed do not occur. Thus, the case 520 can be stably pushed in and pulled out. As a result, a refrigerator and a device, which are excellent in reliability, can be provided.

[0219]

Further, in Fig. 24 and Fig. 25, the internal-box concave portion 717 is capable of receiving at least a part of the rail member 810 (such as rail support portion 820) or the entire rail member 810. Thus, the amount of projection of the rail member 810 into the storage compartment side can be reduced. Therefore, the internal capacity of the storage compartment can be increased, and the capacity of the case 520 can also be increased.

[0220]

In the example described with reference to Fig. 24 and Fig. 25, the reinforcing member 731 is arranged on the external box 710 side of the internal-box concave portion 717 that is recessed as viewed from the storage compartment side of the internal box 750. In the example illustrated in Fig. 26, the reinforcing member 731 is arranged on the external box 710 side of an internal-box convex portion 727 that is projected as viewed from the storage compartment side of the internal box 750. In Fig. 26, the rail portion 755 of the internal box 750 corresponding to the lateral wall 790 is projected to the storage compartment side to form the internal-box convex portion 727. The internal-box convex portion 727 includes an upper convex-portion step portion 728 and a lower convex-portion step portion 729, and the upper convex-portion step portion 728 and the lower convex-portion step portion 729 each have a convex shape.

[0221]

In Fig. 26, the internal-box convex portion 727 has a shape of a concave portion as viewed from the external box 710 side, and the reinforcing member 731 (at least a part or entirety of the reinforcing member 731) is received in this concave portion formed on the external box 710 side of the internal-box convex portion 727. With the lower convex-portion step portion, the reinforcing member 731 is positioned in the vertical direction or the lateral direction. Further, when at least a part or entirety of the reinforcing member 731 is received in the concave portion formed on the external box 710 side of the internal-box convex portion 727, the amount of projection of the reinforcing member 731 to the external box 710 side can be reduced. Thus, when the heat insulating material 701 such as urethane is charged between the vacuum heat insulating material 400 (or external box 710) and the internal box 750, the width R of the passage through which urethane is caused to flow (thickness of the heat insulating material 701 such as urethane between the vacuum heat insulating material 400 and the reinforcing member 731) is suppressed from being reduced. With this, smooth flow of urethane is not hindered. In this way, the flow of the heat insulating material 701 such as urethane is not blocked, and hence the thickness R of the heat insulating material

701 such as urethane between the reinforcing member 731 and the vacuum heat insulating material 400 can be set to 11 mm or less (preferably less than 10 mm in consideration of, for example, variation and the concavo-convex portions on the surface of the vacuum heat insulating material). Thus, the thickness R of the heat insulating material 701 such as urethane can be sufficiently secured between the reinforcing member 731 and the vacuum heat insulating material 400. As a result, the reinforcing member 731 can be suppressed from being deteriorated in holding strength, or the rail fixing member 735 such as a screw can be suppressed from being deteriorated in fixing or holding strength.

[0222]

Further, the rail support portion 820 is formed, for example, by welding integrally with the lower rail 812 as the fixed rail of the rail member 810, and hence the rail member 810 can be easily assembled to the rail portion 755 of the internal box 750. Further, the rail support portion 820 is placed on the partition wall 24 arranged between the storage compartments, or on the bottom surface portion 780. With this, the rail member 810 is positioned so as not to move downward. Further, on the partition wall 24 or the bottom surface portion 780, the fixing portion at which the rail support portion 820 is fixed or held with a screw or the like is arranged. The rail support portion 820 is fixed to or held on the fixing portion (movement suppressing portion) so that the rail support portion 820 or the rail member 810 is suppressed from moving upward or sideways. Note that, the vacuum heat insulating material 400 is arranged in the partition wall 24 or the bottom surface portion 780.

[0223]

The rail member 810 is arranged on the external box 710 side of the internal-box concave portion 717 of the internal box 750 in Fig. 24 and Fig. 25, and is arranged on the external box 710 side of the internal-box convex portion 727 in Fig. 26. The rail member 810 need not necessarily be arranged in the internal-box concave portion 717 or on the internal-box convex portion 727, and may be arranged on a flat portion of the internal box 750 as illustrated in Fig. 27.

[0224]

In Fig. 27, the rail member 810 is arranged at the rail portion 755 of the internal box 750, and the rail portion 755 is fixed to a flat surface of the internal box 750 with the fixing member 735 such as a screw. Further, the reinforcing member 731 is arranged on a surface on the external box 710 side of the rail portion 755, and the reinforcing member 731 is fixed or held by the heat insulating material 701 such as urethane, which is charged between the reinforcing member 731 and the vacuum heat insulating material 400. In this case, the heat insulating material 701 is charged under a state in which the reinforcing member 731 is bonded or fixed to the internal box 750 with the second adhesive material such as a hot melt adhesive or a double-faced tape. With this, the reinforcing member 731 is held on or fixed to the surface on the external box 710 side of the internal box 750.

[0225]

In Fig. 27, as in Fig. 24 to Fig. 26, the density of the heat insulating material 701 such as urethane is set to more than 60 kg/m^3, and hence the fixing member 735 such as a screw is increased in holding strength or fixing strength. As a result, the screw is suppressed from being loosened, disengaged, or dropped off. Further, the reinforcing member 731 is increased in holding strength or fixing strength, and hence not only the occurrence of the displacement of the reinforcing member 731, but also deformation of the screw and deformation of the rail portion 755 of the internal box 750 due to the displacement can be suppressed. As a result, a refrigerator and a device, which are excellent in reliability, can be provided.

[0226]

Further, the thickness P of the heat insulating material 701 such as urethane, which is charged between the vacuum heat insulating material 400 and the rail portion 755 of the internal box 750, is set to 11 mm or less (preferably less than 10 mm in consideration of, for example, variation and the concavo-convex portions on the surface of the vacuum heat insulating material), preferably 6 mm or less.

Thus, the bending elastic modulus of the heat insulating material 701 such as urethane can be increased, and the box body 700 or the refrigerator 1 can be increased in strength. Still further, the thickness R of the heat insulating material 701 such as urethane, which is charged between the reinforcing member 731 and the vacuum heat insulating material 400, is set smaller than the predetermined thickness P by an amount corresponding to the thickness of the reinforcing member 731. Specifically, the thickness R can be set to 8 mm or less when the thickness of the reinforcing member 731 is set to 2 mm, and the thickness R can be set to approximately 6 mm or less when the thickness of the reinforcing member 731 is set to 4 mm. Thus, the strength can be further increased.

[0227]

Further, in Fig. 27, an end portion (such as lower end) of the rail portion 755 of the internal box 750 forms a projecting portion 757 at which the internal box 750 is projected to the storage compartment side, and the rail support portion 820 of the rail member 810 is placed on an upper surface of the projecting portion 757. A length of projection of the projecting portion 757 to the storage compartment side in the width direction is set smaller than a length of projection of the rail member 810 in the width direction. When the projecting portion 757 is less projected into the storage compartment than the rail member 810, reduction in capacity of the storage compartment capacity and the case capacity is suppressed.

[0228]

Further, the rail support portion 820 is formed, for example, by welding integrally with the lower rail 812 as the fixed rail of the rail member 810, and hence the rail member 810 can be easily assembled to the rail portion 755 of the internal box 750. Further, the rail support portion 820 is placed on the upper surface side of the projecting portion 757 formed at the end portion (lower end) of the rail portion 755. With this, the rail member 810 is positioned so as not to move downward. Further, on the upper surface side of the projecting portion 757, the fixing portion at which the rail support portion 820 is fixed or held with a screw or the like is arranged. The rail support portion 820 is fixed to or held on the fixing portion (movement suppressing portion) so that the rail support portion 820 or the rail member 810 is suppressed from moving upward or sideways.

[0229]

Note that, in Fig. 24 and Fig. 26, the rail portion 755 is arranged near the partition wall 24 or the bottom wall 780. Thus, the rail member 810 is mounted near the partition wall 24 or the bottom wall 780, and the case 520 is supported at a lower position in the height direction of the case 520. With this, there is an advantage in that the rail member 810 is increased in placing strength. Meanwhile, in Fig. 25 and Fig. 27, the rail portion 755 and the partition wall 24 or the bottom wall 780 are spaced apart from each other by a predetermined distance G, and hence the rail member 810 can be mounted at the position higher by the predetermined distance G than the partition wall 24 or the bottom wall 780. In this way, the case 520 can be supported at a higher position, and hence the case can be smoothly pushed in and pulled out. Further, the case support portion 830 of the rail member 810 can be shortened. With this, a rail member and a refrigerator, which are excellent in strength and low-cost, can be provided.

[0230]

Note that, the case step portion 525 may be formed on the case lateral wall of the case 520 so that the case support portion 830 of the rail member 810 supports the case step portion 525. With this, the case 520 can be easily supported. Further, the vicinity of a lower side or the lower end in the height direction of the case 520 (specifically, position at the height of 1/2 or less, preferably 1/3 or less of the height of the case 520) may be supported. When the lowermost end, that is, the back surface of the case bottom wall is supported, the step portion 525 need not be formed in the case 520. Thus, the case 520 can be easily manufactured.

[0231]

When the density of the heat insulating material 701 such as urethane (specifically, rigid urethane foam), which is charged between the vacuum heat insulating material 400 (or external box 710) and the internal box 750 in which the rail-portion end portion (rail-portion projecting portion) 757 as a rail placing portion is formed to project to the storage compartment side, is set to more than 60 kg/m^3, there is an advantage in that the rail-portion end portion 757 as the rail member placing portion is increased in strength. With this, even when heavy items are housed in the case 520, deformation and the like of the rail-portion projecting portion 757 as the rail member placing portion on which the rail member 810 is to be placed do not occur. Thus, the case 520 can be stably pushed in and pulled out. As a result, a refrigerator and a device, which are excellent in reliability, can be provided.

[0232]

Note that, the rail member 810 need not necessarily be arranged on the lateral wall 790, and may be arranged on the partition wall of the storage compartment in which the rail member 810 is arranged (including partition wall arranged between storage compartments, such as partition wall 24 as a bottom surface or an upper surface of the storage compartment, bottom wall 780, or top wall 740). In other words, the rail support portion 820 for supporting the rail member 810 may be arranged (placed) on the partition wall (including partition wall 24, top wall 740, or bottom wall 780). In this way, when the rail support portion 820 for supporting the rail member 810 is arranged on the partition wall 24 of the storage compartment, the fixing member 735 need not be arranged on the lateral wall 790. Thus, the vacuum heat insulating material 400 to be arranged in the lateral wall can be increased in thickness, and the heat insulating material 701 such as urethane, which is charged between the vacuum heat insulating material 400 and the internal box 750 in the lateral wall 790, can be reduced in thickness. Therefore, the internal capacity of the storage compartment or the capacity of the case 520 can be increased.

[0233]

Note that, when the rail support portion 820 is arranged on the partition wall, it is appropriate that, on the partition wall 24, the bottom wall 780, or the top wall 740, the vacuum heat insulating material 400 is arranged at a position excluding a position where the rail fixing member 735 is arranged. Further, when the reinforcing member to which the fixing member such as a screw is fixed is arranged at the position where the rail fixing member 735 is arranged, the fixing member is increased in fixing strength or holding strength. Still further, when the heat insulating material such as rigid urethane foam or polystyrene foam is charged, applied, or arranged between the vacuum heat insulating material 400 and an outer shell member corresponding to the partition wall 24, as long as the density of the heat insulating material 701 is set to more than 60 kg/m3, the fixing member or the reinforcing member for fixing or holding the rail member 810 is increased in holding or fixing strength. As a result, the reliability can be enhanced. Note that, the thickness of the heat insulating material 701 is preferably less than 10 mm for the reason described above.

[0234]

In the case described above, the rail portion 755 of the internal box 750 is fixed from the inside of the storage compartment with a screw or the like (a screw head of the screw as the fixing member 735 is arranged on the storage compartment 2, 3, 4, 5, or 6 side, and the threaded portion of the fixing member 735 is arranged between the rail portion 755 of the internal box 750 and the vacuum heat insulating material 400). However, the screw 735 as the fixing member may be fixed while being projected from the inside of the lateral wall 790 into the storage compartment 2, 3, 4, 5, or 6. In this case, the screw head is arranged between the vacuum heat insulating material 400 and the rail portion 755 of the internal box 750 (the threaded portion is fixed to the rail portion 755, the rail reinforcing member 731, or the heat insulating material 701 such as urethane). Also in this case, the density of urethane is more than 60 kg/m^3. Thus, the heat insulating material 701 such as urethane is increased in strength, and the fixing strength or the holding strength between the fixing member 735 such as the screw and the heat insulating material 701 such as urethane and between the internal box 750 and the heat insulating material 701 such as urethane is increased. With this, deformation of, for example, the internal box, displacement of the reinforcing member 731, loosening of the screw, and the like are suppressed. As a result, the case 520 and the like can be smoothly pulled out (smoothly pushed in and pulled out).

[0235]

In the embodiment of the present invention, at a position of facing a part of the lateral wall 790 where the rail member is arranged, the thickness of the foam heat insulating material (such as rigid urethane foam) is set to 11 mm or less (preferably less than 10 mm) between the internal box 750 and the vacuum heat insulating material 400. With this, the bending elastic modulus of urethane can be increased, and hence the wall thickness can be reduced while maintaining the wall strength. Further, at the position of facing the part of the lateral wall 790 where the rail member is arranged, the thickness of the foam heat insulating material (such as rigid urethane foam) is set to 6 mm or less between the internal box 750 and the vacuum heat insulating material 400. With this, the bending elastic modulus of urethane can be further increased, and hence the wall thickness can be reduced while maintaining the wall strength.

[0236]

Further, the ratio expressed by "Thickness of Foam Heat Insulating Material/(Thickness of Foam Heat Insulating Material+Thickness of Vacuum Heat Insulating Material)" is set to 0.3 or less. With this, a composite heat conductivity of a composite member formed by combining the foam heat insulating material and the vacuum heat insulating material can be reduced. Thus, even when the wall thickness is reduced, the heat insulating performance can be enhanced.

[0237]

Further, the density of foamed urethane is set to more than 60 kg/m^3. With this, the wall thickness can be reduced while maintaining the wall strength.

[0238]

In this way, in the embodiment of the present invention, at the position of facing the part of the lateral wall 790 where the rail member is arranged, the thickness of the foam heat insulating material (such as rigid urethane foam) is set to 11 mm or less (preferably less than 10 mm) between the internal box 750 and the vacuum heat insulating material 400. The ratio expressed by "Thickness of Foam Heat Insulating Material/(Thickness of Foam Heat Insulating Material+Thickness of Vacuum Heat Insulating Material)" is set to 0.3 or less. The density of foamed urethane is set to more than 60 kg/m^3. With this, the wall thickness can be further reduced while maintaining the wall strength. Note that, the "Thickness of Foam Heat Insulating Material" in the above-mentioned expression corresponds to the thickness of urethane. Thus, the thickness P of the heat insulating material 701 such as urethane, which is charged between the vacuum heat insulating material 400 and the rail portion 755 of the internal box 750, the thickness Q of the heat insulating material 701 such as urethane, which is charged between the vacuum heat insulating material 400 and the internal box 750, or the thickness R of the heat insulating material 701 such as urethane between the vacuum heat insulating material 400 and the reinforcing member 731 may be the "Thickness of Foam Heat Insulating Material." For example, when the "Thickness of Foam Heat Insulating Material" is the thickness R of the heat insulating material 701 such as urethane between the vacuum heat insulating material 400 and the reinforcing member 731, it is only necessary to set a ratio expressed by "Thickness R of Foam Heat Insulating Material/(Thickness R of Foam Heat Insulating Material+Thickness of Vacuum Heat Insulating Material)" to 0.3 or less. Similarly, when the "Thickness" is the thickness P or Q, it is only necessary to replace "R" of the "Thickness R" with "P" or "Q." Further, the thickness of urethane, which is shown in Fig. 17, Fig. 18, and Fig. 19, may similarly correspond to the thickness P of the heat insulating material 701 such as urethane, which is charged between the vacuum heat insulating material 400 and the rail portion 755 of the internal box 750, the thickness Q of the heat insulating material 701 such as urethane, which is charged between the vacuum heat insulating material 400 and the internal box 750, or the thickness R of the heat insulating material 701 such as urethane between the vacuum heat insulating material 400 and the reinforcing member 731.

Further, the box body is formed of the external box 750 and the internal box 710, and has the rear wall 730 and the lateral walls 790. The storage compartments 2, 3, 4, 5, and 6 each having the opening portion formed on the front side are formed by partitioning the inside of the box body with the partition walls 24. The pull-out case is housed in the storage compartment, and pulled out through intermediation of the rail member 810 arranged on the lateral wall of the storage compartment. The vacuum heat insulating material 400 is formed of a fibrous core material made of an inorganic fiber or an organic fiber, and is arranged between the part of the internal box and the part of the external box corresponding to the lateral wall 790 on which the rail member 810 is arranged. The reinforcing member 731 is arranged on the internal box side between the internal box and the vacuum heat insulating material at the position of facing the rail member, for supporting or holding the rail member. The heat insulating material 701 is charged between the reinforcing member and the vacuum heat insulating material at the position of facing the rail member. When the thickness of the heat insulating material is less than 10 mm at the position of facing the rail member, and when the density of the heat insulating material to be charged between the internal box and the vacuum heat insulating material is set to more than 60 kg/m^3 at the rail portion, the wall thickness can be reduced while maintaining the wall strength. In addition, the heat insulating performance can also be enhanced. Note that, when the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member is excessively high, there arise problems of, for example, quality degradation, performance deterioration, and cost increase, specifically, (1) cost may be increased due to increase in injection amount of urethane, (2) leakage of urethane from the box body or the like may occur due to increase in injection pressure of urethane, (3) a force of close contact or an adhesive force between urethane and a box body deformation suppressing die set, a box body pressing member, or the like may be increased due to increase in foaming pressure at the time of foaming of urethane, with the result that the box body deformation suppressing die set, the box body pressing member, or the like may be difficult to pull out of the box body (difficult to take out of the box body), and (4) the heat insulating performance may be abruptly deteriorated due to the increase in density of urethane. As a countermeasure, the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member (density after foaming as for the foam heat insulating material) is set to preferably 100 kg/m^3 or less (more preferably 90 kg/m^3 or less).

[0239]

Further, when the bending elastic modulus of the vacuum heat insulating material 400 is set to 20 MPa or more, the wall thickness can be further reduced. In this case, it is appropriate to fix the rail member not to the lateral wall 790 but to the bottom wall 780, the partition wall 24 as the bottom surface, the upper wall (top wall) 740, or the partition wall 24 as the upper surface near the lateral wall 790. Note that, when the vacuum heat insulating material 400 is not arranged between the external box 710 and the internal box 750 at the position of facing the part where the fixing member such as a screw is arranged, it is preferred that the bottom wall 780, the partition wall 24 as the lower surface, the top wall 740, or the partition wall 24 as the upper surface, on which the fixing member is arranged, be arranged as a wall or a partition wall not to be exposed to the outside air. When a proportion of the part where the vacuum heat insulating material 400 is not arranged is reduced as much as possible on the walls to be exposed to the outside air (such as lateral wall 790, top wall 740, rear wall 730, or bottom wall 780), there is an advantage in that loss caused by heat leakage can be reduced. As a result, a high-performance heat insulating box body, refrigerator, and device can be provided. With this, the arrangement area of the vacuum heat insulating material 400 in the rear wall 730 or the lateral wall 790 can be increased, and hence the coverage or the charging rate of the vacuum heat insulating materials 400 relative to the heat insulating box body 700 can be increased.

[0240]

In this way, the heat insulating box body 700 according to Embodiment 1 is constructed not based on the related-art technical idea that the rigid urethane foam in the heat insulating box body 700 mainly exerts the heat insulating function, but based on a novel technical idea that the vacuum heat insulating material 400 secures both the heat insulating performance and the box body strength at the part where the vacuum heat insulating material 400 is arranged. Thus, in the heat insulating box body 700 according to Embodiment 1, the charging rate of the vacuum heat insulating materials 400 relative to the wall internal spaces 315 to be formed between the external box 710 and the internal box 750 (proportion of a volume of the vacuum heat insulating materials 400 relative to a total volume of the wall internal spaces 315 to be formed between the external box 710 and the internal box 750) is set to a predetermined value or more (specifically, 40% or more (preferably 45% or more)). Note that, the charging rate of the vacuum heat insulating materials 400 includes a charging rate in the door, that is, a proportion of the volume of the vacuum heat insulating materials 400 relative to a volume in a door inner space between the door outer plate and the door inner plate of the door outer shell.

[0241]

Hitherto, the vacuum heat insulating materials have been arranged in a manner that a proportion of the area of the vacuum heat insulating materials relative to the surface area of the external box 710 or the internal box 750 (coverage) falls within a predetermined range, and hence influence of the thickness of the vacuum heat insulating materials 400 is not taken into consideration. Thus, the thickness of the rigid urethane foam is set larger than the thickness of the vacuum heat insulating materials 400 so that the strength of the heat insulating box body is secured with rigid urethane. Hitherto, attempts have been made to increase the coverage of the vacuum heat insulating materials 400 so as to enhance the heat insulating performance of the box body, but attempts have not been made to increase the charging rate of the vacuum heat insulating materials 400 so as to enhance both the heat insulating performance and the box body strength. Thus, the charging rate of the vacuum heat insulating materials 400 is low (specifically, charging rate in related-art refrigerators is approximately 20%), and the heat insulating performance is not enhanced in some cases. Further, the box body strength depends on the rigid urethane foam. In this embodiment, the vacuum heat insulating materials 400 are arranged based on the charging rate in consideration of the thickness of the vacuum heat insulating materials 400. Thus, unlike the related art, there is no such case that the heat insulating performance is not enhanced. When the charging rate of the vacuum heat insulating materials 400 is set to a predetermined value or more (specifically, 40% or more), the heat insulating performance can be enhanced. In addition, the wall thickness can be reduced while satisfying the box body strength and the heat insulating performance, and hence the internal capacity of the storage compartment can be increased. With this, the required internal capacity of the storage compartment of the product can be set to a predetermined capacity or higher. In other words, the length, the width, the thickness, and the arrangement positions of the vacuum heat insulating materials 400 can be appropriately set. Thus, the wall thickness can be reduced, and in accordance therewith, the internal capacity of the storage compartment can be increased.

[0242]

In this way, when the charging rate of the vacuum heat insulating materials 400 relative to the spaces 315 is set higher than that in the related art, the heat insulating performance is enhanced in comparison with that in the related art. Thus, even when the heat insulating box body 700 is reduced in wall thickness in comparison with that in the related art, heat insulating performance equivalent to or greater than that in the related art can be secured.

[0243]

(Other Structures of First Air Passage Component)

As described above, in the embodiment of the present invention, a widthwise length of the first air passage component 762 as a part of the cooling air passage 760, which is illustrated, for example, in Fig. 4, Fig. 5, Fig. 6, or Fig. 8, is set smaller than the width of the concave portion 440. With this, the first air passage component 762 can be fixed to or held on the convex portions 450, the second concave portion 441, or the protruding portions 910 forming the second concave portion 441 therebetween by using, for example, the fixing members such as screws, a hooking structure, or a fitting structure. Note that, the widthwise length of the first air passage component 762 as a part of the cooling air passage 760 may be extended to the inner surfaces of the lateral walls 790 to cover a part of the rear wall 730 or the lateral walls 790. In this state, the first air passage component 762 may be fixed to or held on the inner surfaces of the lateral walls 790 by using, for example, the fixing members such as screws, the hooking structure, or the fitting structure. As a matter of course, the first air passage component 762 may be fixed to or held on not only the inner surfaces of the lateral walls 790 but also, for example, the protruding portions 910, the concave portion 440, or the convex portions 450 by using, for example, the fixing members, the hooking structure, or the fitting structure.

[0244]

Further, when the widthwise length of the first air passage component 762 as a part of the cooling air passage 760 is extended to the inner surfaces of the lateral walls 790 to cover not only the second concave portion 441 but also the concave portion 440 and at least a part or entirety of the convex portions 450, the first air passage component 762 can be used also as a designed panel, and can cover the rear wall 730 of a compartment (such as storage compartment), or at least a part or entirety of the inner surfaces of the lateral walls 790. In this way, the first air passage component 762 can be used as a cover member for covering a part of the rear surface or the lateral walls. Thus, the supply ports through which the cooling air is to be supplied from the cooling air passage 760 into the compartment are formed through the first air passage component 762 with a high degree of freedom in arrangement. With this, stored items in the compartment can be efficiently cooled. Further, the first air passage component 762 can be formed of a member separate from the internal box 750, and hence can be easily changed in shape and color. In addition, various kinds of processing, painting, and letter printing can be easily performed thereon. Thus, the functionality is increased and the design properties are enhanced. When the first air passage component is used not only as the designed panel but also as the cover member, it is appropriate to form the first air passage component into a substantially U-shape so as to cover at least a part of the inner surfaces of the rear wall 730 and the lateral walls 790 of the compartment, or to cover the entire inner surfaces of the wall surfaces. In this case, by arranging the illumination device (internal illumination device) 900 in the top wall 740 or the bottom wall 780 of the compartment, when the first air passage component 762 as the cover member is extended to the lateral walls 790, unlike a case where the illumination device 900 is arranged in each of the inner surfaces of the lateral walls 790, the first air passage component 762 need not be cut out or openings need not be formed at a part where the illumination device 900 is arranged. Thus, the designed panel (first air passage component 762) as the cover member can be simplified in shape. As a result, a low-cost heat insulating box body, refrigerator, and device can be provided. Note that, the designed panel as the cover member may be formed to cover at least a part of the top wall 740 and the rear wall 730 of the compartment, or the entire inner surface side of the wall surfaces.

[0245]

(Thickness of Urethane and Charging Rate of Vacuum Heat Insulating Materials)

Next, description is made of a relationship between the charging rate of the vacuum heat insulating materials 400 and the strength of the box body. Fig. 15 is a graph showing a relationship between the density and the heat conductivity of the rigid urethane foam. Fig. 16 is a graph showing the density and the bending elastic modulus of the rigid urethane foam. Fig. 17 is a graph showing a relationship between a thickness of urethane in a passage at the time when rigid urethane is charged, and the heat conductivity of urethane. Fig. 18 is a graph showing a relationship between the thickness of urethane in the passage at the time when rigid urethane is charged, and the bending elastic modulus of urethane. The test results shown in Fig. 15 to Fig. 18 are obtained at the time of forming a simulated structure by charging rigid urethane into a predetermined clearance (passage) between two surfaces and foaming rigid urethane therein. A surface on one side of the passage is formed of a steel plate as a first member (such as vacuum heat insulating material or pre-coated metal to form the external box 710 as the outer shell of the heat insulating box body 700 of the refrigerator 1). A surface on another side of the passage is made of a resin as a second member (such as resin to be used for the internal box 750, specifically, acrylonitrile butadiene styrene (ABS) copolymer synthetic resin or foamed plastic (EPS)).

[0246]

In Fig. 15, the abscissa axis represents the density of the rigid urethane foam (kg/m^3), and the ordinate axis represents the heat conductivity of the rigid urethane foam [W/(m·K)]. Further, in Fig. 16, the abscissa axis represents the density of the rigid urethane foam (kg/m^3), and the ordinate axis represents the bending elastic modulus of the rigid urethane foam (MPa). In Fig. 17, the abscissa axis represents a thickness of the passage to be charged with the rigid urethane foam (mm), and the ordinate axis represents the heat conductivity of the rigid urethane foam [W/(m·K)]. In Fig. 18, the abscissa axis represents the thickness of the passage to be charged with the rigid urethane foam (mm), and the ordinate axis represents the bending elastic modulus of the rigid urethane foam (MPa). Note that, the thickness of the passage to be charged with the rigid urethane foam corresponds to a thickness of the rigid urethane foam under a state of being charged and foamed in the passage.

[0247]

As shown in Fig. 15 and Fig. 16, the rigid urethane foam is increased in heat conductivity and bending elastic modulus in accordance with increase in density, and decreased in heat conductivity and bending elastic modulus in accordance with decrease in density. In other words, the density and the heat conductivity or the density and the bending elastic modulus have a substantially proportional relationship.

[0248]

As shown in Fig. 17 and Fig. 18, the rigid urethane foam is increased in heat conductivity and bending elastic modulus in accordance with decrease in thickness of the passage to be charged with urethane (or thickness of urethane under the state in which the rigid urethane foam is charged and foamed in the passage). Thus, as the thickness of urethane foamed in the passage is increased, the heat conductivity is decreased and the heat insulating performance is enhanced, but the bending elastic modulus is decreased to reduce the strength. Thus, when the thickness of urethane is reduced so as to reduce the wall thickness, the bending elastic modulus is increased, and hence there are no problems with the strength. However, the heat conductivity is excessively high, and hence the heat insulating performance is deteriorated. As a result, the thickness of urethane cannot be reduced to be lower than a certain level (specifically, lower than 15 mm).

[0249]

Further, as shown in Fig. 17 and Fig. 18, the density is increased in accordance with decrease in thickness of the passage to be charged with urethane (or thickness of urethane foamed in the passage). In accordance with the increase in density, the heat conductivity is increased as shown in Fig. 15, and hence the heat insulating performance is deteriorated. Still further, as shown in

Fig. 17, when the thickness of the passage to be charged with urethane (or thickness of urethane foamed in the passage) is decreased to a predetermined thickness or smaller (specifically, 11 mm or less), the heat conductivity is abruptly increased, and hence the heat insulating performance is deteriorated. The rigid urethane foam is foamed between the first member and the second member of the urethane passage, and cured under a state of being bonded to the first member and the second member. At this time, in urethane, there are formed a core layer and boundary layers called skin layers on both sides of the core layer (first member side and second member side).

[0250]

Fig. 23A and Fig. 23B are each a sectional schematic view illustrating the foamed rigid urethane foam. Fig. 23A is a sectional schematic view illustrating a case where rigid urethane foam 701A is charged between the first member (internal box 750) and the second member (external box 710). Fig. 23B is a sectional schematic view illustrating a case where a third member (vacuum heat insulating material 400) is interposed between the first member (internal box 750) and the second member (external box 710), and the rigid urethane foam 701A is charged between the first member and the third member.

[0251]

In Fig. 23A, in a heat insulating wall having urethane that is charged and foamed between the first member and the second member, the first member (such as internal box 750), a first skin layer 701B, a core layer 701C, a second skin layer 701D, and the second member (such as external box 710) are arranged in the stated order. Meanwhile, as shown in Fig. 23B, when the vacuum heat insulating material 400 is arranged as the third member between the first member (internal box 750) and the second member (external box 710), in the heat insulating wall, the first member (internal box 750), the first skin layer 701B, the core layer 701C, the second skin layer 701D, and the third member (vacuum heat insulating material 400), a second adhesive agent 715, and the second member (external box 710) are arranged in the stated order. Note that, the first skin layer 701B, the core layer 701C, and the second skin layer 701D correspond to the rigid urethane foam 701A.

[0252]

The skin layer is formed near the first member, near the second member, or near the third member. When the thickness of the passage for urethane (thickness of urethane) is set to a range of from approximately 20 mm to 30 mm as in the related art, the skin layer is sufficiently smaller in thickness than the core layer, and hence influence on, for example, the density or the heat conductivity is insignificant. However, when the thickness of urethane is reduced to a predetermined thickness or smaller (specifically, to 11 mm or less), a proportion of the thickness of the skin layer relative to the thickness of the core layer is increased. Thus, the influence on the density, the heat conductivity, and the bending elastic modulus of urethane is abruptly increased, and hence the density, the heat conductivity, and the bending elastic modulus are abruptly increased. As a result, the heat insulating performance is abruptly deteriorated. Further, as shown in Fig. 18, the bending elastic modulus of urethane is abruptly increased in accordance with the increase in density of urethane.

[0253]

In this way, when the thickness of urethane is reduced, the bending elastic modulus is increased, and the strength is also increased. Meanwhile, the heat conductivity of urethane is increased, and the heat insulating performance is deteriorated. For those reasons, hitherto, the thickness of urethane cannot be reduced, and urethane is used in a range of from approximately 15 mm to 30 mm. Hitherto, urethane and the vacuum heat insulating materials are arranged respectively as a main heat insulating material and an auxiliary heat insulating material. Based on this idea, the thickness of urethane is determined within such a range that the urethane heat insulating material is not deteriorated in heat insulating performance. Specifically, a range of from approximately 15 mm to 20 mm is secured even at narrow parts.

[0254]

However, in this embodiment, the heat insulating wall is formed based on the idea of using the vacuum heat insulating materials as a main heat insulating material and securing the box body strength with the vacuum heat insulating materials. Thus, at the parts where the vacuum heat insulating materials are arranged, rigid urethane need not exert the heat insulating performance. Thus, there are no problems even when rigid urethane has a predetermined thickness or smaller (specifically, 11 mm or less, preferably 6 mm or less). As the thickness of rigid urethane is reduced, there is an advantage in that the bending elastic modulus is increased, and the box body strength is also increased. When the predetermined thickness is reduced to 11 mm or less, influence of the thickness of the skin layers on the core layer is increased. As a result, the heat conductivity is abruptly increased, and hence the heat insulating performance is abruptly deteriorated. Thus, hitherto, the thickness of the rigid urethane foam has been difficult to set to 11 mm or less. Hitherto, even when the predetermined value of the thickness of the rigid urethane foam can be set to 11 mm or less in a locally small range, an average thickness has been difficult to set to 11 mm or less. Further, when the predetermined thickness is reduced to 6 mm or less, the influence of the thickness of the skin layers on the core layer is further increased. As a result, the heat insulating performance is further deteriorated. Thus, the rigid urethane foam has been difficult to use in the relate art. Meanwhile, in this embodiment, the heat insulating performance of the heat insulating box body 700 is secured with the vacuum heat insulating materials 400, and hence there are no problems even when urethane to be used is reduced in thickness. Thus, in this embodiment, the thickness of the rigid urethane foam is set to 11 mm or less (preferably less than 10 mm) to increase the bending elastic modulus of the rigid urethane foam, to thereby increase the strength (rigidity) of the box body 700. Further, when the thickness of the rigid urethane foam is set to 6 mm or less, the bending elastic modulus of the rigid urethane foam can be further increased, to thereby further increase the strength (rigidity) of the box body 700.

[0255]

Note that, at the parts where the vacuum heat insulating materials 400 are not arranged, the thickness of urethane can be set large by an amount corresponding to the thickness of the vacuum heat insulating materials (specifically, approximately 15 mm to 30 mm). Thus, a thickness of from approximately 20 mm to 40 mm can be secured for urethane, and hence urethane need not be used in the range in which urethane is abruptly increased in heat conductivity (specifically, urethane thickness of 11 mm or less). With this, urethane can be used in a range in which an increasing rate (slope) of the heat conductivity of urethane is low (specifically, in a range in which the thickness of urethane is 15 mm or more). Even when variation of the thickness of urethane is taken into consideration, a predetermined value or less of the heat insulating performance of urethane can be secured. In this way, both the strength of the heat insulating box body 700 and the heat insulating performance of the heat insulating box body 700 can be satisfied.

[0256]

Note that, the first member to be used on the one side of the urethane passage is made of a resin (such as an acrylonitrile butadiene styrene (ABS) copolymer synthetic resin to be used for the internal box 750 or a resin such as foamed plastic (EPS)). The surface on the another side of the passage is formed of an aluminum-deposited film as the outer wrapping material of the vacuum heat insulating materials or a steel plate such as a pre-coated metal (PCM) to form the external box 710.

[0257]

Next, description is made of a relationship between the composite heat conductivity (heat conductivity of the heat insulating wall formed by combining the vacuum heat insulating material and urethane) and a ratio (="Thickness of Urethane/(Thickness of Urethane+Thickness of Vacuum Heat Insulating Material)) of the thickness of urethane relative to a thickness of the heat insulating wall including foamed urethane and the vacuum heat insulating material 400 (Thickness of Vacuum Heat Insulating Material+Thickness of Urethane) at the parts where the vacuum heat insulating materials 400 are arranged (such as concave portion 440 or second concave portion 441).

[0258]

Fig. 19 is a graph showing a relationship between the composite heat conductivity and the ratio of the thickness of urethane relative to the thickness of a heat insulating material formed by combining the vacuum heat insulating material and urethane when the wall thickness (thickness between inner walls of the walls) is uniformly set to 27 mm. In Fig. 19, the abscissa axis represents the ratio of the thickness of urethane relative to the thickness of the heat insulating material formed by combining the vacuum heat insulating material and urethane, that is, "Thickness of Urethane/(Thickness of Urethane+Thickness of Vacuum Heat Insulating Material)," and the ordinate axis represents the composite heat conductivity (total heat conductivity of the vacuum heat insulating material and urethane). In this case, a sum of the thickness of urethane and the thickness of the vacuum heat insulating material, that is, a value expressed by "Thickness of Urethane+Thickness of Vacuum Heat Insulating Material" represents a wall internal thickness.

[0259]

As shown in Fig. 19, in accordance with the decrease in thickness of urethane relative to the wall internal thickness, the composite heat conductivity is decreased, and hence the heat insulating performance is enhanced. Note that, the composite heat conductivity represents the heat conductivity of the composite member formed by combining urethane and the vacuum heat insulating material. In Fig. 19, the steepness of the slope of the ratio of "Thickness of Urethane/Wall Internal Thickness" changes at 0.3. The slope in the case where the ratio of "Thickness of Urethane/Wall Internal Thickness" is approximately 0.3 or less is milder than that in the case where the ratio of "Thickness of Urethane/Wall Internal

Thickness" is more than 0.3. In other words, a rate of decrease in composite heat conductivity is low. The results shown in Fig. 19 are obtained through tests in which the wall internal thickness is set uniform. Thus, as the ratio of "Thickness of Urethane/Wall Internal Thickness" is decreased, the thickness of urethane is decreased, and the thickness of the vacuum heat insulating material is increased in contrast. Therefore, a proportion of the thickness of the vacuum heat insulating material relative to the wall internal thickness is increased. In other words, when the thickness of urethane is decreased relative to the wall internal thickness, the proportion of the thickness of the vacuum heat insulating material relative to the thickness of urethane is increased. In Fig. 19, when the ratio of "Thickness of Urethane/Wall Internal Thickness" is approximately 0.6, the thickness of urethane is larger than the thickness of the vacuum heat insulating material. Thus, the heat conductivity of urethane has a great influence on the composite heat conductivity (total heat conductivity of the vacuum heat insulating material and urethane), and hence the composite heat conductivity is high (heat insulating performance is poor). As the ratio of "Thickness of Urethane/Wall Internal Thickness" is set low, the proportion of the thickness of the vacuum heat insulating material relative to the thickness of urethane is increased. Thus, the heat conductivity of the vacuum heat insulating material has a greater influence on the composite heat conductivity than the heat conductivity of urethane has. As a result, as the ratio of "Thickness of Urethane/(Thickness of Urethane+Thickness of Vacuum Heat Insulating Material)" is decreased, the heat conductivity (composite heat conductivity) of the composite member formed by combining urethane and the vacuum heat insulating material is decreased. Therefore, when the ratio of "Thickness of Urethane/(Thickness of Urethane+Thickness of Vacuum Heat Insulating Material)" is approximately 0.3 or more, the heat conductivity of the vacuum heat insulating material has a greater influence on the composite heat conductivity than the heat conductivity of urethane has. Thus, the rate of decrease in composite heat conductivity is high. In this way, as the ratio of "Thickness of Urethane/(Thickness of Urethane+Thickness of Vacuum Heat Insulating Material)" is decreased, the composite heat conductivity is decreased, and hence the heat insulating performance is significantly enhanced.

[0260]

However, when the ratio of the thickness of urethane relative to the wall internal thickness, that is, the ratio of "Thickness of Urethane/(Thickness of Urethane+Thickness of Vacuum Heat Insulating Material)" is less than approximately 0.3, the steepness of the slope of the decrease in composite heat conductivity changes to be milder (rate of decrease in composite heat conductivity is decreased). The reason is considered as follows. The ratio of the thickness of urethane relative to the wall internal thickness, that is, the ratio of "Thickness of Urethane/Wall Internal Thickness" is decreased, and hence the heat insulating performance of the vacuum heat insulating material is predominant over the heat insulating performance of the composite member (member formed by combining urethane and the vacuum heat insulating material). As a result, influence of the heat insulating performance of urethane on the heat insulating performance of the composite member is decreased. As a countermeasure, in this embodiment, in the heat insulating wall formed of the composite member (heat insulating member formed of urethane and the vacuum heat insulating material adjacent to each other), the thickness of urethane is set such that the ratio of "Thickness of Urethane/Wall Internal Thickness" is 0.3 or less. With this, the rate of deterioration in heat insulating performance is low, and hence there is an advantage in that non-uniformity in heat insulating performance can be reduced even when the thickness of urethane or the thickness of the vacuum heat insulating material is non-uniform. In contrast, a ratio of "Thickness of Vacuum Heat Insulating Material/Wall Internal Thickness" may be set to 0.7 or more.

[0261]

Thus, when the thickness of urethane is set such that the ratio of "Thickness of Urethane/Wall Internal Thickness" is approximately 0.3 or less, the composite heat conductivity can be reduced, and hence the heat insulating performance of the composite member is significantly enhanced. Further, in consideration of the non-uniformity in thickness of urethane (or non-uniformity in thickness of the vacuum heat insulating material), when the ratio of "Thickness of Urethane/Wall Internal Thickness" is set within a range of 0.3 or less, deterioration in heat insulating performance of the composite member can be suppressed even when urethane or the vacuum heat insulating material varies in thickness. In addition, non-uniformity in composite heat conductivity of the composite member can be suppressed. Thus, a high-performance heat insulating wall, heat insulating box body, refrigerator, device, and the like, which are excellent in reliability, can be provided.

[0262]

Fig. 20 is a graph showing a relationship between the charging rate of the vacuum heat insulating materials, that is, the proportion of the volumes of the vacuum heat insulating materials 400 relative to the volumes of the wall internal spaces 315, and the deformation amount of the heat insulating box body at the time when a load is applied to the heat insulating box body 700. In Fig. 20, the abscissa axis represents the charging rate of the vacuum heat insulating materials, and the ordinate axis represents the deformation amount of the heat insulating box body. Note that, the charging rate of the vacuum heat insulating materials represents the ratio (proportion) of the volumes of the vacuum heat insulating materials 400 relative to the volumes of the wall internal spaces 315. The deformation amount of the heat insulating box body represents results of calculation of the amount of deformation in the right-and-left direction (lateral direction) at an upper end position of the lateral wall 790 of the box body 700 at the time when a predetermined load is applied in a substantially horizontal direction (lateral direction, that is, right-and-left direction in front view of the front opening portion) at a height position of approximately 1/4 from the top of the lateral wall of the box body such as the heat insulating box body of, for example, the refrigerator 1 under a state in which the door is mounted. The deformation amount at the time when the charging rate of the vacuum heat insulating materials 400 is set to 20% is defined as "1." The results shown in Fig. 20 are obtained in a case where the thickness of the vacuum heat insulating materials is varied to change the charging rate of the vacuum heat insulating materials while, for example, the coverage of the vacuum heat insulating materials (for example, 65%), the density of urethane (for example, 60 kg/m^3), the bending elastic modulus of urethane (for example, 9 MPa), the bending elastic modulus of the vacuum heat insulating materials (for example, 15 MPa), a thickness of the composite member (for example, 28 mm), and a total wall thickness inclusive of the thicknesses of the external box and the internal box (for example, 30 mm) are each set uniform.

[0263]

As shown in Fig. 20, in accordance with the increase in charging rate of the vacuum heat insulating materials, the deformation amount of the box body is decreased. The reason is considered as follows. The bending elastic modulus of the vacuum heat insulating materials is larger than the bending elastic modulus of urethane. Thus, in accordance with increase in ratio of the volumes of the vacuum heat insulating materials relative to the volume of urethane in the heat insulating box body, the influence of the bending elastic modulus of the vacuum heat insulating materials is increased. As a result, the box body 700 is increased in rigidity. When the charging rate of the vacuum heat insulating materials 400 is increased to 40% or more, a rate of decrease in deformation amount of the box body is significantly decreased, and the deformation amount of the box body scarcely varies even by further increasing the charging rate of the vacuum heat insulating materials. This may be because the degree of influence of the vacuum heat insulating materials 400 on the box body strength (deformation of the box body) has substantially reached the limit.

[0264]

The bending elastic modulus of the vacuum heat insulating materials 400 is larger than that of the rigid urethane foam. Thus, when the ratio (proportion) of the volumes of the vacuum heat insulating materials 400 relative to the volumes of the spaces 315 is increased (charging rate of the vacuum heat insulating materials is increased), the deformation amount of the heat insulating box body 700 can be reduced. Thus, the heat insulating box body 700 can be enhanced in heat insulating performance, and the heat insulating box body 700, the refrigerator 1, or the device can be increased in box body strength. At this time, when the charging rate is increased by increasing the thickness of the vacuum heat insulating materials 400, there is an advantage in that not only the strength but also the heat insulating performance of the box body can be enhanced. Note that, the charging rate of the vacuum heat insulating materials may be increased by increasing the thickness of the vacuum heat insulating materials, or the charging rate of the vacuum heat insulating materials may be increased by increasing a proportion of the surface areas of the vacuum heat insulating materials 400 relative to the surfaces area of the box body 700 (coverage of the vacuum heat insulating materials). Also in this case, the strength of the box body can be increased, and in addition, the charging rate of the vacuum heat insulating materials can be increased by increasing the coverage of the vacuum heat insulating materials 400. Further, when the coverage of the vacuum heat insulating materials 400 is increased, an arrangement range (arrangement part) of the vacuum heat insulating materials is increased. With this, the wall thickness of the heat insulating box body 700 can be reduced. Thus, by an amount of reducing the wall thickness, the internal capacity of the storage compartment can be increased.

[0265]

In this embodiment, for example, the vacuum heat insulating material 400 is arranged at least in a part of the spaces 315 between the external box 710 forming the outer shell of the heat insulating box body and the internal box 750 forming the parts of the inner walls of the storage compartment of the heat insulating box body. The charging rate of the vacuum heat insulating materials 400 relative to the spaces 315 is set to 40% or more. The ratio of the areas (coverage) of the vacuum heat insulating materials 400 relative to the surface area of the external box 710 is set to 60% or more. With this, a heat insulating box body, a refrigerator, a device, and the like, which are excellent in heat insulating performance, box body strength, and reliability, can be provided. Note that, in the configuration of this embodiment, the vacuum heat insulating materials 400, which are larger in bending elastic modulus than rigid urethane foam used in related-art heat insulating box bodies, are used to secure the wall surface strength of the heat insulating box body 700. With this, both the box body strength and the heat insulating performance can be satisfied. In addition, the wall thickness can be reduced, and hence the internal capacity of the storage compartment can be increased.

[0266]

In the heat insulating box body 700 according to this embodiment, the charging rate of the vacuum heat insulating materials 400 larger in bending strength than rigid urethane is set to a predetermined value or more (or within a predetermined range), or the charging rate and the coverage of the vacuum heat insulating materials 400 are each set to a predetermined value or more (or within a predetermined range). With this, both the heat insulating performance and the box body strength can be satisfied, and the wall thickness of the heat insulating box body 700 can be reduced. Thus, the internal capacity of the storage compartment can be increased without changing the outer sizes of the heat insulating box body 700 and the refrigerator 1, and hence the number of items to be housed or items to be stored in the heat insulating box body 700, the refrigerator 1, or the device can be increased. Note that, when the wall strength is decreased, the heat insulating box body 700 is distorted, which may cause such troubles that the shelves 80 installed in the inside are disengaged from the rail portions and dropped off, or that the pull-out type storage compartment (or pull-out door or case, or opening-and-closing door) is deteriorated in slidability. In this embodiment, the charging rate and/or the coverage of the vacuum heat insulating materials 400 is set to a predetermined value or more (within a predetermined range). Thus, the heat insulating box body 700 can be reduced in wall thickness, and enhanced in box body strength and heat insulating performance. As a result, deterioration in reliability, which is caused by the risk in that the shelves 80 are disengaged from the rail portions and dropped off, or that the pull-out type storage compartment (or door or case, or opening-and-closing door) is deteriorated in slidability, can be suppressed.

[0267]

Further, in the heat insulating box body 700 according to Embodiment 1, the charging rate of the vacuum heat insulating materials 400 relative to the spaces 315 is set to 90% or less. Based on the technical idea as described above in this embodiment, it is ideal that the spaces 315 be fully charged with the vacuum heat insulating materials 400. However, as described above with reference, for example, to Fig. 11, the convex portions 450 or the protruding portions 910 are formed on the rear wall 730, and the rail portions 755 are arranged in the internal box 750 in a manner of projecting into the spaces 315. Further, when the heat insulating box body 700 is used, for example, in the refrigerator 1, the pipe 720 for accommodating harnesses that bundle the wires for connecting the compressor 12 mounted in the machine room 1A in the heat insulating box body 700, the controller 30 (for controlling, for example, the rotation speed of the compressor) accommodated in the control board room 31, and the like to each other is also arranged in the wall internal spaces 315. Thus, the charging rate of the vacuum heat insulating materials 400 is difficult to set to more than 90%. Further, when the heat insulating box body 700 is applied, for example, to the refrigerator 1, the refrigerant pipe 725 or the like is also arranged in the spaces 315. Thus, when the vacuum heat insulating materials 400 are arranged to occupy more than 90% of the spaces 315, the vacuum heat insulating materials 400 need to be formed in conformity with shapes of, for example, the wires 720, the refrigerant pipe 725, or the rail portions 755. In this way, the vacuum heat insulating materials 400 are complicated in shape, and hence the vacuum heat insulating materials 400 are difficult to mold (or form). For those reasons, the charging rate of the vacuum heat insulating materials 400 is set to 90% or less.

[0268]

Further, in order to suppress distortion due to decrease in strength of the heat insulating box body 700, the external box 710, the internal box 750, and the vacuum heat insulating materials 400 need to be bonded to each other so that the bonding strength is secured therebetween. In many cases, in the internal box 750, the rail portions 755 for holding the shelves 80 installed in the storage compartment (such as refrigerator compartment 2), or other components (such as illumination device 900, misting device 200, or partition walls 24) are mounted, and hence the internal box 750 is complicated in shape. Thus, even when the vacuum heat insulating materials 400 are easily bonded to the external box 710 side with the second adhesive agent such as a hot melt adhesive or a double-faced tape, the vacuum heat insulating materials 400 are difficult to bond to the internal box 750 side complicated in shape to secure the bonding strength.

[0269]

However, when the rigid urethane foam is used as an adhesive agent between the internal box 750 and the vacuum heat insulating materials 400, the rigid urethane foam can be charged and foamed in the spaces 315 while being caused to flow in a two-phase state. Thus, even when the convex portions 450, the protruding portions 910, the rail portions 755, and other components are arranged in the spaces 315, the internal box 750 and the vacuum heat insulating materials 400 can be bonded to each other without problems by using urethane. As a matter of course, the rigid urethane foam may be charged as the adhesive agent between the external box 710 and the vacuum heat insulating materials 400, or between the external box 710 and the internal box 750. In this case, when uncharged portions (in other words, voids) in which the rigid urethane foam is not charged into the heat insulating box body 700 are formed, the heat insulating performance of the heat insulating box body 700 is deteriorated. As a countermeasure, in the heat insulating box body 700 according to this embodiment, predetermined gaps each having a certain size (specifically, approximately 1 mm or more, preferably approximately 3 mm or more) need to be secured so that the rigid urethane foam can be charged. Thus, the charging rate of the vacuum heat insulating materials 400 relative to the spaces 315 is preferably 90% or less, more preferably 80% or less.

[0270]

Incidentally, when the charging rate of the vacuum heat insulating materials 400 relative to the spaces 315 is increased, the charging rate of the rigid urethane foam relative to the spaces 315 is reduced. Thus, it seems that the box body strength of the heat insulating box body 700 may be reduced due to the reduction in thickness of urethane between the external box 710 and the internal box 750. However, the vacuum heat insulating materials 400 used in the heat insulating box body 700 according to this embodiment are superior to urethane in both heat insulating performance and bending rigidity. Thus, the reduction in box body strength can be suppressed. Further, this embodiment is carried out based on the technical idea of securing the heat insulating function and the strength mainly with the vacuum heat insulating materials 400 having low heat conductivity. Thus, even when a charging amount of rigid urethane is reduced as a result of setting the charging rate of the vacuum heat insulating materials to 40% or more as shown in Fig. 20, the strength of the box body 700 can be increased. Further, as shown in Fig. 19, when the thickness of the vacuum heat insulating materials 400 is increased (in other words, when the charging rate of the vacuum heat insulating materials is increased), the composite heat conductivity of the composite heat insulating material formed by combining the vacuum heat insulating material and the rigid urethane foam can be reduced. As a result, the heat insulating performance of the box body 700 can be enhanced.

[0271]

Note that, when the bending elastic modulus (bending rigidity) of the rigid urethane foam is increased by increasing its density, the heat insulating performance of the rigid urethane foam itself is deteriorated. However, the coverage and the charging rate of the vacuum heat insulating materials 400 are each set to a predetermined value or more so that the influence of the deterioration in heat insulating performance of urethane is insignificant to cause no problem. In the heat insulating box body 700 according to this embodiment, as shown in Fig. 16, when the density of the rigid urethane foam is set higher than that in the related art, for example, to 60 kg/m^3 or more, the bending elastic modulus of the rigid urethane foam can be set higher than a bending elastic modulus of rigid urethane foam that has been used in related-art heat insulating box bodies (for example, from approximately 6 MPa to 10 MPa). Specifically, the bending elastic modulus can be set to 15 MPa or more. Thus, the box body strength can be increased also at the parts where the vacuum heat insulating materials 400 are not arranged. Therefore, in the heat insulating box body 700, the refrigerator 1, and the devices such as a showcase and a hot water supplier according to this embodiment, when the charging rate of the vacuum heat insulating materials 400 is set to 40% or more, and when a coverage of the vacuum heat insulating materials relative to the lateral and rear surfaces is set to 70% or more, the strength reduction to be caused by the reduction in charging rate of the rigid urethane foam can be suppressed. In addition, the deformation of the heat insulating box body 700, which is caused by distortion due to an overload of the housed items, can be suppressed. In other words, when the charging rate of the vacuum heat insulating materials 400 is increased, the strength of the heat insulating box body 700 can be increased. Further, excellent heat insulating performance can be obtained. Thus, a heat insulating box body including the vacuum heat insulating material, a refrigerator including the vacuum heat insulating material, a showcase including the vacuum heat insulating material, a hot water supply device including the vacuum heat insulating material, a device including the vacuum heat insulating material, and the like, which are excellent in reliability and energy efficiency, can be provided.

[0272]

Note that, the density of the rigid urethane foam can be adjusted to be high or low, for example, by charging a larger amount of the liquid raw material of the rigid urethane foam to be injected into the spaces 315 than that in the related art (prolonging an injection duration, or increasing injection pressure). Further, as shown in Fig. 16, the bending elastic modulus of the rigid urethane foam is increased substantially in proportion to the magnitude of the density, and hence can be increased by increasing the density. When the bending elastic modulus is high, there is an advantage in that the box body rigidity is increased. However, the bending elastic modulus of urethane is preferably 150 MPa or less. When the bending elastic modulus of the rigid urethane foam is more than 150 MPa, the density of the rigid urethane foam is excessively high. As a result, the rigid urethane foam is cured without being foamed into a sponge, and the heat insulating performance is abruptly deteriorated. For this reason, when the bending elastic modulus of the rigid urethane foam is set to 150 MPa or less, there is an advantage in that deterioration in heat insulating performance can be suppressed. With this, a high-performance heat insulating box body can be provided. Further, when the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member is excessively high, there arise problems of, for example, quality degradation, performance deterioration, and cost increase, specifically, (1) cost may be increased due to increase in injection amount of urethane, (2) leakage of urethane from the box body or the like may occur due to increase in injection pressure of urethane, (3) a force of close contact or an adhesive force between urethane and a box body deformation suppressing die set, a box body pressing member, or the like may be increased due to increase in foaming pressure at the time of foaming of urethane, with the result that the box body deformation suppressing die set, the box body pressing member, or the like may be difficult to pull out of the box body (difficult to take out of the box body), and

(4) the heat insulating performance may be abruptly deteriorated due to the increase in density of urethane. As a countermeasure, the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member (density after foaming as for the foam heat insulating material) is set to preferably 100 kg/m^3 or less (more preferably 90 kg/m^3 or less).

[0273]

In this embodiment, the heat insulating box body 700 is applied to refrigerators having the specifications as follows.

(1) Using such a heat insulating box body that a total plate thickness of the external box 710 and the internal box 750 is set to approximately 2 mm or less, and an average wall thickness of the heat insulating box body 700 inclusive of a plate thickness of the external box 710 and a plate thickness of the internal box 750 is set to approximately 20 mm or more and approximately 40 mm or less (note that, the wall thickness including the plate thicknesses of the rear wall 730, the lateral wall 790, the top wall 740, the bottom wall 780, the upper wall 24, and the like is preferably approximately 20 mm or more and 40 mm or less, and an average distance (wall internal thickness) in a wall thickness direction of the space 315 excluding the plate thicknesses of the external box 710 and the internal box 750 is set to approximately 18 mm to approximately to 38 mm).

(2) Setting the thickness of the vacuum heat insulating materials 400 to approximately 10 mm to approximately 30 mm, and setting an average passage width in the wall thickness direction of the rigid urethane foam in the wall internal spaces 315 (thickness of urethane in the passage) at the parts where the vacuum heat insulating materials are arranged (such as concave portion 440 or second concave portion 441) to 1 mm or more (preferably 3 mm or more) and to 11 mm or less (preferably less than 10 mm in consideration of, for example, variation and the concavo-convex portions on the surfaces of the vacuum heat insulating materials 400, more preferably 6 mm or less).

(3) Setting the heat conductivity of the rigid urethane foam to 0.018 W/(m·K)

to 0.026 W/(m·K).

(4) Setting the heat conductivity of the vacuum heat insulating materials 400 to 0.0019 W/(m·K) to 0.0025 W/(m·K).

(5) Having an internal capacity of from 200 L to 600 L, and having a power consumption of approximately 60 W or less under a predetermined condition.

[0274]

For the heat insulating performance of such a refrigerator 1, the charging rate and the coverage of the vacuum heat insulating materials 400 are each set within a predetermined range, and then the size and the thickness of the vacuum heat insulating materials 400 are selected. As a result, the vacuum heat insulating materials 400 are predominant over the heat insulating performance and the box body strength of the heat insulating box body. In this way, when the heat conductivity of the vacuum heat insulating materials 400 is low, there is an advantage in that the composite heat conductivity of the heat insulating box body can be reduced. The heat conductivity is preferably set to 0.0030 W/(m·K) or less. When the heat conductivity of the vacuum heat insulating materials 400 exceeds 0.0030 W/mK, influence on the heat insulating performance due to the reduction in wall thickness is increased. As a result, the heat insulating performance is deteriorated, and the power consumption is increased. As a countermeasure, in this embodiment, the heat conductivity of the vacuum heat insulating materials 400 is set to 0.0030 W/(m·K) or less to suppress the influence of the deterioration in heat insulating performance due to the reduction in wall thickness. Further, although the lower heat conductivity of the vacuum heat insulating materials 400 is preferred, a significantly high cost is required to reduce the heat conductivity to 0.001 W/(m·K). Therefore, the heat conductivity of the vacuum heat insulating materials 400 to be used is set to 0.0012 W/(m·K) or more. When the heat conductivity of the vacuum heat insulating materials 400 is 0.0019 W/(m·K) or more and 0.0025 W/(m·K) or less, the heat conductivity is approximately ten times as low as the heat conductivity of the rigid urethane foam. Thus, the heat insulating performance of the heat insulating box body 700 is significantly enhanced in comparison with that in the related art, and hence product specifications can be satisfied. For those reasons, it is appropriate to use the vacuum heat insulating materials 400 having the heat conductivity of approximately 0.0012 W/(m·K) or more and 0.0030 W/(m·K) or less (preferably approximately 0.0019 W/(m·K) or more and 0.0025 W/(m·K) or less).

[0275]

As an example of the heat insulating box body 700 according to the embodiment of the present invention, the relationship between the wall thickness, the charging rate of the vacuum heat insulating materials 400, the bending elastic modulus of the rigid urethane foam, and the box body deformation amount of the heat insulating box body 700 is shown in Table 1. Results shown in Item 1 in Table 1 are obtained under related-art specifications, in which the wall thickness is 40 mm, the charging rate of the vacuum heat insulating materials 400 is 20%, and the bending elastic modulus of urethane to be charged between the internal box 750 and the vacuum heat insulating materials 400 is 9 MPa. In this case, the bending elastic modulus of the vacuum heat insulating materials 400 to be used is set to 20 MPa. As shown in Item 1 and Item 2 in Table 1, when the charging rate of the vacuum heat insulating materials 400 is set to 20% and the bending elastic modulus of urethane is set to 9 MPa, as long as the wall thickness of the heat insulating box body 700 is reduced from 40 mm to 30 mm, the box body strength is reduced. Thus, as shown in Item 3, when the wall thickness is reduced to 30 mm, as long as the charging rate of the vacuum heat insulating materials 400 is increased to 40% or more, the deformation amount of the box body is reduced to be somewhat larger than but equivalent to that in Item 1 (related art).

[0276]

As shown in Item 4 in Table 1, even when the wall thickness of the heat insulating box body 700 is reduced from 40 mm in the related art (Item 1 in Table 1) to 30 mm, as long as the charging rate of the vacuum heat insulating materials 400 is 40% or more and the bending elastic modulus of urethane is set to 15 Mpa or more (Item 4 in Table 1), the deformation amount of the box body can be reduced in comparison with that in the related art (Item 1). Thus, the box body strength of the heat insulating box body 700 can be increased to be equal to or more than that of the related-art product (Item 1). In other words, even when the wall thickness is reduced (for example, from 40 mm to 30 mm), as long as the charging rate of the vacuum heat insulating materials 400 and the bending elastic modulus of urethane are each set to a predetermined value or more, the heat insulating performance can be enhanced without reducing the box body strength. Thus, in this embodiment, the vacuum heat insulating materials 400 to be used have the bending elastic modulus of 20 MPa or more, the charging rate of the vacuum heat insulating materials 400 is set to 40% or more, and the bending elastic modulus of the rigid urethane foam is set to 15 MPa or more. With this, even when the wall thickness of the heat insulating box body is reduced (for example, from 40 mm to 30 mm), the strength of the heat insulating box body 700 can be increased in comparison with that in the related art.

[0277]

[Table 1]

Item	Wall thickness mm	Charging rate %	Bending elastic modulus of urethane Mpa	Deformation amount of box body
1	40	20	9	1
2	30	20	9	1.53
3	30	40	9	1.08
4	30	40	15	0.93

[0278]

Further, as the outer wrapping material (outer film) to form the outer shell of the vacuum heat insulating material 400, it is preferred to use an aluminum-deposited film to an aluminum foil film. In order to suppress heat leakage through intermediation of the outer wrapping material of the vacuum heat insulating material 400 (what is called heat bridge in which heat is transferred and leaked from a front surface to a back surface of the vacuum heat insulating material 400 via the outer wrapping material of the vacuum heat insulating material 400), as the outer wrapping material (outer film) of the vacuum heat insulating material 400, it is preferred to use the aluminum-deposited film, which is less liable to cause the heat bridge than the aluminum foil film.

[0279]

Note that, the bending elastic modulus, the heat conductivity, and the density of the rigid urethane foam according to Embodiment 1 may be measured by, for example, cutting out the rigid urethane foam into a predetermined size (for example, 100×100×5 mm or more). At the parts where the vacuum heat insulating materials 400 are arranged, it is appropriate to cut out a plurality of pieces of the parts where the vacuum heat insulating materials are arranged respectively from the five surfaces of the right and left lateral surfaces, the rear surface, the top surface, and the bottom surface, and to calculate an average value therebetween (when only a single piece can be cut out, the measurement may be performed at a plurality of positions in the single piece). When the vacuum heat insulating materials are arranged also in the doors, the density, the bending elastic modulus, and the heat conductivity of urethane in the doors may also be measured. Further, also at the parts where the vacuum heat insulating materials 400 are not arranged, it is appropriate to cut out a plurality of pieces of the parts respectively from the five surfaces of the right and left lateral surfaces, the rear surface, the top surface, and the bottom surface, and to calculate an average value therebetween. In this embodiment, in any of the cases, the measurement is performed on the pieces cut out from the positions where the density or the bending elastic modulus is presumably high. Note that, when the rigid urethane foam cannot be cut out into a predetermined size as in the case where the refrigerant pipe 725 or the pipe component 720 such as the lead wires are arranged, the rigid urethane foam may be cut out at a position near a central positon so that the rigid urethane foam of a predetermined size can be cut out.

[0280]

In this embodiment, on each of the six surfaces of the right lateral surface, the left lateral surface, the rear surface, the top surface, the bottom surface, and the door, the density or the bending elastic modulus of urethane is measured at a part where the vacuum heat insulating materials 400 are arranged and a part where the vacuum heat insulating materials 400 are not arranged, and the density or the bending elastic modulus of urethane is set to a predetermined value or more. Through adjustment of, for example, the free foam density of urethane, the thickness of the vacuum heat insulating materials, and the wall thickness, the density or the bending elastic modulus of urethane to be interposed between the vacuum heat insulating material 400 and the internal box 750, between the vacuum heat insulating material 400 and the external box 710, or between the external box 710 and the internal box 750 can be set to a predetermined value or more.

[0281]

Note that, in this embodiment, on each of the six surfaces of the right and left lateral surfaces, the rear surface, the top surface, the bottom surface, and the door, the density or the bending elastic modulus of urethane is set to a predetermined value or more at least in the part where the vacuum heat insulating material 400 is arranged. In addition, on each of the surfaces, the density or the bending elastic modulus of urethane may be set to a predetermined value or more at least in the part where the vacuum heat insulating material 400 is not arranged. Note that, when, on each of the six surfaces of the right and left lateral surfaces, the rear surface, the top surface, the bottom surface, and the door, the density or the bending elastic modulus of urethane is set to a predetermined value or more, the strength of the part where the vacuum heat insulating material 400 is not arranged is also increased. Further, the strength of each of the surfaces can be independently obtained, and hence high strengths can be set only at parts where high strengths are required. With this, a good heat insulating box body, refrigerator, and device, which are low-cost and excellent in reliability, can be provided. Further, when the average value of the density or the bending elastic modulus on the six surfaces of the right and left lateral surfaces, the rear surface, the top surface, the bottom surface, and the door is set to a first predetermined value or more (to a density of 60 kg/m^3 or more, or a bending elastic modulus of 15 MPa or more) and a second predetermined value or less (to a density of 100 kg/m^3 or less, or a bending elastic modulus of 150 MPa or less), the strength of the entire box body can be secured. With this, a heat insulating box body, a refrigerator, and a device, which are excellent in heat insulating performance and reliability, can be provided.

[0282]

Still further, also for the coverage or the charging rate of the vacuum heat insulating materials 400, when the coverage or the charging rate relative to each of the six surfaces of the right and left lateral surfaces, the rear surface, the top surface, the bottom surface, and the door or a total of the coverages or the charging rates relative to the plurality of surfaces is set to a predetermined value or more, the strength and the heat insulating performance of each of the surfaces can be independently obtained, and hence high strengths can be set only at parts where high strengths are required. With this, a heat insulating box body, a refrigerator, and a device, which are low-cost and excellent in heat insulating performance and reliability, can be provided. In addition, when all of the six surfaces of the right and left lateral surfaces, the rear surface, the top surface, the bottom surface, and the door are set to a predetermined value or more, the strength and the heat insulating performance of the entire box body can be secured and enhanced. With this, a heat insulating box body, a refrigerator, and a device, which are excellent in heat insulating performance and reliability, can be provided.

[0283]

As described above, in the heat insulating box body 700 according to this embodiment, the coverage of the vacuum heat insulating materials 400 is set to more than a predetermined value (60%) (the coverage of the vacuum heat insulating materials 400 relative to the lateral and rear surfaces is set to 70% or more). Further, the charging rate of the vacuum heat insulating materials 400 is also set to a predetermined value (40%) or more so that the charging amount of the rigid urethane foam is reduced. With this, while securing the heat insulating performance and the box body strength of the heat insulating box body, the wall thickness of the heat insulating box body 700 can be reduced in comparison with that in the related art. Therefore, the heat insulating performance can be enhanced, and hence the energy efficiency can be increased. In addition, the wall thickness can be reduced, and hence, in accordance therewith, the internal capacity of the storage compartment can be increased in comparison with that in the related art. As a result, the heat insulating box body 700, the refrigerator 1, the showcase, and the device, which are excellent in internal volumetric efficiency, can be provided. In other words, according to the embodiment of the present invention, without changing the outer sizes of the heat insulating box body 700, the refrigerator 1, or the device such as the showcase, the internal capacities (such as internal capacities of the storage compartments 2 to 6) can be increased in comparison with those in the related art. Thus, a larger number of items to be housed can be stored in the heat insulating box body 700 or the refrigerator 1 than those in the related art. With this, the heat insulating box body 700, the refrigerator 1, and the device such as a showcase, which are user-friendly and energy-efficient, can be provided. Meanwhile, when the internal capacities (such as internal capacities of the storage compartments 2 to 6) are set equivalent to those in the related art, the outer sizes can be reduced. With this, the heat insulating box body 700, the refrigerator 1, and the devices such as a showcase and a hot water supply device, which are energy-efficient and compact, can be provided.

[0284]

Note that, the configuration and the shape of the heat insulating box body 700 and the refrigerator 1 described in this embodiment are merely an example. Specifically, the stored item housing space of the heat insulating box body 700 may be partitioned with three lateral partition plates into four housing spaces (storage compartments) in the vertical direction. Alternatively, for example, the stored item housing space of the heat insulating box body 700 may be partitioned not only with the three lateral partition plates but also with a vertical partition plate into five housing spaces (storage compartments). By increasing the number of the partition plates, the strength of the heat insulating box body 700 can be further increased. In other words, when the number of the partition plates is increased so as to increase the number of housing compartments or storage compartments, an effect of increasing the box body strength by the partition plates is obtained. Thus, even when an average thickness of the rigid urethane foam is reduced (for example, to 11 mm or less, preferably less than 10 mm, more preferably 6 mm or less) at the parts covered with the vacuum heat insulating materials 400 (spaces 315 between the vacuum heat insulating materials 400 and the internal box 750), the box body strength can be sufficiently secured. Thus, the internal capacity of the storage compartment can be further increased without changing the outer size of the heat insulating box body 700, and hence the number of items to be housed and stored in the heat insulating box body 700 can be further increased.

[0285]

Further, in this embodiment, the partition wall 24 may have the same internal structure as that of the heat insulating box body 700. Specifically, the vacuum heat insulating material 400 is arranged in an internal space of the partition wall 24, and rigid urethane foam is charged therein. The rigid urethane foam only needs to be used as the adhesive agent, and hence may be thinned, for example, to preferably approximately 11 mm or less (more preferably less than 10 mm in consideration of, for example, variation and the concavo-convex portions on the surface of the vacuum heat insulating material), still more preferably approximately 6 mm or less. Note that, unlike the heat insulating box body 700, the pipe 725, the wires 720, and the like are not arranged in the partition wall 24 in many cases. In such cases, the charging rate of the vacuum heat insulating material 400 relative to the partition wall 24 may be set equivalent to that relative to the heat insulating box body 700. Specifically, the charging rate may be set to 40% or more and 90% or less. For the partition wall 24, the vacuum heat insulating material 400 can be arranged substantially all over the size of the partition wall 24 (space in the partition wall 24), and hence the charging rate of the vacuum heat insulating material 400 can be increased to approximately 40% or more and 95% or less. Further, it is appropriate to set the bending elastic modulus of the rigid urethane foam to 15 MPa or more, and the density thereof to more than 60 kg/m^3. In this way, when the vacuum heat insulating material 400 is arranged also in the partition wall 24, and the charging rate thereof is set within a predetermined range, the heat insulating performance of the heat insulating box body 700 can be further enhanced.

[0286]

In this embodiment, as for the heat insulating box body or the heat insulating wall including the vacuum heat insulating materials, in consideration of the assembly efficiency, the vacuum heat insulating materials 400 are attached directly to the external box 710 with the second adhesive agent other than foamed urethane, such as a hot melt adhesive or a double-faced tape, and rigid urethane foam is charged as the adhesive agent intended mainly to perform bonding between the vacuum heat insulating materials 400 and the internal box 750. Alternatively, spacers made of a resin such as EPS may be arranged in the spaces 315 formed between the external box 710 and the internal box 750 so that the vacuum heat insulating materials 400 are arranged in a floating manner between the internal box 750 and the external box 710. In this state, the rigid urethane foam may be charged between the vacuum heat insulating materials 400 and the external box 710, and between the vacuum heat insulating materials 400 and the internal box 750. Still alternatively, the vacuum heat insulating materials 400 may be attached directly to the internal box 750 with the second adhesive agent such as a hot melt adhesive or a double-faced tape, and the urethane foam may be charged between the vacuum heat insulating materials 400 and the external box 710.

[0287]

Note that, when the vacuum heat insulating materials 400 are arranged in a floating manner with the spacers or the like between the external box 710 and the internal box 750, it is appropriate to arrange the spacers on the inner surface side of the external box 710 (space between the external box 710 and the vacuum heat insulating materials 400), and to arrange the refrigerant pipe 725 (such as condensation pipe) in a space formed by the spacers. The refrigerant pipe 725 is used also as a condensation pipe through which high-temperature and high-pressure refrigerant discharged from the compressor 12 arranged in the machine room 1A is caused to flow. Specifically, the refrigerant caused to flow through the pipe 725 is condensed by being cooled with the air around the pipe 725, specifically, by heat transfer through intermediation of a pipe wall of the refrigerant pipe 725 and the external box 710, to thereby use the pipe 725 as the condensation pipe. Further, the heat insulating box body 700 according to this embodiment can be easily manufactured by arranging, on an inner wall of the external box 710 at a position of not overlapping with (position of not facing) the refrigerant pipe 725, a resin spacer having a thickness equal to or larger than a diameter of the refrigerant pipe 725, and by attaching the vacuum heat insulating materials 400 to the spacer, to thereby allow the spacer, to which the vacuum heat insulating materials 400 are attached, to be attached directly to the external box 710 with a double-faced tape or the like in a manner of covering the refrigerant pipe 725 under a state in which the refrigerant pipe 725 is routed along the external box 710. In the heat insulating box body 700 according to this embodiment, the vacuum heat insulating materials 400 are arranged at a predetermined interval with the internal box 750, and the vacuum heat insulating materials 400 are arranged at a predetermined interval with the external box 710. Thus, the vacuum heat insulating materials 400 are embedded in the rigid urethane foam. With this structure, the heat insulating performance is enhanced.

[0288]

As described above, in this embodiment, in the space 315 between the external box 710 and the internal box 750 of the heat insulating box body 700, the rigid urethane foam may be charged and foamed in a manner that the vacuum heat insulating materials 400 are embedded in the rigid urethane foam. In many cases, the condensation pipe 725 is arranged between the external box 710 and the vacuum heat insulating materials 400. Thus, a predetermined distance is secured between the vacuum heat insulating materials 400 and the external box 710 with the spacer made of a resin such as EPS so that the vacuum heat insulating materials 400 can be arranged.

[0289]

Further, a risk in that the vacuum heat insulating materials 400 absorb an ambient gas is increased in accordance with increase in temperature, and hence the degree of vacuum therein is decreased. As a result, the heat conductivity may be deteriorated. When an outside air temperature is high as in a summer season, an ambient temperature of the external box 710 (temperature of ambient air) is increased. In accordance therewith, a temperature of the external box 710 itself may be increased. Further, a temperature of the pipe 725 to be used as the condensation pipe is also increased. Thus, in view of securing the reliability of the vacuum heat insulating materials 400, it is desired that the vacuum heat insulating materials 400 be spaced away from the external box 710 or the refrigerant pipe (condensation pipe) 725. When the vacuum heat insulating materials 400 are spaced away from the external box 710 or the refrigerant pipe (condensation pipe) 725, the vacuum heat insulating materials 400 can be suppressed from being deteriorated due to the increase in temperature. Thus, when the vacuum heat insulating materials 400 are spaced away from the wall surface of the external box 710 or the refrigerant pipe 725 in a floating manner by using the spacer or the like, deterioration in heat insulating performance can be suppressed. With this, the heat insulating box body 700 and the refrigerator 1, which are excellent in long-term reliability, can be provided.

[0290]

Further, the vacuum heat insulating materials 400 may absorb the ambient gas (such as air) to cause the decrease in degree of vacuum therein and the deterioration in heat conductivity. When the vacuum heat insulating materials 400 are embedded in the rigid urethane foam, for example, by attaching the space made of a resin such as EPS to the external box 710, the amount of the ambient gas (such as air) that is present around the vacuum heat insulating materials 400 can be reduced. Thus, the vacuum heat insulating materials 400 can be suppressed from absorbing the ambient gas (such as air), and hence the vacuum heat insulating materials 400 can be suppressed from being deteriorated due to the decrease in degree of vacuum. With this, the heat insulating box body 700, the refrigerator 1, the device, and the like, which are capable of maintaining high heat insulating performance over a long time period and excellent in reliability, can be provided.

[0291]

In particular, the density of the rigid urethane foam used in the heat insulating box body 700 according to this embodiment is higher than the density of the rigid urethane foam used in related-art heat insulating box bodies (set to more than 60 kg/m^3). In accordance with the increase in density, the amount of bubbles in the rigid urethane foam is reduced, and hence the amount of gas (amount of air) in the bubbles can be reduced. Thus, when the rigid urethane foam is charged or arranged in a manner of embedding or covering the peripheries of the vacuum heat insulating materials 400, the amount of the ambient gas (such as air) that is present around the vacuum heat insulating materials 400 can be reduced. With this, the decrease in degree of vacuum in the vacuum heat insulating materials 400 can be suppressed (as the density of urethane is increased, the number of voids in urethane is decreased, and hence the amount of air in urethane is also decreased). In particular, when urethane is thin (for example, 11 mm or less), the gas such as air, for example, from the periphery of urethane is liable to enter the vacuum heat insulating materials 400. Thus, when the density of urethane is increased so as to reduce the amount of the ambient gas of the vacuum heat insulating materials 400, a great effect of suppressing the deterioration of the vacuum heat insulating materials 400 can be obtained. Thus, the vacuum heat insulating materials 400 can be further suppressed from being deteriorated, and hence the heat insulating box body 700, the refrigerator 1, and the device, which are excellent in long-term reliability, can be provided.

[0292]

Note that, in the heat insulating box body 700 described in the example of this embodiment, the refrigerant pipe 725 is arranged in the space 315. Also in the heat insulating box body 700 in which the refrigerant pipe 725 is not arranged in the space 315, as a matter of course, the vacuum heat insulating materials 400 may be embedded in the rigid urethane foam. The amount of the ambient gas that is present around the vacuum heat insulating materials 400 can be reduced, and hence the vacuum heat insulating materials 400 can be suppressed from being deteriorated. With this, the heat insulating box body 700 excellent in long-term reliability can be provided.

[0293]

Note that, as in the heat insulating box body 700 or the refrigerator 1 in which the rail portions (such as pull-out rails or concave portion in the pull-out type storage compartment) 755 are not formed in the internal box 750, when the internal box 750 is formed into a shape in which the vacuum heat insulating materials 400 are directly and easily attached with the adhesive agent, a double-faced tape, or the like, an entirety or part of the vacuum heat insulating materials 400 may be arranged on the internal box 750 side.

[0294]

Further, as in the heat insulating box body 700 of this embodiment, when the vacuum heat insulating materials 400 are attached directly to the internal box 750 side with a hot melt adhesive or a double-faced tape, the heat insulating box body 700 and the refrigerator 1, which can be reduced in amount of the vacuum heat insulating material 400, increased in energy efficiency, and increased in internal volumetric efficiency of the storage compartments in comparison with that in the related art, can be provided. Specifically, when the heat insulating box body 700 has a substantially rectangular parallelepiped shape or a cylindrical shape, the surface area of the external box 710 is larger than the surface area of the internal box 750. Thus, when the vacuum heat insulating material 400 is attached, the area of the vacuum heat insulating material 400 to be stretched over the surface of the internal box 750 is smaller than the area of the vacuum heat insulating material 400 to be stretched over the surface of the external box 710. With this, a heat insulating box body, a refrigerator, a showcase, a hot water supplier, and a device, which are low-cost and excellent in heat insulating performance, can be provided. Further, for example, when the vacuum heat insulating materials 400 having the same size are attached, at a corner portion of the heat insulating box body 700 having the rectangular parallelepiped shape (such as corner portion as a connecting portion between the rear surface and the lateral surface, corner portion between the top surface and the lateral surface, or corner portion between the top surface and the rear surface of the heat insulating box body 700), a gap at a corner portion between the vacuum heat insulating materials 400 in wall surfaces adjacent to each other (such as gap or distance between the vacuum heat insulating material 400 in the top surface and the vacuum heat insulating material 400 in the adjacent lateral surface) is larger in a case where the vacuum heat insulating materials 400 are arranged on the external box 710 side than in a case where the vacuum heat insulating materials 400 are arranged on the internal box 750 side.

In other words, when the vacuum heat insulating materials 400 are arranged on the internal box 750, the gaps to be formed between the adjacent vacuum heat insulating materials 400 can be narrowed in comparison with those in the case where the vacuum heat insulating materials 400 having the same size are arranged on the external box 710. By an amount corresponding to the narrowed gaps, heat loss to be caused by heat leakage can be reduced. With this, the heat insulating box body 700, the refrigerator 1, a hot water supplier, a showcase, and a device, which are excellent in heat insulating efficiency, can be provided.

[0295]

Further, the heat insulating box body 700 according to this embodiment includes the opening-and-closing doors of the hinge type or the pull-out type, for opening or closing the opening portions of the plurality of storage compartments 2, 3, 4, 5, and 6 formed therein by being partitioned, for example, by the partition walls 24. Those doors each include an outer shell member (outer plate) made, for example, of a metal, and an inner member (inner plate) made, for example, of a resin. Then, in a door internal space formed between the outer shell member and the inner member, the rigid urethane foam and the vacuum heat insulating material 400 are arranged (charged). Also in the doors, the charging rate of the vacuum heat insulating material relative to the heat insulating box body described in this embodiment is set within the predetermined range, and the doors are formed based on the technical idea of securing most of the heat insulating functions with the vacuum heat insulating materials 400. Thus, the charging rate of the vacuum heat insulating materials 400 relative to the door internal spaces is set to 40% to 90%, and the coverage thereof is set to 70% or more.

[0296]

At the time of manufacturing such an opening-and-closing door, the vacuum heat insulating materials 400 are bonded and fixed in advance to the outer shell member, for example, with the second adhesive agent, and the liquid raw material of the rigid urethane foam is injected into the space between the vacuum heat insulating materials and the inner member and the space between the outer member and the inner member, and foamed so that the outer shell member, the vacuum heat insulating materials 400, and the inner member are formed integrally with each other. In this way, the rigid urethane foam as the foam heat insulating materials can be charged into the door internal space. Also in this case, the thickness of the rigid urethane foam only needs to be set so that the strength of the adhesive agent can be secured, and hence may be set to 1 mm or more, preferably 3 mm or more, and 11 mm or less (preferably less than 10 mm, more preferably 6 mm or less).

[0297]

Note that, in the opening-and-closing door, frames for supporting the housing box (housing case 520), the door pockets, the shelves 80, or the like may be mounted to the storage compartments 2, 3, 4, 5, and 6. In this case, fixing screws for the frames, the fixing members for the door pockets, mounting members for the shelves 80, or the like may need to be fastened to or held on an inner side of the opening-and-closing door (compartment interior side) with fastening members, fixing members, or holding members such as screws. In such a case, the fastening members, the fixing members, or the holding members may be projected into the door internal space to damage the outer wrapping material of the vacuum heat insulating material when being brought into contact with the vacuum heat insulating material 400. Therefore, it is preferred that the urethane foam to be arranged or charged into the opening-and-closing door have a thickness so as not to damage the vacuum heat insulating material 400. Note that, when it is not particularly necessary to mount the mounting components to be mounted to the storage compartment interior side (inner plate side) of the opening-and-closing door (such as fastening members, fixing members, or holding members), the vacuum heat insulating materials 400 may be attached to the inner plate. Note that, when the vacuum heat insulating materials are arranged so as not to overlap with the mounting components, the vacuum heat insulating materials may be attached to the inner plate.

[0298]

Further, when the outer shell member (outer plate) and the inner member (inner plate) are arranged, the vacuum heat insulating material 400 is arranged in the door internal space formed between the outer shell member and the inner member, and the rigid urethane foam as the foam heat insulating material is charged between the outer shell member or the inner member and the vacuum heat insulating material 400, as long as the density of the foam heat insulating material is set to more than 60 kg/m^3, the holding strength or the fixing strength of the screws or the like as the fixing members for fixing the frames for supporting the housing box (housing case 520) is increased. With this, even when heavy items are housed in the case 520, the door is less liable to be deformed, and hence the case 520 can be stably pushed in and pulled out. As a result, a refrigerator and a device, which are excellent in reliability, can be provided. Further, the holding strength or the fixing strength of the screws or the like as the fixing members for fixing a separate member such as a handle is increased. Thus, when the member to be mounted to the door, such as the handle that is a separate member, is mounted to the door, the mounting strength of the member to be mounted to the door is increased. With this, the door is less liable to be deformed, and hence the door can be stably opened and closed. As a result, a refrigerator and a device, which are excellent in reliability, can be provided. In addition, when the rigid urethane foam as the foam heat insulating material between the outer shell member or the inner member and the vacuum heat insulating material 400 is set to more than 60 kg/m3, the bending elastic modulus of the foam heat insulating material is increased, and the strength of the door is also increased.

[0299]

Note that, the vacuum heat insulating material 400 may be arranged in all of the opening-and-closing doors, or may be arranged in some of the opening-and-closing doors. Specifically, when a difference in temperature between the outside air and the inside of the heat insulating box body 700 (specifically, inside of the storage compartment) is relatively small (such as storage compartments in a refrigerating temperature range, including the refrigerator compartment 2 or the vegetable compartment 5), even though the vacuum heat insulating material 400 is arranged in the opening-and-closing door, an effect of improving the heat insulating performance is insignificant. In such a case, even when the vacuum heat insulating material 400 is not arranged in the opening-and-closing door, sufficient heat insulating performance can be secured. When the difference in temperature between the outside air and the inside of the heat insulating box body 700 (specifically, inside of the storage compartment) is relatively large (such as storage compartments in a freezing temperature range, including the ice making compartment 3, the switching compartment 4, or the freezer compartment 6), the vacuum heat insulating material 400 has a significant effect of improving the heat insulating performance as long as the vacuum heat insulating material 400 is arranged in the opening-and-closing door. Thus, as for the storage compartments in the freezing temperature range, that is, in the case where the difference in temperature between the outside air and the inside of the heat insulating box body 700 (specifically, inside of the storage compartment) is relatively large, when the vacuum heat insulating material 400 is arranged in the opening-and-closing door, sufficient heat insulating performance can be secured.

Further, the glass plate member may be used as the door outer plate. In this case, it is appropriate that the inner member be formed of a resin into a shape having a frame portion and a compartment internal side-surface portion and also having an opening formed on the front side, that the door internal space be formed by attaching, instead of the outer plate, the glass plate member with a double-faced tape or the like to the opening portion formed on the front side (side opposite to the compartment internal side-surface portion) of the frame portion of the inner member, and that the rigid urethane foam and the vacuum heat insulating material 400 be arranged (charged) in this door internal space. Further, the vacuum heat insulating material 400 is bonded to the compartment internal side-surface portion of the inner member with the second adhesive agent such as a double-faced tape, and in this state, the adhesive agent (such as rigid urethane foam) being the intermediate member is charged, applied, or sealed in the door internal space. In this case, when the density of the adhesive agent (such as rigid urethane foam) being the intermediate member is set to more than 60 kg/m^3, the rigid urethane foam being the intermediate member is formed at a high density, and increased in bending elastic modulus. With this, also when the glass plate member is used, the holding or bonding strength of the glass plate member is increased. Further, the strength (rigidity) of the rigid urethane foam being the intermediate member in the door internal space is increased, and hence the strength (rigidity) of the door is also increased. Still further, the thickness of the intermediate member is set to 11 mm or less (specifically, preferably less than 10 mm), and hence the bending elastic modulus of the urethane foam can be increased. Thus, even when the urethane foam is reduced in thickness, the strength can be increased. Therefore, a door thickness can be reduced, and in addition, the box body strength can be increased. Further, when the self-adhesive rigid urethane foam is used as the intermediate member (adhesive agent), and when a ratio of [(Thickness of Intermediate Member)/(Thickness of Intermediate Member+Thickness of Vacuum Heat Insulating Material)] is set to 0.3 or less, a composite heat conductivity of the door formed of the composite member including the vacuum heat insulating material 400 and the rigid urethane foam can be reduced. Thus, even when the door thickness is reduced, the heat insulating performance can be enhanced.

[0300]

As described above, in the heat insulating box body 700, the refrigerator 1, or the device according to this embodiment, a volumetric ratio of the vacuum heat insulating material 400, that is, the charging rate of the vacuum heat insulating material 400 is set to fall within a predetermined range (for example, from 40% or more to 80% or less) relative to a space volume corresponding to a sum of the space 315 formed between the external box 710 and the internal box 750, and the door internal space that is an internal space in the opening-and-closing door. Thus, the wall thickness of the heat insulating box body 700 (such as distance between the external box 710 and the internal box 750, and thickness of the opening-and-closing door) can be reduced in comparison with that in the related art. As a result, the heat insulating box body 700, the refrigerator 1, and the device, which are excellent in energy efficiency and internal volumetric efficiency of the storage compartments, can be provided. In this way, the internal capacity of the storage compartment can be set higher than that in the related art without changing the outer sizes of the heat insulating box body 700 or the refrigerator 1, and hence the number of items to be housed in the heat insulating box body 700 can be set larger than that in the related art. Thus, the heat insulating box body 700, the refrigerator 1, a hot water supplier, a showcase, and a device, which have higher product quality in terms of the energy efficiency and the heat insulating performance than that in the related art, can be provided.

[0301]

Note that, when the charging rate of the vacuum heat insulating materials 400 relative to the spaces 315 is increased, the charging rate of the rigid urethane foam relative to the spaces 315 is reduced. In the heat insulating box body 700 according to this embodiment, the density of the rigid urethane foam is set higher than that in the related art (specifically, more than 60 kg/m^3). The bending elastic modulus of the rigid urethane foam is set higher than the bending elastic modulus of rigid urethane foam used in the related-art heat insulating box body (approximately 6 MPa to 10 MPa). Specifically, the bending elastic modulus is set to 15.0 MPa or more. With this, the heat insulating box body 700 according to this embodiment is capable of also suppressing decrease in strength due to the reduction in charging rate of the rigid urethane foam. Thus, there are no problems such as deformation of the heat insulating box body 700, which is caused by distortion due to an overload of the housed items in the stored item housing space or in the storage compartment or weight of the opening-and-closing door. As a result, the heat insulating box body 700, the refrigerator 1, and the device, which are excellent in reliability, can be provided.

[0302]

Thus, in the refrigerator 1 or the device including the heat insulating box body 700 having the vacuum heat insulating materials 400 according to this embodiment, such a problem that the heat insulating box body 700 is distorted to cause the opening-and-closing door to be inclined, or to hinder the opening-and-closing door from being smoothly opened or closed can be suppressed. Further, deterioration in external appearance due to the deformation can be suppressed. In addition, formation of a gap due to displacement of a gasket for sealing the opening portions of the opening-and-closing door and the heat insulating box body from a contact surface (sealing surface) with respect to the gasket can be prevented, to thereby prevent the air in the storage compartment (cooling air in the case of the refrigerator) from flowing to the outside of the heat insulating box body. Thus, even when a large amount of the vacuum heat insulating material 400 is used, the heat insulating box body 700 can be suppressed from being deteriorated in performance or reliability, and hence high heat insulating performance can be obtained. As a result, a refrigerator, a heat insulating box body having a vacuum heat insulating material, a device including the vacuum heat insulating material, or a device including the heat insulating box body, which is excellent in energy efficiency and reliability, can be provided.

Further, when the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member is excessively high, there arise problems of, for example, quality degradation, performance deterioration, and cost increase, specifically, (1) cost may be increased due to increase in injection amount of urethane, (2) leakage of urethane from the box body or the like may occur due to increase in injection pressure of urethane, (3) a force of close contact or an adhesive force between urethane and a box body deformation suppressing die set, a box body pressing member, or the like may be increased due to increase in foaming pressure at the time of foaming of urethane, with the result that the box body deformation suppressing die set, the box body pressing member, or the like may be difficult to pull out of the box body (difficult to take out of the box body), and (4) the heat insulating performance may be abruptly deteriorated due to the increase in density of urethane. As a countermeasure, the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member (density after foaming as for the foam heat insulating material) is set to preferably 100 kg/m3 or less (more preferably 90 kg/m^3 or less).

[0303]

Note that, as in the case of being used in the refrigerator, when the heat insulating box body 700 has an elongated rectangular parallelepiped shape in which a vertical height is larger than the widthwise length, the lateral walls 790 and the rear wall 730, which are substantially perpendicularly arranged, are more elongated in shape than the bottom surface portion 780, the top portion 740, and the partition walls 24 between the storage compartments, which are substantially horizontally arranged. Thus, the lateral walls 790 and the rear wall 730 are poor in rigidity, and hence are easily deformed. As a countermeasure, when the charging rate and the coverage of the vacuum heat insulating materials 400 are each set within a predetermined range as in this embodiment, the strength (rigidity) of the heat insulating box body 700 can be increased. Further, the box body strength can be increased also by forming the convex portions 450 or the protruding portions 910. Still further, the one end of each of the convex portions 450 is arranged to overlap, by the predetermined length X, with a part of the vacuum heat insulating material 400 corresponding to the concave portion 440 or the second concave portion 441, and the another end thereof is connected to the lateral surface portion 790. With this, the vacuum heat insulating materials 400 can be formed integrally with the convex portions 450 through intermediation of the rigid urethane foam, and the vacuum heat insulating materials 400 can be formed integrally with the lateral walls 790 through intermediation of the rigid urethane foam. Also in this way, the strength of the heat insulating box body 700 can be increased.

[0304]

Fig. 21 is a graph showing a relationship between a ratio of the areas of the vacuum heat insulating materials 400 relative to the surface areas of the lateral surface portions 790 and the rear surface portion of the heat insulating box body 700 (coverage relative to the lateral and rear surfaces), and the deformation amount of the box body, that is, showing calculation results thereof. The lateral walls 790 and the rear wall 730 are each formed into an elongated rectangular shape, and hence are lower in rigidity than the top wall 740, the bottom wall 780, the partition walls 24, and the like each formed into a substantially square shape. Thus, when the coverage of the vacuum heat insulating materials 400 relative to the lateral and rear surfaces is set to a predetermined value or more, the strength of the heat insulating box body can be increased. Now, description is made of a relationship between the ratio of the areas of the vacuum heat insulating materials 400 relative to the surface areas of the lateral walls 790 and the rear wall 730 (coverage relative to the lateral and rear surfaces), and the box body strength.

[0305]

In Fig. 21, the abscissa axis represents the ratio of the areas of the vacuum heat insulating materials 400 relative to the surface areas of the lateral walls 790 and the rear wall 730 of the heat insulating box body 700 (coverage relative to the lateral and rear surfaces), and the ordinate axis represents the deformation amount of the box body. Note that, the deformation amount of the box body at the time when the density of urethane is set to 60 kg/m^3, the charging rate of the vacuum heat insulating materials 400 is set to 40%, and the ratio of the area relative to the lateral and rear surfaces (coverage relative to the lateral and rear surfaces) is set to 50% is defined as "1." Based on results of measurement of the bending elastic modulus of vacuum heat insulating materials to be actually used, the bending elastic modulus of the vacuum heat insulating materials 400 used in the calculation is 20 MPa, which is higher than the bending elastic modulus of the rigid urethane foam in the related art (approximately 6 MPa to 10 MPa). Note that, when the ratio of the area (coverage relative to the lateral and rear surfaces) is changed, in accordance with increase in ratio of the areas of the vacuum heat insulating materials (coverage relative to the lateral and rear surfaces), the thickness of the vacuum heat insulating materials is decreased because the charging rate of the vacuum heat insulating materials is set uniformly to 40%.

[0306]

Note that, although the refrigerator 1 used in the calculation is an example, a refrigerator having four or more doors (such as four-door, five-door, or six-door structure), an internal capacity of a 500 liter class, and a power consumption of approximately 40 W or less is supposed. The distance between the external box 710 and the internal box 750 inclusive of the plate thicknesses thereof (wall thickness) was set to 30 mm on average, and the thickness of the space 315 (wall internal thickness) was set to 28 mm on a premise that the plate thicknesses of the external box 710 and the internal box 750 were each set to 1 mm. The density of the rigid urethane foam was set to 60 kg/m^3, the heat conductivity of the vacuum heat insulating materials 400 was set to 0.0021 (W/mK), and the heat conductivity of the rigid urethane foam was set to 0.019 (W/mK). The heat insulating performance of the vacuum heat insulating materials 400 is approximately ten times as great as that of the rigid urethane foam.

[0307]

In Fig. 21, the abscissa axis represents the ratio of the areas of the vacuum heat insulating materials 400 relative to the total surface area of the lateral walls and the rear wall (coverage of the vacuum heat insulating materials relative to the lateral and rear surfaces), and the ordinate axis represents the deformation amount of the box body (inclination amount of the box body) at a time when a predetermined load is applied to the heat insulating box body 700 having the opening-and-closing door. Specifically, the deformation amount of the box body represents, for example, an amount of deformation in the right-and-left direction at the upper end of the lateral wall of the heat insulating box body at the time when the predetermined load is applied in the substantially horizontal direction (lateral direction, that is, right-and-left direction in front view of the front opening portion) at the height position of approximately 1/4 from the top of the lateral wall on the one side of the heat insulating box body.

[0308]

As shown in Fig. 21, as the ratio of the areas of the vacuum heat insulating materials 400 is increased, the deformation amount of the box body is decreased. When the ratio of the area relative to the lateral and rear surfaces (coverage of the vacuum heat insulating materials relative to the lateral and rear surfaces) is increased to 70% or more, the rate of change in deformation amount of the box body is decreased. In other words, when the ratio of the area relative to the lateral and rear surfaces is less than approximately 70%, the deformation amount of the box body is abruptly decreased as the ratio of the area is increased. However, when the ratio of the area relative to the lateral and rear surfaces is increased to 70% or more, the deformation amount of the box body scarcely varies even with the increase in ratio of the area. Thus, when the ratio of the area relative to the lateral and rear surfaces (coverage of the vacuum heat insulating materials relative to the lateral and rear surfaces) is increased to 70% or more, the rate of the decrease in deformation amount of the box body is significantly decreased, and the deformation amount of the box body scarcely varies even by further increasing the ratio of the areas of the vacuum heat insulating materials relative to the lateral and rear surfaces. This may be because the degree of influence of the ratio of the areas of the vacuum heat insulating materials relative to the lateral and rear surfaces on the box body strength has substantially reached the limit.

[0309]

Note that, the calculation is carried out under the state in which the charging rate of the vacuum heat insulating materials is maintained at 40%. Thus, as the arrangement areas of the vacuum heat insulating materials 400 are increased, the thickness of the vacuum heat insulating materials 400 is decreased. As the ratio of the areas of the vacuum heat insulating materials is increased to less than approximately 70% of the lateral and rear surfaces, an amount by which the deformation of the box body is reduced due to the increase in strength of the box body in accordance with increase in arrangement area of the vacuum heat insulating materials is larger than an amount by which the deformation of the box body is increased due to the decrease in thickness of the vacuum heat insulating materials. Thus, the box body is increased in rigidity and decreased in deformation amount. However, when the ratio of the areas of the vacuum heat insulating materials exceeds approximately 70% of the lateral and rear surfaces, the amount by which the deformation of the box body is increased due to the decrease in strength of the box body in accordance with the decrease in thickness of the vacuum heat insulating materials, and the amount by which the deformation of the box body is reduced due to the increase in strength of the box body in accordance with the increase in arrangement area of the vacuum heat insulating materials are equivalent to each other. In this way, it is considered that the rate of the decrease in deformation amount of the box body is decreased.

[0310]

Further, when the thickness of the vacuum heat insulating materials is reduced by increasing the ratio of the arrangement areas (coverage) of the vacuum heat insulating materials, the thickness of the urethane foam is increased. When the ratio of the arrangement area is less than approximately 70%, the thickness of the vacuum heat insulating materials is equal to or larger than a predetermined thickness. Thus, the strength of the heat insulating box body is more greatly influenced by the amount of increasing the ratio of the area than by the amount of reducing the thickness of the vacuum heat insulating materials, thereby reducing the deformation amount of the box body. However, as the ratio of the arrangement areas of the vacuum heat insulating materials is further increased, the thickness of the vacuum heat insulating materials is reduced, and the thickness of urethane is increased. With this, the strength of the heat insulating box body is influenced equivalently by the amount of increasing the thickness of urethane, and the amount of increasing the ratio of the arrangement areas of the vacuum heat insulating materials. In this way, it is considered that the rate of the decrease in deformation amount of the box body is decreased.

[0311]

Thus, when the ratio of the areas of the vacuum heat insulating materials 400 relative to the lateral and rear surfaces (coverage relative to the lateral and rear surfaces) is set to the predetermined value (70%) or more, the box body strength can be secured. As a result, a box body excellent in reliability can be provided. Further, when the ratio of the areas of the vacuum heat insulating materials relative to the lateral and rear surfaces is set to the predetermined value of (70%) or more, the deformation amount of the box body scarcely varies in this region. Thus, even when the arrangement areas of the vacuum heat insulating materials are non-uniform, the deformation amount of the box body scarcely varies. As a result, a heat insulating box body, a refrigerator, a showcase, and a device, which are excellent in strength, design property, and reliability, can be provided. When the coverage of the vacuum heat insulating materials 400 is set to a predetermined value or more (60% or more), and when the ratio of the areas of the vacuum heat insulating materials 400 relative to the lateral and rear surfaces is set to a second predetermined value (70%) or more, the heat insulating performance can be enhanced, and the deformation amount of the box body can be reduced. Thus, a refrigerator, a showcase, and a device, which are excellent in heat insulating performance, reliability, and energy efficiency, can be provided.

[0312]

Note that, when the thickness of the vacuum heat insulating materials is set uniform, and when the arrangement areas of the vacuum heat insulating materials 400 are increased, both the coverage and the charging rate of the vacuum heat insulating materials can be increased. However, high cost is required to increase the charging rate of the vacuum heat insulating materials 400. Thus, in order to reduce the cost, it is preferred that the coverage be increased without changing the charging rate to increase the strength of the heat insulating box body 700. In addition, the arrangement areas of the vacuum heat insulating materials can be increased, and hence the heat insulating efficiency can be improved. Thus, when the charging rate of the vacuum heat insulating materials 400 is set to 40% or more, and when the ratio of the area relative to the lateral and rear surfaces (coverage of the vacuum heat insulating materials relative to the lateral and rear surfaces) is set to 70% or more, the strength of the heat insulating box body can be secured at low cost and with high efficiency. Thus, when the ratio of the areas of the vacuum heat insulating materials relative to the lateral and rear surfaces (coverage of the vacuum heat insulating materials relative to the lateral and rear surfaces) is set equal to or more than the second predetermined value (for example, approximately 70%, which corresponds to an area ratio above which the rate of the decrease in deformation amount of the heat insulating box body is decreased), the wall thickness of the heat insulating box body 700 can be reduced (thickness of urethane can be reduced). As a result, the internal capacity of the storage compartment can be increased. As the arrangement areas of the vacuum heat insulating materials 400 relative to the lateral walls 790 and the rear wall 730 (coverage of the vacuum heat insulating materials relative to the lateral and rear surfaces) are increased, the deformation amount of the heat insulating box body 700 is decreased. Thus, the strength of the heat insulating box body 700 can be increased. As a result, the heat insulating box body 700, the refrigerator 1, and the device including the heat insulating box body, which are excellent in strength and heat insulating performance, can be provided.

[0313]

(Physical Property of Urethane)

Next, description is made of physical properties and characteristics of the rigid urethane foam to be charged into the heat insulating box body 700. When the free foam density of the rigid urethane foam is set high, the strength after foaming can be stabilized. With this, the heat insulating box body 700 having high quality in terms of external appearance can be provided.

[0314]

Note that, the free foam density refers to a density of the rigid urethane foam at the time when urethane is foamed not in a sealed space such as that in a box body, but in an open state, specifically, in an inside of an opened container. However, actually, urethane is foamed and expanded within a narrow sealed space in the heat insulating box body 700. Thus, the density of urethane that is foamed and expanded within the narrow sealed space such as the heat insulating box body 700 is higher than the free foam density of urethane that is foamed and expanded in the open state.

[0315]

As described with reference to Fig. 16, when the density of the foamed rigid urethane foam is increased, the bending elastic modulus can be increased. However, when the liquid raw material of urethane is injected directly and charged into the heat insulating box body 700 to increase the density, urethane used in the related art, which is low in expansion ratio, has a free foam density as low as from 26 kg/m^3 to 28 kg/m^3. Thus, when parts through which urethane is caused to flow are irregular in passage thickness, urethane cannot be uniformly foamed. In this way, a density of urethane is liable to be uneven near the charging ports 703 and 704 and at terminal portions (parts away from the charging ports). For this reason, stable strength is difficult to secure.

[0316]

The free foam density of the rigid urethane foam used in this embodiment (specifically, the free foam density is approximately 30 kg/m^3 to 45 kg/m^3) is set higher than that in the related art (specifically, approximately 25 kg/m^3 to 28 kg/m^3). With this, even when the parts through which urethane is caused to flow are irregular in passage thickness to some extent, the expansion ratio is increased, and hence urethane can be stably foamed. Thus, non-uniformity in density after foaming can be reduced. Therefore, the density of urethane after foaming is easy to substantially equalize.

[0317]

When a density of a foam body such as the rigid urethane foam having bubbles contained therein is reduced, the amount of bubbles is increased, and hence the heat insulating effect is increased. Thus, in the related art, the rigid urethane foam having a density after foaming that is as low as from approximately 25 kg/m3 to 28 kg/m3 is used in the heat insulating box body 700. When this related-art urethane foam is set to have a bending elastic modulus of 15 MPa or more, and used to secure the strength of the heat insulating box body 700 having, for example, a wall internal thickness of 28 mm and a urethane thickness of 8 mm exclusive of a thickness of a vacuum heat insulating material, urethane needs to be injected and charged by an amount larger than a precise packing amount of urethane (urethane amount at which rigid urethane foam is charged by a precise amount without applying an excessive load to an inside of a target box body, and at which the density after foaming is likely to be equalized). Thus, the density is liable to be uneven.

[0318]

Further, when urethane needs to be injected and charged by the amount larger than the precise packing amount, urethane needs to be pressurized at the time of the injection, or a charging time needs to be prolonged, which may cause urethane to leak out through gaps, for example, at joining portions in the heat insulating box body 700 or the outer shell of the opening-and-closing door (such as joining portions between the external box 710 and the internal box 750). As a result, urethane may not be injected (may not be charged) by a required predetermined amount. In this way, the density of the rigid urethane foam after being charged into the box body is difficult to reliably set higher than a predetermined value (for example, 60 Kg/m^3). Further, when urethane leaks out of the outer shell of the box body, an operation of removing leaked urethane needs to be performed. Thus, work hours or assembly hours need to be prolonged, which cause increase in cost and deterioration in design property. For this reason, hitherto, the density of urethane after being charged into the heat insulating box body has been set to less than 60 kg/m^3, specifically, within a range of from 25 kg/m^3 to 30 kg/m^3, or at most to approximately 55 kg/m^3 or less.

[0319]

Note that, in this embodiment, the possibility of increasing the free foam density by reducing the amount of, for example, a foam material contained in the liquid raw material of urethane has been investigated. For example, in the heat insulating box body 700 in which the thickness of urethane is set to 8 mm (a thickness of a urethane passage exclusive of the thickness of the vacuum heat insulating material is set to approximately 8 mm), when the free foam density is set to a predetermined value (30 kg/m3 or more, preferably 35 kg/m3 or more), the density at the precise packing amount (density of urethane after being charged into the box body without applying an excessive load) can be set to more than 60 kg/m3. Thus, the bending elastic modulus of the rigid urethane foam can be set to 15 MPa or more. With this, troubles of the heat insulating box body, such as the density unevenness of urethane and the leakage of urethane, can be solved. In this way, the heat insulating box body 700, the refrigerator 1, a showcase, and a device including the heat insulating box body, which are excellent in reliability and strength, can be provided.

[0320]

In this case, the heat insulating performance may be influenced by the increase in density of urethane after foaming by setting the free foam density of rigid urethane to more than the predetermined value. However, as described with reference to Fig. 17 to Fig. 21, for example, when the thickness of urethane at the parts where the vacuum heat insulating material 400 is arranged is set to a predetermined value or less (11 mm or less, or 6 mm or less), the ratio of "Thickness of Urethane/Wall Internal Thickness" is set to a predetermined value (0.3) or less, or when the charging rate of the vacuum heat insulating material 400 is set within a predetermined range (from 40% or more to 90% or less), the influence on the heat insulating performance of the heat insulating box body (influence by the heat insulating box body 700 or the opening-and-closing door on the heat insulating performance of the heat insulating box body) can be reduced. Note that, when the thickness of urethane is set to 11 mm or less, as long as the free foam density is set to a predetermined value (for example, 35 kg/m^3) or more, the precise packing amount can be set so that the leakage of urethane does not occur (the precise packing amount can be adjusted).

[0321]

In the heat insulating box body 700 according to this embodiment, the wall thickness of the heat insulating box body 700 can be set smaller than that in the related art. Further, even when predetermined strength is secured, urethane is less liable to leak out of the outer shell at the time of urethane charging, and hence required product quality can be satisfied. With this, the heat insulating box body 700 excellent in energy efficiency and internal volumetric efficiency can be provided. Specifically, without changing the outer size of the heat insulating box body 700, the refrigerator 1, or the device including the heat insulating box body, a housing capacity of the heat insulating box body for items to be stored (such as compartment internal capacity or storage compartment capacity in the case of the refrigerator) can be increased in comparison with that in the related art. Thus, a larger number of items to be housed can be stored in the heat insulating box body 700 than those in the related art. With this, the heat insulating box body 700, the refrigerator 1, or the device including the heat insulating box body, which is user-friendly and excellent not only in heat insulating performance but also in strength and reliability, can be provided. Further, when the housing capacity in the compartment (in the storage compartment) is set equivalent to that in the related art, the outer dimensions can be reduced by an amount corresponding to the reduced wall thickness.

[0322]

Incidentally, the refrigerator 1 includes a cooling device for cooling the air (cooling air) to be supplied into the plurality of storage compartments such as the refrigerator compartment 2, the freezer compartment 6, or the vegetable compartment 5. This cooling device includes the compressor 12, the refrigerant pipe (such as condensation pipe 725), the decompression device (such as expansion valve or capillary tube), and the cooler 13 to form a refrigeration cycle. Of the components of the refrigeration cycle, the compressor 12 and the decompression device are arranged in the machine room 1A formed on the lower rear side (may be upper rear side) of the heat insulating box body 700 of the refrigerator 1. The condensation pipe 725 is arranged, for example, through the lateral walls 790, the rear wall 730, or the top wall 740 of the heat insulating box body 700. On the rear of the storage compartment, on the storage compartment side of the rear wall 730, a rear cover such as a fan grille for forming a space for housing items to be stored is arranged as a member separate from the internal box 750, and the cooler 13 is arranged in the cooler room 131 formed, for example, between the internal box 750 and the rear cover member such as the fan grille. Further, the cooling air circulation fan 14 for sending the air (cooling air) generated by cooling around the cooler 13 to each of the storage compartments such as the refrigerator compartment 2, the freezer compartment 6, or the vegetable compartment 5 is also arranged in the cooler room 131. In addition, the control board room 31 is arranged in the upper portion of the top wall 740 or the rear wall 730 of the heat insulating box body 700 (or position at a substantial center of the height of the rear wall 730), and the controller 30 is arranged in the control board room 31. The controller 30 controls, for example, the operating conditions such as the rotation speeds of the compressor 12 and the cooling air circulation fan 14, or the internal temperatures.

[0323]

In the refrigerator 1 structured as described above, the high-temperature and high-pressure gas refrigerant discharged out of the compressor 12 arranged in the machine room 1A is condensed into low-temperature and high-pressure liquid refrigerant through the refrigerant pipe (such as condensation pipe) 725, and the low-temperature and high-pressure liquid refrigerant is decompressed into low-temperature and low-pressure two-phase gas-liquid refrigerant by the decompression device. At the time of reaching the cooler 13, a temperature of the low-temperature and low-pressure two-phase gas-liquid refrigerant is reduced, for example, to -20 degrees C or less. The low-temperature and low-pressure two-phase gas-liquid refrigerant cools the air in the cooler room 131, and the cooled air is supplied with the cooling air circulation fan 14 to the storage compartments such as the refrigerator compartment 2, the freezer compartment 6, or the vegetable compartment 5, to thereby cool the storage compartments such as the refrigerator compartment 2, the freezer compartment 6, or the vegetable compartment 5 (or housed items in those storage compartments). Meanwhile, after cooling the air in the cooler room 131, the low-temperature and low-pressure two-phase gas-liquid refrigerant is heated and evaporated by the air in the cooler room 131 into low-pressure gas refrigerant, and the low-pressure gas refrigerant is sucked again into the compressor 12 and compressed therein.

[0324]

As described above, in the refrigerator 1 according to this embodiment, the charging rate of the vacuum heat insulating material, that is, the proportion of the vacuum heat insulating material 400 relative to the total capacity of the internal capacity of the spaces 315 formed between the external box 710 and the internal box 750 and the internal capacity of the door internal space of the opening-and-closing door is set to a predetermined value (for example, 40% to 80%). Thus, even when the wall internal thickness of the heat insulating box body 700 (such as distance (thickness) between the external box 710 and the internal box 750, or thickness of the opening-and-closing door) is set smaller than that in the related art, the heat insulating performance can be secured. With this, in the refrigerator 1 according to this embodiment, the heat insulating performance of the heat insulating box body 700 is increased, and hence the cooling air or the housed items in the plurality of storage compartments 2, 3, 4, 5, and 6 are difficult to warm. Thus, an operating time of the compressor 12 for cooling can be shortened, or an airflow rate of the fan can be reduced. With this, an airflow rate of the air (cooling air) necessary for cooling the insides of the storage compartments 2, 3, 4, 5, and 6 can be suppressed, the rotation speed of the compressor 12 can be reduced, or an operation OFF time can be prolonged. As a result, energy-efficient operations can be performed. In this way, the energy efficiency of the refrigerator 1 according to this embodiment is increased in comparison with that in the related art. Further, without changing the outer size of the refrigerator 1, the storage compartment capacity (compartment internal capacity) can be increased in comparison with that in the related art. Thus, a larger number of items to be housed can be stored in the storage compartments than those in the related art. With this, a user-friendly refrigerator and device can be provided.

[0325]

Further, when the freezer compartment 6 having a largest temperature difference with respect to the outside air is arranged at a substantially central position in the vertical direction, heat entry from the outside air into the freezer compartment 6 via the upper surface and the lower surface can be suppressed. Thus, heat entry surfaces through which the heat from the outside air is caused to enter the freezer compartment 6 can be limited to four surfaces (four surfaces of front opening-and-closing door, right lateral surface, left lateral surface, and rear surface). With this, the energy-efficient refrigerator 1 can be provided.

[0326]

Further, according to this embodiment, the bending elastic modulus of the rigid urethane foam to be charged into the spaces 315 and the door internal spaces is set to 15.0 MPa or more. With this, the box body strength of the heat insulating box body 700 is allowed to satisfy the predetermined strength, and hence deformation of the heat insulating box body 700, which is caused by distortion due to an overload of the housed items, can be suppressed. Thus, the heat insulating box body 700 can be suppressed from being distorted to incline the front opening-and-closing door, to thereby prevent deterioration in external appearance. In addition, the sealing members for sealing a portion between the opening-and-closing door and the front opening portion of the heat insulating box body can be suppressed from being displaced from each other to form a gap. Thus, the air (cooling air) in the refrigerator compartment 2, the freezer compartment 6, the vegetable compartment 5, the ice making compartment 3, or the switching compartment 4 can be suppressed from leaking to the outside of the heat insulating box body 700 or the refrigerator 1. With this, a refrigerator and a device, which are increased in energy efficiency, can be provided.

[0327]

Note that, for a distribution of the charging rate of the vacuum heat insulating material 400 relative to the spaces 315 or the door internal spaces, in accordance with temperature difference between the outside air and each of the storage compartments, the charging rate of the vacuum heat insulating material 400 may be altered at predetermined positions in the spaces 315 or the door internal spaces.

[0328]

For example, in the freezer compartment 6 (or ice making compartment 3 or switching compartment 4), which is a low-temperature compartment, the temperature difference between the temperature in the storage compartment and the temperature of the outside air is largest. Thus, in a range of facing the freezer compartment 6, the charging rate of the vacuum heat insulating material 400 relative to the right lateral surface, the left lateral surface, the rear surface, and the front surface (opening-and-closing door) of the heat insulating box body 700 may be set higher (for example, to 60% or more) than those on wall surfaces (such as right lateral surface, left lateral surface, rear surface, and front surface (opening-and-closing door)) in a range of facing other storage compartments (such as refrigerator compartment 2 and vegetable compartment 5, which are high-temperature compartments). With this structure, heat entry into the freezer compartment 6, which is a lowest temperature compartment, can be suppressed, and hence the refrigerator 1 and the device, which are increased in energy efficiency, can be provided.

[0329]

Further, when a temperature of the outside air is, for example, 30 degrees C, a temperature in the machine room 1A reaches 40 degrees C or more, and a temperature in the control board room 31 is also increased, for example, to 40 degrees C or more. In other words, on the wall surfaces and the partition walls 24 between the machine room 1A or the control board room 31 and the storage compartments at the position of facing those rooms, temperature differences with respect to the insides of the storage compartments are larger than those on the other wall surfaces and partition walls 24. Thus, heat is liable to enter the storage compartments arranged near the machine room 1A or the control board room 31. As a countermeasure, on the wall surfaces and the partition walls 24 to be arranged between the machine room 1A or the control board room 31 and the storage compartments, the charging rate of the vacuum heat insulating material 400 may be set higher than those on the other wall surfaces and the partition walls 24, to thereby enhance the heat insulating performance. Specifically, on the wall surfaces and the partition walls 24 to be arranged between the machine room 1A or the control board room 31 and the storage compartments, the charging rate of the vacuum heat insulating material 400 may be set to 60% or more (the coverage of the vacuum heat insulating material 400 relative to the lateral and rear surfaces may be set to 70% or more), and the charging rate of the vacuum heat insulating material 400 relative to the other wall surfaces or the partition walls 24 may be set to 40% or more (90% or less). With this configuration, heat entry from the machine room 1A and the control board room having high temperature into the storage compartments near the machine room 1A and the control board room can be suppressed. As a result, the refrigerator 1 can be further increased in energy efficiency.

[0330]

The heat insulating box body 700 according to this embodiment is applicable also to, for example, a heating device for heating water and a hot water storage device including a tank for storing the water heated by the heating device. When the tank is arranged in the heat insulating box body 700, the tank can be heat-insulated by the heat insulating box body 700 that is smaller in outer size than that in the related art. As a result, a space for the hot water storage device can be saved. Further, this embodiment is applicable to any device having the heat insulating walls including the vacuum heat insulating materials (such as refrigerator, showcase, freezing machine, hot water supply device, hot water dispenser, and air-conditioning device).

[0331]

In the embodiment of the present invention, the vacuum heat insulating material 400 need not have concave portions, convex portions, or the like. Further, the core material to be sealed in the outer wrapping material need not be formed in conformity with the concavo-convex shape of the outer wrapping material, and hence the vacuum heat insulating material 400 to be used may be formed into a flat plate shape. Thus, a particulate material having fluidity need not be used as the core material, and fibrous core materials such as an inorganic fiber including a glass fiber, and an organic fiber can be used. In addition, complicated processing of, for example, forming the concavo-convex portions on the outer wrapping material need not be executed. With this, a heat insulating box body, a refrigerator, and a device, which are low-cost and excellent in handling property and heat insulating performance, can be provided.

Note that, in this embodiment, the third intermediate member may be the same as the first intermediate member, and the second intermediate member may also be the same as the first intermediate member.

[0332]

(Advantages of Embodiment)

As described above, in the heat insulating box body 700 according to this embodiment, which is formed of the external box 710 and the internal box 750, has at least the lateral walls 790 and the rear wall 730, and also has the opening portion on the front side, the convex portions 450 are formed at the corner portions between the rear wall 730 and the lateral walls 790 in a manner of projecting to the front opening portion side with respect to the rear wall 730, and the concave portion 440 (may be second concave portion 441) is formed in a part of the internal box 750 corresponding to the rear wall 730 in a manner of being recessed to the rear side with respect to the convex portions 450 as viewed from the front side. The flat-plate-like vacuum heat insulating material 400 is arranged at least between the external box 710 and the part of the internal box 750 corresponding to the rear wall 730, specifically, arranged between the external box 710 and the internal box 750 at the position where the flat-plate-like vacuum heat insulating material 400 faces the concave portion 440, and has a width at least larger than that of the concave portion 440 (represented as the range W of the concave portion 440 in Fig. 8) in the width direction (or longitudinal direction). The convex portions 450 are each formed to overlap with the vacuum heat insulating material 400 by the predetermined length X. The adhesive agent is charged as an intermediate member between the vacuum heat insulating material 400 and a part of the internal box 750 corresponding to the concave portion 440, and between the vacuum heat insulating material 400 and the parts of the internal box 750 corresponding to the convex portions 450. With this, even when the thickness of the adhesive agent is reduced between the vacuum heat insulating material 400 and the internal box 750, the adhesive thickness of the adhesive agent (such as foam heat insulating material, specifically, rigid urethane foam) is increased by an amount corresponding to the overlapping lengths X by which the convex portions 450 and the vacuum heat insulating material 400 overlap with each other. Thus, the vacuum heat insulating material 400 can be firmly bonded to the part of the internal box 750 (or external box 710) corresponding to the concave portion 440 through intermediation of the adhesive agent in the convex portions 450. Further, the part of the internal box 750 corresponding to the concave portion 440 and the parts of the internal box 750 corresponding to the lateral walls 790 can also be firmly bonded through intermediation of the convex portions 450. With this, even when the thickness of the adhesive agent between the vacuum heat insulating material 400 and the internal box 750 is reduced at the part corresponding to the concave portion 440, the concave portion 440, the vacuum heat insulating material 400, and the lateral walls 790 are formed integrally with each other through intermediation of the convex portions 450 at which the thickness of the adhesive agent is large. In this way, the wall thickness of the concave portion 440 corresponding to the part where the vacuum heat insulating material is arranged is reduced, and the strength of the box body or the walls can be increased.

[0333]

Note that, a self-adhesive foam heat insulating material being rigid urethane foam is used as the adhesive agent being the intermediate member. With this, even when the thickness of the rigid urethane foam between the vacuum heat insulating material 400 and the internal box 750 is set as small as a predetermined value of 11 mm or less (preferably less than 10 mm in consideration of, for example, variation in thickness and the concavo-convex portions on the surface of the vacuum heat insulating material 400), the thickness of the rigid urethane foam between the vacuum heat insulating material 400 and the internal box 750 can be increased by the amount corresponding to the overlapping lengths X by which the convex portions 450 and the vacuum heat insulating material 400 overlap with each other. Thus, the vacuum heat insulating material 400 can be firmly bonded to the internal box 750 (or external box 710) through intermediation of the rigid urethane foam in the convex portions 450. Further, even when the thickness of the rigid urethane foam is reduced between the vacuum heat insulating material 400 and the internal box 750 at the position where the vacuum heat insulating material 400 faces the concave portion 440, the vacuum heat insulating material 400 is formed integrally with the lateral walls 790 through intermediation of the rigid urethane foam in the convex portions 450 at the position where the vacuum heat insulating material 400 faces the concave portion 440. With this, even when the wall thickness is reduced at the part corresponding to the concave portion 440, the strength of the box body or the walls can be increased.

[0334]

Further, in the heat insulating box body 700, which is formed of the external box 710 and the internal box 750, has at least one peripheral wall (such as lateral wall 790, top wall 740, bottom wall 780, and partition wall 24) around the rear wall 730, and also has the opening portion on the front side, the rear wall 730 includes the convex portions 450 that are formed at the corner portions between the rear wall 730 and the peripheral walls, and the concave portion 440 (or second concave portion 441) that is recessed to the rear side with respect to the convex portions 450 as viewed from the front side. The flat-plate-like vacuum heat insulating material 400 is arranged between the internal box 750 and the external box 710 at the position where the flat-plate-like vacuum heat insulating material 400 faces the concave portion 440 (or second concave portion 441), and has a width at least larger than the width P of the concave portion (range W of the concave portion) in the width direction or the longitudinal direction. The convex portions 450 are each formed to overlap with the vacuum heat insulating material 400 by the predetermined length X.

The adhesive agent is charged as an intermediate member between the internal box 750 and the vacuum heat insulating material 400 at the position where the vacuum heat insulating material 400 faces the concave portion 440, and between the internal box 750 and the vacuum heat insulating material 400 at the positions where the vacuum heat insulating material 400 faces the convex portions 450. With this, even when the thickness of the adhesive agent is reduced between the vacuum heat insulating material 400 and the internal box 750, the adhesive thickness of the adhesive agent (such as foam heat insulating material, specifically, rigid urethane foam) is increased by the amount corresponding to the overlapping lengths X by which the convex portions 450 and the vacuum heat insulating material 400 overlap with each other. Thus, the vacuum heat insulating material 400 can be firmly bonded to the part of the internal box 750 (or external box 710) corresponding to the concave portion 440 through intermediation of the adhesive agent in the convex portions 450. Further, the part of the internal box 750 corresponding to the concave portion 440 and the at least one peripheral wall (such as lateral wall 790, top wall 740, bottom wall 780, and partition wall 24) can also be firmly bonded through intermediation of the convex portions 450. With this, even when the thickness of the adhesive agent between the vacuum heat insulating material 400 and the internal box 750 is reduced at the part corresponding to the concave portion 440, the concave portion 440, the vacuum heat insulating material 400, and the at least one peripheral wall (such as lateral wall 790, top wall 740, bottom wall 780, and partition wall 24) are formed integrally with each other through intermediation of the convex portions at which the thickness of the intermediate member (thickness of the adhesive agent) is large. In this way, the wall thickness of the concave portion 440 corresponding to the part where the vacuum heat insulating material is arranged is reduced, and the strength of the box body or the walls can be increased.

[0335]

Further, the peripheral wall is any one of the lateral wall 790, the top wall 740, the bottom wall 780, and the partition wall 24, each of which is connected to the rear wall 730 to form a compartment (such as storage compartment). With this, even when the thickness of the adhesive agent as the intermediate member is reduced between the vacuum heat insulating material 400 and the internal box 750 at the part corresponding to the concave portion 440, the part of the vacuum heat insulating material 400 corresponding to in the concave portion 440 is formed integrally with the at least one peripheral wall (such as lateral wall 790, top wall 740, bottom wall 780, and partition wall 24) through intermediation of the intermediate member (adhesive agent) in the convex portions. Thus, even when the wall thickness of the part corresponding to the concave portion is reduced, the strength of the box body or the walls can be increased. Further, when the rigid urethane foam is used as the intermediate member (adhesive agent), predetermined heat insulating performance can also be obtained.

[0336]

Further, the self-adhesive foam heat insulating material that is in a liquid state with fluidity or a two-phase state before charging and foamed after charging to function as the adhesive agent is used as the intermediate member (adhesive agent). With this, even when the gap between the vacuum heat insulating material 400 and the internal box 750 is narrowed in the concave portion 440, the intermediate member (adhesive agent) can be caused to flow into the narrow gap in the liquid state or the two-phase state, and hence can be evenly charged. Thus, the bonding strength or the fixing strength can be secured. In this way, even when the wall thickness is reduced, the box body strength can be secured. Further, the intermediate member (adhesive agent) functions also as a heat insulating material, and hence the heat insulating performance can be enhanced.

[0337]

In addition, when the rigid urethane foam being the foam heat insulating material is used as the adhesive agent being the intermediate member, an effect of the heat insulating material is reduced at parts where the thickness of urethane is small (for example, wall in which the vacuum heat insulating material 400 is arranged, such as the concave portion 440). As in this embodiment, it is appropriate to use the rigid urethane foam being the intermediate member as the adhesive agent. Meanwhile, at parts where a large thickness of urethane can be secured (for example, wall in which the vacuum heat insulating material 400 is not arranged), the effect of the heat insulating material can be obtained, and hence the rigid urethane foam can be used as the heat insulating material. Thus, both the box body strength and the heat insulating performance can be secured. With this, a heat insulating box body, a refrigerator, a device, and the like, which are excellent in performance and reliability, can be provided. Further, the rigid urethane foam has a great feature of self-adhesiveness unlike heat insulating materials of other types. Thus, even without using the adhesive agents of other types, when the rigid urethane foam is foamed directly on a surface of a target (internal box 750, vacuum heat insulating material 400, and external box 710), a firmly-bonded heat insulating layer can be formed on the target. With this, both the adhesiveness and the heat insulating properties can be obtained.

[0338]

Further, even when the thickness of the adhesive agent as the intermediate member to be charged between the vacuum heat insulating material 400 and the internal box 750 is set smaller than the thickness of the vacuum heat insulating material 400, the wall strength or the box body strength can be secured with the vacuum heat insulating material 400. Thus, the wall thicknesses of the walls having the vacuum heat insulating materials 400 can be reduced.

[0339]

Further, when the thickness of the adhesive agent (such as rigid urethane foam) as the intermediate member to be charged between the internal box 750 and the vacuum heat insulating material 400 at the position where the vacuum heat insulating material 400 faces the concave portion 440 is set to 11 mm or less, the bending elastic modulus of the rigid urethane foam can be increased. Thus, even when the rigid urethane foam is reduced in thickness, the strength can be increased. Therefore, even when the wall thickness is reduced, the box body strength can be increased.

In addition, in the heat insulating box body, which is formed of the rear wall 730, the lateral wall 790, the upper wall 24 (or top wall 740), and the lower wall 24 (or bottom wall 780), and is opened on the front side, the vacuum heat insulating material 400 is arranged between a part of the internal box 750 corresponding to the inner surface of the rear wall 730 and a part of the external box 710 corresponding to the outer surface of the rear wall 730, or between a part of the internal box 750 corresponding to the inner surface of the lateral wall 790 and a part of the external box 710 corresponding to the outer surface of the lateral wall 790. The intermediate member is charged, sealed, applied, or arranged between the vacuum heat insulating material 400 and the internal box 750 so that the vacuum heat insulating material 400 and the internal box 750 are bonded, firmly attached, or fixed to each other. Examples of the intermediate member include urethane foam, and the thickness of the intermediate member is set to 11 mm or less. With this, the bending elastic modulus of the urethane foam can be increased. Thus, even when the urethane foam is reduced in thickness, the strength can be increased. Therefore, even when the wall thickness is reduced, the box body strength can be increased.

[0340]

Further, when the self-adhesive rigid urethane foam is used as the intermediate member (adhesive agent), and a ratio of [(Thickness of Intermediate Member)/(Thickness of Intermediate Member+Thickness of Vacuum Heat Insulating Material)] is set to 0.3 or less, the composite heat conductivity of the wall formed of the composite member including the vacuum heat insulating material 400 and the rigid urethane foam can be reduced. Thus, even when the wall thickness is reduced, the heat insulating performance can be enhanced.

[0341]

Alternatively, the vacuum heat insulating material 400 and the external box

710 are bonded directly to each other with the second adhesive agent as the second intermediate member other than the foam heat insulating material, such as a hot melt adhesive or a double-faced tape. The thickness of the adhesive agent (such as rigid urethane foam) as the first intermediate member to be charged between the internal box 750 and the vacuum heat insulating material 400 at the position where the vacuum heat insulating material 400 faces the concave portion 440 (or second concave portion 441) is set to 11 mm or less, and a ratio of "Thickness of First Intermediate Member/(Thickness of First Intermediate Member+Thickness of Vacuum Heat Insulating Material)" is set to 0.3 or less. With this, the adhesive agent as the first intermediate member is allowed to be charged between the vacuum heat insulating material 400 and the internal box 750 after the vacuum heat insulating material 400 is bonded directly to the external box 710 with the second adhesive agent as the second intermediate member. In this way, the assembly efficiency is improved. Further, when the external box 710 and the vacuum heat insulating material 400 are bonded directly to each other with the second adhesive agent other than the foam heat insulating material, such as a hot melt adhesive or a double-faced tape, the wall thickness can be reduced. In addition, the bending elastic modulus of the rigid urethane foam as the first intermediate member can be increased. Thus, even when the rigid urethane foam is reduced in thickness, the strength can be increased. Therefore, even when the wall thickness is reduced, the box body strength can be increased. Further, the composite heat conductivity of the wall formed of the composite member including the vacuum heat insulating material 400 and the rigid urethane foam can be reduced. Thus, even when the wall thickness is reduced, the heat insulating performance can be enhanced.

[0342]

Further, the vacuum heat insulating material 400 is arranged at least in the rear wall 730, and the ratio of the arrangement areas of the vacuum heat insulating materials 400 to be arranged in the rear wall 730 and the lateral walls 790 relative to the surfaces areas of the rear wall 730 and the lateral walls 790 is set to 70% or more. With this, the box body strength can be increased, and the deformation amount of the box body can be reduced. Thus, a heat insulating box body, a refrigerator, a hot water supplier, a device, and the like, which are excellent in strength and reliability, can be provided.

In other words, the vacuum heat insulating material 400 is arranged at least in the rear wall 730 such that a proportion of a sum of areas of projection of the vacuum heat insulating materials 400 arranged in the rear wall 730 or the lateral walls 790 onto the rear wall 730 or the lateral walls 790 relative to the total surface area of the rear wall 730 and the lateral walls 790 is set to 70% or more. With this, the box body strength can be increased, and the deformation amount of the box body can be reduced. Thus, a heat insulating box body, a refrigerator, a hot water supplier, a device, and the like, which are excellent in strength and reliability, can be provided.

[0343]

Still further, in the heat insulating box body 700 including the external box 710 and the internal box 750, when the volumes of the vacuum heat insulating materials 400 relative to the volumes of the spaces 315 formed between the external box 710 and the internal box 750 are set to 40% or more, the box body strength can be increased, and the deformation amount of the box body can be reduced. Thus, a heat insulating box body, a refrigerator, a hot water supplier, a device, and the like, which are excellent in strength and reliability, can be provided.

[0344]

Yet further, the convex portions 450 are formed at the corner portions between the lateral walls 790 and the rear wall 730, and the vacuum heat insulating materials 400 are arranged between the external box 710 and the internal box 750. With this, the box body strength can be increased, and hence it is unnecessary to form, for example, concavo-convex portions on the vacuum heat insulating material 400, or to form the core material to be sealed in the outer wrapping material into a concavo-convex shape. Thus, the vacuum heat insulating material 400 to be used may be formed into a flat plate shape, and hence the fiber-diameter core materials such as an organic fiber or an inorganic fiber can be used as the core material of the vacuum heat insulating material 400. In this way, the fiber-diameter core materials such as an organic fiber or an inorganic fiber can be used as the core material of the vacuum heat insulating material 400, and hence a particulate material having fluidity need not be used as the core material, or the core material need not be formed into a complicated shape having, for example, the concavo-convex portions. In addition, complicated processing of, for example, forming the concavo-convex portions on the outer wrapping material need not be executed. With this, a heat insulating box body, a refrigerator, and a device, which are low-cost and excellent in handling property and heat insulating performance, can be provided.

Yet further, the vacuum heat insulating material 400 is arranged between the external box 710 and the internal box 750, and the thickness of the rigid urethane foam as the intermediate member between the vacuum heat insulating material 400 and the internal box 750 is set to 11 mm or less (preferably less than 10 mm). With this, the box body strength can be increased, and hence it is unnecessary to form, for example, concavo-convex portions on the vacuum heat insulating material 400, or to form the core material to be sealed in the outer wrapping material into a concavo-convex shape. Thus, the vacuum heat insulating material 400 to be used may be formed into a flat plate shape, and hence the fiber-diameter core materials such as an organic fiber or an inorganic fiber can be used as the core material of the vacuum heat insulating material 400. In this way, the fiber-diameter core materials such as an organic fiber or an inorganic fiber can be used as the core material of the vacuum heat insulating material 400, and hence a particulate material having fluidity need not be used as the core material, or the core material need not be formed into a complicated shape having, for example, the concavo-convex portions. In addition, complicated processes of, for example, forming the concavo-convex portions on the outer wrapping material need not be executed. With this, a heat insulating box body, a refrigerator, and a device, which are low-cost and excellent in handling property and heat insulating performance, can be provided.

[0345]

Yet further, the heat insulating box body 700, the storage compartments 2, 3, 4, 5, and 6 for housing items to be stored, and the cooler 13 for generating the cooling air for cooling the storage compartments are arranged. The concave portion 440 or the second concave portion 441 is formed in the vertical direction, and the concave portion 440 or the second concave portion 441 can be used as the cooling air passage 760 through which the cooling air generated by the cooler 13 is caused to flow. Thus, the wall thickness can be reduced at the part corresponding to the concave portion, and hence the internal capacity of the storage compartment can be increased. In addition, the concave portion can be used as the cooling air passage 760, and hence additional cooling air passages need not be formed.

[0346]

Yet further, the heat insulating box body 700, the storage compartments 2, 3, 4, 5, and 6 for housing items to be stored, and the cooler 13 for generating the cooling air for cooling the storage compartments are arranged. The concave portion 440 or the second concave portion 441 is formed in the vertical direction, and the concave portion 440 or the second concave portion 441 can be used as the passage through which the mist generated by the misting device 200 is caused to flow. Thus, the wall thickness can be reduced at the part corresponding to the concave portion, and hence the internal capacity of the storage compartment can be increased. In addition, the concave portion can be used as the mist passage, and hence additional mist passages need not be formed.

[0347]

Yet further, the cooler room 131 in which the cooler 13 is arranged is formed, and the concave portion 440 or the second concave portion 441 communicates to the cooler room 131. Thus, the concave portion can be used as the cooling air passage.

[0348]

Yet further, the insides of the convex portions 450 are used as the mist passage through which the mist generated by the misting device 200 is to be supplied. With this, the convex portions increase the strength of the box body, and additional passages through which the mist is to be supplied need not be formed. Thus, a heat insulating box body that is capable of performing humidification and sterilization at low cost, and is excellent in design property, and a device such as a refrigerator including the heat insulating box body can be provided.

[0349]

Yet further, the concave portion 440 or the second concave portion 441 is formed on the rear of the storage compartment (such as refrigerator compartment 2), and the illumination device 900 for illuminating the inside of the storage compartment is arranged in the upper wall, the lower wall, the lateral wall, or the partition wall 24 of the storage compartment. With this, the cooling air passage 760 and the illumination device 900 can be provided to different wall surfaces. Thus, the degree of freedom in structure and arrangement position of the passage, and structure and arrangement position of the illumination device is increased in comparison with a case where the cooling air passage 760 and the illumination device 900 are provided to the same wall surface.

[0350]

Yet further, the refrigeration cycle is arranged, and the pipe 725 of the refrigeration cycle is arranged in the convex portion 450. With this, the strength of the box body can be increased, and additional spaces for the pipe 725 need not be secured. Thus, a heat insulating box body, a refrigerator, and a device, which are low-cost and excellent in design property, can be provided.

[0351]

Yet further, the refrigeration cycle and the protruding portions 910 formed in the concave portion 440 or the second concave portion 441 in a manner of projecting to the front side (front opening side) are provided, and the pipe 725 of the refrigeration cycle is arranged between the protruding portions 910. With this, the strength of the box body can be increased, and additional spaces for the pipe 725 need not be secured. Thus, a heat insulating box body, a refrigerator, and a device, which are low-cost and excellent in design property, can be provided.

[0352]

Yet further, the control lead wires such as compressor drive control lead wires or temperature control lead wires, or the pipe 720 having the control lead wires arranged therein are/is arranged through the convex portion 450. With this, the strength of the box body can be increased, and additional spaces for the control lead wires, the pipe 720, or the like need not be secured. Thus, a heat insulating box body, a refrigerator, and a device, which are low-cost and excellent in design property, can be provided.

[0353]

Yet further, the refrigeration cycle and the protruding portions 910 formed in the concave portion 440 or the second concave portion 441 in a manner of projecting to the front side are provided. In addition, for example, the control lead wires such as the compressor drive control lead wires or the temperature control lead wires, or the pipe 720 having the control lead wires or the like arranged therein are/is arranged through the protruding portions 910. With this, the strength of the box body can be increased, and additional spaces for the control lead wires, the pipe 720, or the like need not be secured. Thus, a heat insulating box body, a refrigerator, and a device, which are low-cost and excellent in design property, can be provided.

[0354]

Yet further, the charging ports 703 and 704 for the foam heat insulating material are formed in the external box 710, and the vacuum heat insulating material 400 may be arranged without closing the charging ports. With this, at the time of charging the foam heat insulating material, the foam heat insulating material is not hindered by the vacuum heat insulating material from being charged, and hence can be thoroughly charged all over the box body. In this way, a heat insulating box body, a refrigerator, a device, and the like, which are excellent in strength and reliability, can be provided.

[0355]

Yet further, the heat insulating box body 700 includes an outer shell that is formed of the external box 710 and the internal box 750 and has the top wall 740, the rear wall 730, the lateral walls 790, and the bottom wall 780. The storage compartments 2, 3, 4, 5, and 6 each having the opening portion on the front side are arranged in the heat insulating box body 700. On the rear wall 730 of the storage compartment, the concave portion 440 (or second concave portion 441) is formed at the substantially widthwise central position on the rear wall of the storage compartment. The flat-plate-like vacuum heat insulating material 400 is arranged between the internal box 750 and the external box 710 at the position where the flat-plate-like vacuum heat insulating material 400 faces the concave portion 440, and has a width at least larger than the width of the concave portion 440 in the width direction. The foam heat insulating material (such as rigid urethane foam) as the intermediate member is charged between the internal box 750 and the vacuum heat insulating material 400 at the position where the vacuum heat insulating material 400 faces the concave portion 440. The bending elastic modulus of the vacuum heat insulating material 400 is set to 20 MPa or more, the thickness of the foam heat insulating material as the intermediate member at the position where the vacuum heat insulating material 400 faces the concave portion 440 is set to 11 mm or less, and the ratio of "Thickness of Foam Heat Insulating Material/(Thickness of Foam Heat Insulating Material+Thickness of Vacuum Heat Insulating Material)" is set to 0.3 or less. In other words, at least one of the following conditions (1), (2), or (3) is satisfied.

(1) Bending Elastic Modulus of Vacuum Heat Insulating Material>=20 MPa,

(2) Thickness of Foam Heat Insulating Material/(Thickness of Foam Heat Insulating Material+Thickness of Vacuum Heat Insulating Material)<=0.3, and

(3) Thickness of Foam Heat Insulating Material<=11 mm (preferably Thickness of Foam Heat Insulating Material<10 mm)

With this, the wall thickness of the box body can be reduced, and in addition, both the box body strength and the heat insulating performance can be enhanced. Thus, a heat insulating box body, a refrigerator, and a device, which are large in internal capacity of the compartments (such as storage compartments) and excellent in strength and heat insulating performance, can be provided. Further, the bending elastic modulus of the rigid urethane foam can be increased. Thus, even when the rigid urethane foam is reduced in thickness, the strength can be increased. Therefore, even when the wall thickness is reduced, the box body strength can be increased. In addition, the composite heat conductivity of the wall formed of the composite member including the vacuum heat insulating material 400 and the rigid urethane foam can be reduced. Thus, even when the wall thickness is reduced, the heat insulating performance can be enhanced.

Further, the heat insulating box body 700 includes an outer shell that is formed of the external box 710 and the internal box 750 and has the top wall 740, the rear wall 730, the lateral walls 790, and the bottom wall 780. The storage compartments 2, 3, 4, 5, and 6 each having the opening portion formed on the front side are formed in the heat insulating box body 700. The injection ports 703 and 704 are formed through the outer surface of the rear wall 730 of the heat insulating box body 700, specifically, formed at the end portions in the width direction or the end portions in the vertical direction of the outer surface of the rear wall 730. The foam heat insulating material such as urethane is injected into the spaces 315 formed of the external box 710 and the internal box 750 through the injection ports. The bending elastic modulus of the vacuum heat insulating material 400 is set to 20 MPa or more, the thickness of the foam heat insulating material being the intermediate member is set to 11 mm or less, and the ratio of "Thickness of Foam Heat Insulating Material/(Thickness of Foam Heat Insulating Material+Thickness of Vacuum Heat Insulating Material)" is set to 0.3 or less. In other words, at least one of the following conditions (1), (2), and (3) is satisfied.

(1) Bending Elastic Modulus of Vacuum Heat Insulating Material>=20 MPa,

(2) Thickness of Foam Heat Insulating Material/(Thickness of Foam Heat Insulating Material+Thickness of Vacuum Heat Insulating Material)<=0.3, and

(3) Thickness of Foam Heat Insulating Material<=11 mm (preferably Thickness of Foam Heat Insulating Material<10 mm)

The cutout portions 33 are formed at the parts of the vacuum heat insulating material 400 to face the injection ports 703 and 704 so that the vacuum heat insulating material 400 does not interfere with the injection ports 703 and 704. With this, the wall thickness of the box body can be reduced, and in addition, both the box body strength and the heat insulating performance can be enhanced. Thus, a heat insulating box body, a refrigerator, and a device, which are large in internal capacity of the compartments (such as storage compartments) and excellent in strength and heat insulating performance, can be provided. Further, the bending elastic modulus of the rigid urethane foam can be increased. Thus, even when the rigid urethane foam is reduced in thickness, the strength can be increased. Therefore, even when the wall thickness is reduced, the box body strength can be increased. In addition, the composite heat conductivity of the wall formed of the composite member including the vacuum heat insulating material 400 and the rigid urethane foam can be reduced. Thus, even when the wall thickness is reduced, the heat insulating performance can be enhanced. Further, a coverage area of the vacuum heat insulating material 400 can be increased without causing the interference with the injection ports 703 and 704, and hence a heat insulating box body, a refrigerator, and a device, which are excellent in heat insulating performance, can be provided.

Further, the heat insulating box body 700 includes an outer shell that is formed of the external box 710 and the internal box 750 and has the top wall 740, the rear wall 730, the lateral walls 790, and the bottom wall 780. The storage compartments 2, 3, 4, 5, and 6 each having the opening portion formed on the front side are formed in the heat insulating box body 700. The injection ports 703 and 704 are formed through the outer surface of the rear wall 730 of the heat insulating box body 700, specifically, formed at the end portions in the width direction or the end portions in the vertical direction of the outer surface of the rear wall 730. The foam heat insulating material such as urethane is injected into the spaces 315 formed of the external box 710 and the internal box 750 through the injection ports. The bending elastic modulus of the vacuum heat insulating material 400 is set to 20 MPa or more, the thickness of the foam heat insulating material being the intermediate member is set to 11 mm or less (the thickness of the foam heat insulating material is preferably less than 10 mm), and the density of the foam heat insulating material is set to more than 60 kg/m^3. Thus, the wall thickness can be reduced while securing the heat insulating performance and the wall strength.

In addition, the cutout portions 33 are formed at the parts of the vacuum heat insulating material 400 to face the injection ports 703 and 704 so that the vacuum heat insulating material 400 does not interfere with the injection ports 703 and 704. With this, the wall thickness of the box body can be reduced, and in addition, both the box body strength and the heat insulating performance can be enhanced. Thus, a heat insulating box body, a refrigerator, and a device, which are large in internal capacity of the compartments (such as storage compartments) and excellent in strength and heat insulating performance, can be provided. Further, the bending elastic modulus of the rigid urethane foam can be increased. Thus, even when the rigid urethane foam is reduced in thickness, the strength can be increased. Therefore, even when the wall thickness is reduced, the box body strength can be increased. In addition, the composite heat conductivity of the wall formed of the composite member including the vacuum heat insulating material 400 and the rigid urethane foam can be reduced. Thus, even when the wall thickness is reduced, the heat insulating performance can be enhanced. Further, the coverage area of the vacuum heat insulating material 400 can be increased without causing the interference with the injection ports 703 and 704, and hence a heat insulating box body, a refrigerator, and a device, which are excellent in heat insulating performance, can be provided. Note that, when the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member is excessively high, there arise problems of, for example, quality degradation, performance deterioration, and cost increase, specifically, (1) cost may be increased due to increase in injection amount of urethane, (2) leakage of urethane from the box body or the like may occur due to increase in injection pressure of urethane, (3) a force of close contact or an adhesive force between urethane and a box body deformation suppressing die set, a box body pressing member, or the like may be increased due to increase in foaming pressure at the time of foaming of urethane, with the result that the box body deformation suppressing die set, the box body pressing member, or the like may be difficult to pull out of the box body (difficult to take out of the box body), and (4) the heat insulating performance may be abruptly deteriorated due to the increase in density of urethane. As a countermeasure, the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member (density after foaming as for the foam heat insulating material) is set to preferably 100 kg/m^3 or less (more preferably 90 kg/m^3 or less).

[0356]

Yet further, the vacuum heat insulating material 400 is arranged at least in the rear wall 730, and the ratio of the arrangement areas of the vacuum heat insulating materials 400 to be arranged in the rear wall 730 and the lateral walls 790 relative to the total surface area of the rear wall 730 and the lateral walls 790 is set to 70% or more. With this, a heat insulating box body, a refrigerator, and a device, which are small in deformation amount of the box body and excellent in strength, rigidity, and heat insulating performance, can be provided.

Yet further, the heat insulating box body is formed of the external box 710 and the internal box 750 and has the opening portion formed on the front side. The vacuum heat insulating material 400 is arranged on an inner surface of the external box (attached to an internal surface of the external box) in the space 315 between the external box 710 and the internal box 750. The injection ports 703 and 704 are formed through the outer surface of the rear wall 730 of the heat insulating box body, specifically, formed at the end portions in the width direction or the end portions in the vertical direction of the outer surface of the rear wall 730. The foam heat insulating material such as urethane is injected into the spaces 315 formed of the external box 710 and the internal box 750 through the injection ports. The cutout portions 33 are formed at the parts to face the injection ports 703 and 704 so that the injection ports 703 and 704 do not interfere with the vacuum heat insulating material 400. With this, the ratio of the arrangement area (coverage) of the vacuum heat insulating material relative to the outer surface area of the heat insulating box body or the rear wall of the heat insulating box body can be increased. Further, the proportion of the volume of the vacuum heat insulating material (charging rate of the vacuum heat insulating material) relative to the volumes of the spaces between the external box and the internal box forming the box body can also be increased. With this, the refrigerator or the heat insulating box body can be enhanced in heat insulating performance. Note that, the cutout portions 33 are not particularly limited in size or shape as long as the injection ports 703 and 704 do not interfere with the vacuum heat insulating material 400, but it is preferred that cutout portions or openings be formed to have a size substantially equivalent to or larger than a size of the injection ports 703 and 704.

Yet further, when each of the arrangement positions in the width direction (positions of inner end portions in the width direction) of the charging ports (injection ports) 703 and 704, that is, the distance from the left edge or the right edge of the box body 700 is represented by Y1, the thickness of each of the lateral walls 790 (wall thickness) is represented by T1 mm, and the widthwise length of each of the charging ports (diameter of circle) is represented by r1, as long as the predetermined distance Y1 in the width direction of each of the injection ports 703 and 704 (positions of the inner end portions in the width direction) is set to T1+r1 or less, at the time of being charged through the charging ports (injection ports) 703 and 704, the filler such as urethane smoothly flows through the lateral walls 790.

Yet further, when each of the arrangement positions in the vertical direction (positions of inner end portions in the vertical direction) of the charging ports (injection ports) 703 and 704, that is, the distance from the upper edge or the lower edge in the vertical direction of the box body 700 or the end portion of the machine room 1A is represented by Y2, the thickness of the top wall, the bottom wall, or the heat insulating partition wall for partitioning the machine room and the storage compartment from each other (wall thickness) is represented by T2 mm, and the vertical length of each of the charging ports (diameter of circle) is represented by r2, as long as the predetermined distance Y2 in the vertical direction of each of the injection ports 703 and 704 (positions of the inner end portions in the vertical direction) is set to T2+r2 or less, at the time of being charged through the charging ports (injection ports) 703 and 704, the filler such as urethane smoothly flows through the top wall, the bottom wall, or the partition wall.

[0357]

Yet further, the proportion of the volumes of the vacuum heat insulating materials 400 relative to the volumes of the spaces 315 between the external box 710 and the internal box 750 forming the outer shell of the heat insulating box body is set to 40% or more. With this, a heat insulating box body, a refrigerator, and a device, which are small in deformation amount of the box body and excellent in strength, rigidity, and heat insulating performance, can be provided.

Yet further, the heat insulating box body is formed of the external box 710 and the internal box 750 and has the opening portion formed on the front side. The vacuum heat insulating material 400 is arranged on an inner surface of the external box (attached to an internal surface of the external box) in the spaces 315 between the external box 710 and the internal box 750. The injection ports 703 and 704 are formed through the outer surface of the rear wall 730 of the heat insulating box body, specifically, formed at the end portions in the width direction or the end portions in the vertical direction of the outer surface of the rear wall 730. The foam heat insulating material such as urethane is injected into the spaces 315 formed of the external box 710 and the internal box 750 through the injection ports. The vacuum heat insulating material includes the cutout portions 33 such as cutouts or openings, which are formed at the parts to face the injection ports 703 and 704 so that the vacuum heat insulating material does not interfere with the injection ports 703 and 704. The vacuum heat insulating material is arranged at least in the rear wall 730, and the ratio of the arrangement areas of the vacuum heat insulating materials 400 arranged in the rear wall 730 and the lateral walls 790 relative to the total surface area of the rear wall 730 and the lateral walls 790 is set to 70% or more. With this, a heat insulating box body, a refrigerator, and a device, which are small in deformation amount of the box body and excellent in strength, rigidity, and heat insulating performance, can be provided. Further, the coverage area of the vacuum heat insulating materials 400 can be increased without causing the interference with the injection ports 703 and 704, and hence a heat insulating box body, a refrigerator, and a device, which are excellent in heat insulating performance, can be provided.

Yet further, the heat insulating box body is formed of the external box 710 and the internal box 750 and has the opening portion formed on the front side. The vacuum heat insulating material 400 is arranged on an inner surface of the external box (attached to an internal surface of the external box) in the spaces 315 between the external box 710 and the internal box 750. The injection ports 703 and 704 are formed through the outer surface of the rear wall 730 of the heat insulating box body, specifically, formed at the end portions in the width direction or the end portions in the vertical direction of the outer surface of the rear wall 730.

The foam heat insulating material such as urethane is injected into the spaces 315 formed of the external box 710 and the internal box 750 through the injection ports. The vacuum heat insulating material includes the cutout portions 33 such as cutouts or openings, which are formed at the parts to face the injection ports 703 and 704 so that the vacuum heat insulating material does not interfere with the injection ports 703 and 704. As long as the proportion of the volumes of the vacuum heat insulating materials 400 relative to the volumes of the spaces 315 between the external box 710 and the internal box 750 forming the outer shell of the heat insulating box body is set to 40% or more, a heat insulating box body, a refrigerator, and a device, which are small in deformation amount of the box body and excellent in strength, rigidity, and heat insulating performance, can be provided. Further, the coverage area of the vacuum heat insulating materials 400 can be increased without causing the interference with the injection ports 703 and 704, and hence a heat insulating box body, a refrigerator, and a device, which are excellent in heat insulating performance, can be provided. Further, the coverage area of the vacuum heat insulating materials 400 can be increased without causing the interference with the injection ports 703 and 704, and hence a heat insulating box body, a refrigerator, and a device, which are excellent in heat insulating performance, can be provided.

[0358]

Yet further, in this embodiment, the heat insulating box body 700 includes an outer shell that is formed of the external box 710 and the internal box 750 and has the top wall 740, the rear wall 730, the lateral walls 790, and the bottom wall 780. The storage compartments 2, 3, 4, 5, and 6 each having the opening portion on the front side are formed by partitioning the inside of the outer shell of the heat insulating box body 700 with the partition walls 24. The pull-out case 520 is housed in the storage compartment, and pulled out through intermediation of the rail member 810 arranged on the lateral wall 790 forming the storage compartment. The vacuum heat insulating material 400 is arranged at least between the internal box 750 and the external box 710 corresponding to the lateral wall 790 of the storage compartment. In the lateral wall 790, the foam heat insulating material as the intermediate member is charged between the vacuum heat insulating material 400 and the internal box 750 including the rail mount portion 755 to which the rail member 810 is mounted. The thickness of the foam heat insulating material is set to 11 mm or less (specifically, preferably less than 10 mm) at the position where the foam heat insulating material faces the rail mount portion 755. With this, the wall thickness can be reduced. Further, the rigid urethane foam is used as the foam heat insulating material being the intermediate member. With this, the bending elastic modulus is increased, and the strength of the box body is increased. As a result, the holding strength or the fixing strength of the rail mount portions 755 is increased.

[0359]

Yet further, the heat insulating box body 700 includes an outer shell that is formed of the external box 710 and the internal box 750 and has the top wall 740, the rear wall 730, the lateral walls 790, and the bottom wall 780. The storage compartments 2, 3, 4, 5, and 6 each having the opening portion on the front side are formed by partitioning the inside of the outer shell of the heat insulating box body 700 with the partition walls 24. The pull-out case 520 is housed in the storage compartment, and pulled out through intermediation of the rail member 810 arranged on the lateral wall 790 forming the storage compartment. The vacuum heat insulating material 400 is arranged at least between the internal box 750 and the external box 710 corresponding to the lateral wall 790 of the storage compartment. In the lateral wall 790, the foam heat insulating material as the intermediate member is charged or applied between the vacuum heat insulating material 400 and the internal box 750 including the rail mount portion 755 to which the rail member 810 is mounted. The thickness of the foam heat insulating material as the intermediate member is set to 11 mm or less (specifically, preferably less than 10 mm) at the position where the foam heat insulating material faces the rail mount portion 755. The density of the foam heat insulating material as the intermediate member to be charged or applied between the vacuum heat insulating material 400 and the internal box 750 including the rail portion (rail mount portion) 755 to which the rail is mounted is set to more than 60 kg/m^3. In this way, the density of the intermediate member is set to more than 60 kg/m^3, and hence the holding strength or the fixing strength of the screw for fixing the rail and the like or the screw fixing portion is increased. Thus, deformation and the like of the internal box 750 do not occur near the rail mount portion 755, and hence the pull-out door, the case, and the like can be smoothly pulled out. In addition, the rail mount portion 755 to which the fixing member such as the screw is mounted is not damaged, and hence the reliability is enhanced. Further, when the thickness of the foam heat insulating material is set to 11 mm or less (preferably less than 10 mm), the wall thickness can be reduced. Further, when the rigid urethane foam is used as the foam heat insulating material being the intermediate member, the bending elastic modulus is increased, and the strength of the box body is increased.

Note that, when the wall thickness of the lateral walls 790, the rear wall 730, the top wall 740, the bottom wall 730, or the partition walls 24 of the heat insulating box body, the refrigerator, the device, or the like is small, the housing capacity for items to be stored in the compartment can be increased. Thus, the wall thickness is preferably 40 mm or less. Further, when the wall thickness is excessively small, there may arise problems of, for example, decrease in strength, deterioration in heat insulating performance, and deterioration in assembly efficiency due to reduction of the space for the vacuum heat insulating material. Thus, the wall thickness is preferably approximately 20 mm or more. Therefore, the wall thickness of the heat insulating box body, the wall thickness of the refrigerator, or the wall thickness of the device, specifically, the thickness of the lateral walls 790, the rear wall 730, the top wall 740, the bottom wall 730, or the partition walls 24 is preferably set within a range of from 20 mm or more to 40 mm or less.

[0360]

Yet further, in this embodiment, the heat insulating box body 700 includes an outer shell that is formed of the external box 710 and the internal box 750 and has the top wall 740, the rear wall 730, the lateral walls 790, and the bottom wall 780. The storage compartments 2, 3, 4, 5, and 6 each having the opening portion on the front side are formed by partitioning the inside of the outer shell of the heat insulating box body 700 with the partition walls 24. The pull-out case 520 is housed in the storage compartment, and pulled out through intermediation of the rail member 810 arranged on the partition wall (including partition wall 24 between the storage compartments, bottom wall 780, and top wall 740) forming the bottom surface or the upper surface of the storage compartment. The vacuum heat insulating material 400 is arranged in the partition wall (including partition wall 24 between the storage compartments, bottom wall 780, and top wall 740) on which the rail member 810 is arranged. The heat insulating material as the intermediate member is charged, applied, or arranged between the outer shell member forming the partition wall (including partition wall 24 between the storage compartments, bottom wall 780, and top wall 740) and the vacuum heat insulating material 400 in the partition wall (including partition wall 24 between the storage compartments, bottom wall 780, and top wall 740) at the position where the heat insulating material faces the rail member 810. The thickness of the heat insulating material as the intermediate member is set to 11 mm or less (specifically, less than 10 mm) at the position of the partition wall facing the rail member 810. The density of the heat insulating material as the intermediate member to be charged, applied, or arranged between the outer shell member and the vacuum heat insulating material 400 is set to more than 60 kg/m^3. In this way, the density of the intermediate member is set to more than 60 kg/m^3, and hence the holding strength or the fixing strength of the screw for fixing the rail and the like or the screw fixing portion is increased. Thus, deformation and the like of the outer shell member do not occur near the rail mount portion on the partition wall (including partition wall 24 between the storage compartments, bottom wall 780, and top wall 740), and hence the pull-out door, the case, and the like can be smoothly pulled out. In addition, the partition wall to which the fixing member such as the screw is mounted is not damaged, and hence the reliability is enhanced. Further, when the thickness of the heat insulating material as the intermediate member is set to 11 mm or less (specifically, less than 10 mm), the wall thickness can be reduced. Further, when the rigid urethane foam is used as the heat insulating material being the intermediate member, the bending elastic modulus is increased, and the strengths of the partition wall and the box body are increased.

[0361]

Yet further, the ratio of "(Thickness of Foam Heat Insulating Material as Intermediate Member)/(Thickness of Foam Heat Insulating Material as Intermediate Member+Thickness of Vacuum Heat Insulating Material 400)" is set to 0.3 or less. With this, the heat conductivity of the composite member formed by combining the foam heat insulating material as the intermediate member and the vacuum heat insulating material can be reduced. Thus, the heat insulating performance of the composite member can be enhanced.

[0362]

Yet further, when insulating heat of a heat source such as a hot water storage tank, the thickness of the heat insulating walls (such as rear wall 730, top wall 740, bottom wall 780, lateral walls 790, and partitions wall 24) is reduced so as to reduce the outer size (such as outer diameter, width, depth, and height) of the heat insulating box body such as the box body 700 having a cylindrical shape or an angular cylindrical shape and also having a front opening. With this, a compact heat insulating box body, refrigerator, hot water storage device, device, and the like can be provided.

[0363]

Yet further, when the rigid urethane foam is used as the foam heat insulating material being the intermediate member, and when the bending elastic modulus of the rigid urethane foam to be used is set to 15 MPa or more, the holding or fixing strength of the screw for fixing the rail and the like or the screw fixing portion is increased. Thus, deformation and the like of the internal box 750 do not occur near the rail mount portion 755, and hence the pull-out door, the case, and the like can be smoothly pulled out. In addition, the internal box 750 having the mount portion for the screw and the like is not damaged, and hence the reliability is enhanced.

[0364]

Yet further, when two-step rails that can be pulled out in two steps, or three-step rails that can be pulled out in three steps are used as the rails, a load on the rail portion (rail mount portion) 755 is increased. However, when the thickness of the foam heat insulating material as the intermediate member is set to 11 mm or less at the position where the foam heat insulating material faces the rail portion 755, the ratio of "(Thickness of Foam Heat Insulating Material as Intermediate Member)/(Thickness of Foam Heat Insulating Material as Intermediate Member+Thickness of Vacuum Heat Insulating Material 400)" is set to 0.3 or less, and when the density of the foam heat insulating material as the intermediate member to be charged between the vacuum heat insulating material 400 and the internal box 750 including the rail mount portion (rail portion) 755 to which the rail member 810 is mounted is set to more than 60 kg/m^3, the strength of the rail portion 755 of the internal box 750 is increased. Further, the holding strength or the fixing strength of the fixing member 735 such as the screw for fixing the rail member 810 and the like is increased. With this, deformation and the like of the internal box 750 do not occur near the rail portion 755. Thus, even when the two-step rails or the three-step rails are used, the pull-out door, the case, and the like can be smoothly pulled out. Further, the rail portion 755 as the mount portion for the fixing member 735 such as the screw, or the internal box 750 is not damaged. As a result, the reliability is enhanced.

[0365]

Yet further, the case 520 includes the case lateral walls forming the case 520, and the rail support portion (case step portion) 525 as a step portion formed on the case lateral wall and configured to allow the case 520 to be supported by the rail member 810. When the rail support portion (case step portion) 525 as a step portion is arranged at a lower position of 1/2 or less, preferably a lower position of 1/3 or less from the top in the height direction of the case 520, by an amount corresponding to a draft angle of the case 520, the width of the case 520 can be increased in comparison with that in a case where the rail support portion (case step portion) 525 as a step portion is arranged at a position higher than a position of 1/2 in the height direction of the case 520. With this, the capacity of the case 520 can be increased.

[0366]

Yet further, the control board room 31 in which the controller 30 is arranged is formed on a compartment outer side of the top wall 740 or the rear wall 730 (on the opposite side of the storage compartment side as illustrated in Fig. 14). The vacuum heat insulating material 400 is arranged between the control board room 31 and the internal box 750. The rigid urethane foam as the self-adhesive foam heat insulating material being the intermediate member is charged between the vacuum heat insulating material 400 and the internal box 750. The thickness of the foam heat insulating material is set to 11 mm or less at the position where the vacuum heat insulating material 400 faces the control board room 31, and the ratio of "Thickness of Foam Heat Insulating Material as Intermediate Member/(Thickness of Foam Heat Insulating Material as Intermediate Member+Thickness of Vacuum Heat Insulating Material)" is set to 0.3 or less. In other words, the following relationships are established.

Thickness of Foam Heat Insulating Material<=11 mm (specifically, Thickness of Foam Heat Insulating Material<10 mm), and

Thickness of Foam Heat Insulating Material/(Thickness of Foam Heat Insulating Material+Thickness of Vacuum Heat Insulating Material)<=0.3

With this, the wall thickness of the box body can be reduced at the part where the control board room 31 is arranged, and in addition, both the box body strength and the heat insulating performance can be enhanced. Thus, a refrigerator and a device, which are large in internal capacity of the compartments (such as storage compartments) and excellent in strength and heat insulating performance, can be provided. Further, the bending elastic modulus of the rigid urethane foam can be increased by reducing the thickness of the rigid urethane foam as the intermediate member. Thus, even when being reduced in thickness, the rigid urethane foam as the intermediate member can be increased in strength. Therefore, even when the wall thickness is reduced, the box body strength can be increased. In addition, when the ratio of "Thickness of Foam Heat Insulating Material as Intermediate Member/(Thickness of Foam Heat Insulating Material as Intermediate Member+Thickness of Vacuum Heat Insulating Material)" is set to 0.3 or less, the composite heat conductivity of the wall formed of the composite member including the vacuum heat insulating material 400 and the rigid urethane foam can be reduced. Thus, even when the wall thickness is reduced, the heat insulating performance can be enhanced. Note that, when the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member is excessively high, there arise problems of, for example, quality degradation, performance deterioration, and cost increase, specifically, (1) cost may be increased due to increase in injection amount of urethane, (2) leakage of urethane from the box body or the like may occur due to increase in injection pressure of urethane, (3) a force of close contact or an adhesive force between urethane and a box body deformation suppressing die set, a box body pressing member, or the like may be increased due to increase in foaming pressure at the time of foaming of urethane, with the result that the box body deformation suppressing die set, the box body pressing member, or the like may be difficult to pull out of the box body (difficult to take out of the box body), and (4) the heat insulating performance may be abruptly deteriorated due to the increase in density of urethane. As a countermeasure, the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member (density after foaming as for the foam heat insulating material) is set to preferably 100 kg/m^3 or less (more preferably 90 kg/m^3 or less).

[0367]

Yet further, when the density of the rigid urethane foam as the intermediate member is set to more than 60 kg/m^3, the rigid urethane foam as the intermediate member is formed at a high density, and increased in bending elastic modulus. With this, deformation of the control board room 31 can be suppressed. Further, when fixing is performed by using the fixing member such as a screw, the rigid urethane foam is formed at a high density, to thereby increase the holding strength of the screw and the like.

Yet further, the refrigerator includes the door for closing the opening portion formed on the front side of the heat insulating box body 700 in a freely openable and closable manner. The door includes the door outer shell formed, for example, of the door frame member or the door inner plate, and the glass plate member arranged as a designed surface on the front side of the door outer shell. The vacuum heat insulating material 400 is arranged in the door internal space formed of the glass plate member and the door outer shell. When the density of the rigid urethane foam being the intermediate member that is charged, applied, or sealed in the door internal space (specifically, between the glass plate member and the vacuum heat insulating material 400) is set to more than 60 kg/m^3, the rigid urethane foam being the intermediate member is formed at a high density, and increased in bending elastic modulus. With this, also when the glass plate member is arranged on the front side of the door, the holding or bonding strength of the glass plate member is increased. Thus, the glass plate member can be suppressed from dropping off, and the strength of the rigid urethane foam being the intermediate member in the door internal space is increased. Thus, the strength (rigidity) of the door including the glass plate member is also increased. In this case, the glass plate member is larger in thickness and weight than related-art steel plates, and hence a glass plate member-holding structure of the door outer shell needs to be strengthened so that the glass plate member is not liable to drop off. As a result, complication of structure and increase in cost are caused. However, when the density of the rigid urethane foam is set to more than 60 kg/m^3 as in this embodiment, properties of fitting between the urethane foam and the glass plate member are increased. Thus, a force of holding the glass plate member is increased, and hence the reliability in preventing the glass plate member from dropping off is increased. Further, when the thickness of the foam heat insulating material is set to 11 mm or less at a position of facing the glass plate member (preferably less than 10 mm in consideration of influences of, for example, the variation in thickness and the concavo-convex portions on the surface of the vacuum heat insulating material 400), the bending elastic modulus of urethane being the intermediate member can be increased. Thus, the door strength can be increased, and the door thickness can be reduced.

Yet further, the vacuum heat insulating material 400 is arranged in the door internal space between the glass plate member arranged on the front side of the door and the door outer shell (formed, for example, of the door frame member or the door inner plate). The self-adhesive rigid urethane foam as the foam heat insulating material being the intermediate member is charged between the vacuum heat insulating material 400 and the glass plate member. The thickness of the foam heat insulating material is set to 11 mm or less at the position of facing the glass plate member (preferably less than 10 mm in consideration of influences of, for example, the variation in thickness and the concavo-convex portions on the surface of the vacuum heat insulating material 400), and the ratio of "Thickness of Foam Heat Insulating Material as Intermediate Member/(Thickness of Foam Heat Insulating Material as Intermediate Member+Thickness of Vacuum Heat Insulating Material)" is set to 0.3 or less. In other words, the following relationships are established.

Thickness of Foam Heat Insulating Material<=11 mm (specifically, Thickness of Foam Heat Insulating Material<10 mm), and

Thickness of Foam Heat Insulating Material/(Thickness of Foam Heat Insulating Material+Thickness of Vacuum Heat Insulating Material)<=0.3

With this, the thickness of the door including the glass plate member can be reduced, and in addition, both the door body strength and the heat insulating performance can be enhanced. Thus, a refrigerator and a device, which are large in internal capacity of the compartments (such as storage compartments) and excellent in strength and heat insulating performance, can be provided. Further, the bending elastic modulus of the rigid urethane foam can be increased by reducing the thickness of the rigid urethane foam being the intermediate member. Thus, even when being reduced in thickness, the rigid urethane foam being the intermediate member can be increased in strength. Therefore, even when the door thickness is reduced, the door body strength can be increased. In addition, when the ratio of "Thickness of Foam Heat Insulating Material as Intermediate Member/(Thickness of Foam Heat Insulating Material as Intermediate Member+Thickness of Vacuum Heat Insulating Material)" is set to 0.3 or less, the composite heat conductivity of the wall formed of the composite member including the vacuum heat insulating material 400 and the rigid urethane foam can be reduced. Thus, even when the door thickness is reduced, the heat insulating performance can be increased.

Note that, when the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member is excessively high, there arise problems of, for example, quality degradation, performance deterioration, and cost increase, specifically, (1) cost may be increased due to increase in injection amount of urethane, (2) leakage of urethane from the box body or the like may occur due to increase in injection pressure of urethane, (3) a force of close contact or an adhesive force between urethane and a box body deformation suppressing die set, a box body pressing member, or the like may be increased due to increase in foaming pressure at the time of foaming of urethane, with the result that the box body deformation suppressing die set, the box body pressing member, or the like may be difficult to pull out of the box body (difficult to take out of the box body), and (4) the heat insulating performance may be abruptly deteriorated due to the increase in density of urethane. As a countermeasure, the density of the heat insulating material such as urethane (more specifically, rigid urethane foam) being the intermediate member (density after foaming as for the foam heat insulating material) is set to preferably 100 kg/m^3 or less (more preferably 90 kg/m^3 or less).

Yet further, the refrigerator includes the box body formed of the external box and the internal box and having the rear wall and the lateral walls, the storage compartments formed in the inside of the box body and each having the opening portion formed on the front side, and the doors for closing the opening portions formed on the front side of the box body in a freely openable and closable manner. The doors each include the door outer shell formed of the door frame portion forming peripheral walls of the door, and the door inner plate forming the surface portion on the storage compartment side on which items to be stored are housed, and the glass plate member arranged on the front side of the door outer shell (front side under the state of being mounted, for example, to a heat insulating box body, a refrigerator, or a device). The vacuum heat insulating material is arranged in the door internal space formed of the glass plate member and the door outer shell. The foam heat insulating material is charged, applied, or sealed in the door internal space. A proportion of a volume of the vacuum heat insulating material relative to a volume of the door internal space formed of the glass plate member and the door outer shell is set to 40% or more. With this, a door body, a refrigerator, and a device, which are small in deformation amount of the door and excellent in strength, rigidity, and heat insulating performance, can be provided.

Yet further, when the wall thickness of the lateral walls 790, the rear wall 730, the top wall 740, the bottom wall 730, or the partition walls 24 of the heat insulating box body, the refrigerator, the device, or the like, or the door thickness is small, the housing capacity for items to be stored in the compartment can be increased. Thus, the wall thickness is preferably 40 mm or less. Further, when the wall thickness is excessively small, there may arise problems of, for example, decrease in strength, deterioration in heat insulating performance, and deterioration in assembly efficiency due to reduction of the space for the vacuum heat insulating material. Thus, the wall thickness is preferably approximately 20 mm or more. Therefore, the wall thickness of the heat insulating box body, the wall thickness of the refrigerator, or the wall thickness of the device, specifically, the thickness of the lateral walls 790, the rear wall 730, the top wall 740, the bottom wall 730, or the partition walls 24 is preferably set within a range of from 20 mm or more to 40 mm or less.

Yet further, the doors are configured to close the opening portions formed on the front side of the storage compartments. The doors each include the door outer shell formed of the door frame portion and the door inner plate, and the glass plate member arranged in the door outer shell. The vacuum heat insulating material is arranged in the door internal space formed of the glass plate member and the door outer shell. The foam heat insulating material is charged, applied, or sealed in the door internal space. The density of the foam heat insulating material to be charged, applied, or sealed between the glass plate member and the vacuum heat insulating material is set to more than 60 kg/m^3 after foaming, and the thickness thereof is set to less than 10 mm. With this, a refrigerator excellent in heat insulating performance, large in internal capacity of the storage compartments, and excellent in design property due to use of the glass plate member and box body strength can be provided.

[0368]

Yet further, when the transmitting-and-receiving unit capable of transmitting and receiving device information to and from external devices arranged on the outside of the refrigerator 1 via infrared connection, wireless connection, or wired connection (such as connection via lamp lines, Internet link connection, LAN connection, or USB connection) is arranged in or near the control board room 31, the device information of the refrigerator can be transmitted, or the information from the external devices can be received. Thus, the information of the refrigerator and other devices can be displayed on the refrigerator, the mobile terminal, and the external devices. Further, the refrigerator can be controlled by receiving instruction information from the server, and the other devices can be controlled from the refrigerator and the mobile terminal.

[0369]

Yet further, when a control board room cover is arranged on the control board room 31, and when network connection terminals are arranged in the control board room 31 or the control board cover, a wireless adapter, a WiFi adapter, a wired LAN, and the like can be easily connected after installation of the refrigerator to establish a network. As a matter of course, there are no problems as long as the network connection terminals are arranged in the top wall 730 or the lateral walls 790 because the connection can be easily established.

[0370]

Yet further, when the cover member (first air passage component 762) for covering at least a part of the rear surface in the storage compartment or the second concave portion 441 includes the air passage cover portion for forming at least a part of the cooling air passage 760 or covering at least a part of the cooling air passage 760, and the rear cover portion extended in the width direction from the air passage cover portion to cover at least a part of the rear wall 730 or the concave portion 440, at least a part of the rear wall 730 and the convex portions 450 can be covered with the cover member (first air passage component 762). With this, the design properties and the assembly efficiency can be enhanced.

[0371]

Yet further, when the cover member (first air passage component 762) for covering at least a part of the rear surface in the storage compartment or the second concave portion 441 includes the air passage cover portion for forming at least a part of the cooling air passage 760 or covering at least a part of the cooling air passage 760, the rear cover portion extended in the width direction from the air passage cover portion to cover at least a part of the rear wall 730 or the concave portion 440, and the lateral cover portions connected to the rear cover portion or formed integrally with the rear cover portion to cover at least a part of the lateral walls 790, at least a part of the rear wall 730, the lateral walls 790, and the convex portions 450 can be covered with the cover member (first air passage component 762). With this, the design properties and the assembly efficiency can be enhanced.

[0372]

Yet further, when the rear cover portion is mounted, specifically, fixed to or held on the part of the internal box 750 corresponding to the rear wall 730, the concave portion 440, or the convex portions 450, or when the lateral cover portions are mounted, specifically, fixed to or held on the part of the internal box 750 corresponding to the lateral walls 790 or the convex portions 450, at least a part of the rear wall 730, the lateral walls 790, and the convex portions 450 can be covered with the cover member (first air passage component 762). With this, the design properties and the assembly efficiency can be enhanced.

[0373]

Yet further, when the cover member (first air passage component 762) for covering at least a part of the rear surface in the storage compartment includes the air passage cover portion for forming at least a part of the cooling air passage 760 or covering at least a part of the cooling air passage 760, the rear cover portion extended in the width direction (right-and-left direction or toward the lateral walls 790) from the air passage cover portion to cover at least a part of the rear wall 730 or the concave portion 440, and the upper/lower wall cover portion connected to the air passage cover portion or formed integrally with the air passage cover portion in a manner of being extended in a direction toward the front opening from the upper end portion or the lower end portion of the rear wall 730 to cover at least a part of the partition walls 24 arranged at an upper portion or a lower portion of the rear wall 730 (including top wall 740 or bottom wall 780), at least a part of the rear wall 730, the partition walls 24, the top wall 730, and the bottom wall 780 can be covered with the cover member (first air passage component 762). With this, the design properties and the assembly efficiency can be enhanced.

[0374]

Yet further, when the rear cover portion is mounted, specifically, fixed to or held on the part of the internal box 750 corresponding to the rear wall 730, the concave portion 440, or the convex portions 450, or when the upper/lower wall cover portion is mounted, specifically, fixed to or held on the part of the internal box 750 corresponding to the partition walls 24 arranged in the vertical direction of the rear wall 730 (including top wall 740 or bottom wall 780), at least a part of the rear wall 730, the partition walls 24, the top wall 730, and the bottom wall 780 can be covered with the cover member (first air passage component 762). With this, the design properties and the assembly efficiency can be enhanced.

Reference Signs List

[0375]

1 refrigerator 1A machine room 2 refrigerator compartment

2A chilled compartment 2P inner side wall 2X substantially sealed container 2Y substantially sealed container 3 ice making compartment

4 switching compartment 5 vegetable compartment 6 freezer compartment 7 refrigerator compartment door 7A left refrigerator compartment door 7B right refrigerator compartment door 8 ice making compartment door 9 switching compartment door 10 vegetable compartment door 11 freezer compartment door 12 compressor 13 cooler 14 cooling air circulation fan 15 switching compartment damper 16 cooling air passage

17 switching-compartment cooling air passage 18 freezer-compartment

cooling air passage 19 switching compartment thermistor 21 stored item housing space 22 thermopile 24 partition wall 30 controller 30a microcomputer 31 control board room 33 cutout portion 34 sheet metal cover 50 cooling air passage 51 partition wall 53 cooling air passage 55 refrigerator compartment damper 60 operation panel 60a compartment selection switch 60b temperature range changeover switch 60c instant freezing switch 60d ice making changeover switch 60e mist supply switch80 shelf 131 cooler room 150 defrost heater 151 heater roof 152 water receiving container 154 defrost water receiving portion 155 defrost water drain port 200 misting device (electrostatic atomizing device) 250 stored item housing space 315 space (wall internal space) 400 vacuum heat insulating material 410 refrigerator-compartment returning air passage 420 freezer-compartment returning air passage 430 vegetable-compartment returning air passage 440 concave portion 441 second concave portion 450 convex portion 451 front-side end surface of convex portion 520 case 525 case step portion 700 heat insulating box body 701 heat insulating material 703, 704 charging port (injection port) 710 external box 717 internal-box concave portion 718 upper concave-portion step portion 719 lower concave-portion step portion (rail-member placing portion) 720 pipe 725 refrigerant pipe 727 internal-box convex portion 728 upper convex-portion step portion 729 lower convex-portion step portion 730 rear wall 731 reinforcing member732 upper reinforcing-member extending portion 733 lower reinforcing-member extending portion 734 reinforcing member body portion 735 rail fixing member 740 top wall 750 internal box 755 rail portion (rail mount portion) 757 rail-portion end portion (rail-member placing portion) 760 cooling air passage 762 first air passage component 763 projecting portion 764 second air passage component 765 air passage rear member 766 air passage lateral member 768 cooling air supply port 769 front-side end surface of first air passage component 770 space (housing space) 775 step portion 776 step portion 780 bottom wall 790 lateral wall 791, 792 storage compartment inner wall 797 lateral wall-side end portion (of convex portion) 798 rear wall-side end portion (of convex portion) 810 rail member 811 upper rail (movable rail) 812 lower rail (fixed rail) 813 intermediate rail 820 rail support portion 830 case support portion 835 case support portion fixing member 836 rail support portion fixing member 900 illumination device 910 protruding portion

CLAIMS

[Claim 1]

A refrigerator having a storage compartment including a rear wall, a lateral wall and an opening portion formed on a front side, comprising:

a convex portion formed at a corner portion of an internal box forming an inner surface of the lateral wall and an inner surface of the rear wall and provided so as to project toward the front side with respect to an inner surface of the rear wall;

a plate-like vacuum heat insulating material provided between the internal box forming an inner surface of the rear wall and an external box forming an outer surface of the rear wall and arranged so as to be partially overlapped with the convex portion in a width direction;

a first intermediate member charged or sealed in the convex portion, the first intermediate member bonding, attaching, or fixing the internal box and the vacuum heat insulating material;

a second intermediate member bonding, attaching, or fixing the vacuum heat insulating material and the external box, the second intermediate member being different from a foam heat insulating material; and

an injection port that is provided on the rear wall to inject a liquid raw material of the first intermediate member,

wherein the injection port is provided at a position corresponding to the convex portion, and

the vacuum heat insulating material is arranged so as not to block at least part of the injection port and integrally formed with the internal box and the external box at the convex portion.

[Claim 2]

The refrigerator of claim 1, further comprising:

a concave portion formed by a side surface of the convex portion and the rear wall and recessed toward a rear side, and

a cover member covering at least part of a rear surface of the storage compartment,

wherein a first mount portion for mounting the cover member is provided in the concave portion, and

the cover member has a second mount portion mounted onto the first mount portion.

[Claim 3]

The refrigerator of claim 2,

wherein the cover member is mounted onto the concave portion and forms an air passage along with the concave portion.

[Claim 4]

The refrigerator of claim 2,

wherein the cover member forms at least part of an air passage or covers at least part of an air passage.

[Claim 5]

The refrigerator of any one of claims 2 to 4,

wherein the first mount portion is a protruding portion protruding toward the front side and the cover member is fixed or held to the protruding portion by screws, a hooking structure, a fitting structure, or concave-convex fitting structure.

[Claim 6]

The refrigerator of any one of claims 2 to 5, wherein the first intermediate member is charged, sealed, or applied in a part or entirety of the range of the space between the internal box forming the concave portion and the vacuum heat insulating material.

[Claim 7]

The refrigerator of any one of claims 2 to 6,

wherein the first mount portion is formed separately from the internal box forming the concave portion.

[Claim 8]

The refrigerator of any one of claims 1 to 7,

wherein the first intermediate member charged or sealed between the vacuum heat insulating material and the internal box is a foam heat insulating material and density of the foam heat insulating material is set to more than 60 kg/m3 and 100 kg/m3 or less after foaming.

[Claim 9]

The refrigerator of any one of claims 1 to 8,

wherein a cross-section of the convex portion is a substantially triangular shape having an oblique side and the injection port is provided at a position corresponding to the oblique side.

[Claim 10]

The refrigerator of any one of claims 1 to 11,

wherein when a thickness of the lateral wall is represented by T1, a widthwise length of the injection port is represented by r1, a widthwise length of the convex portion is represented by A, and the injection port is arranged while separating from an end portion in the width direction of the rear wall by a distance T01, a distance Y1 from the end portion in the width direction of the rear wall to an inner end portion in the width direction of the injection port is T01+r1 or more and T1+A or less.

[Claim 11]

The refrigerator of claim 10,

wherein the distance T01 corresponds to such a distance that the injection port can be formed so flow of the first intermediate member is not hindered.

[Claim 12]

The refrigerator of claim 10 or 11, further comprising

a second vacuum heat insulating material provided between an internal box corresponding to the inner surface of the lateral wall and the external box corresponding to the outer surface of the lateral wall and a foam heat insulating material charged between the second vacuum heat insulating material and the internal box corresponding to the inner surface of the lateral wall are provided,

wherein the distance T01 corresponds to such a distance that flow of the foam heat insulating material is not hindered by the second vacuum heat insulating material.

[Claim 13]

The refrigerator of any one of claims 1 to 12,

wherein the vacuum heat insulating material is formed with cutout portions at the parts facing the injection port so that the vacuum heat insulating material does not interfere with the injection port.

[Claim 14]

The refrigerator of claim 8,

wherein a thickness of the heat insulating material at the position facing the vacuum heat insulating material is set to less than 10 mm after foaming.

[Claim 15]

The refrigerator of any one of claims 1 to 14, further comprising

a machine room formed on the rear side,

wherein the injection port comprises four and the four injection ports are formed at four corners of the rear wall excluding the machine room.

[Claim 16]

The refrigerator of claim 8 or 14,

wherein "a thickness of the foam heat insulating material / (a thickness of the foam heat insulating material + a thickness of the vacuum heat insulating material)" is set to 0.3 or less.

[Claim 17]

The refrigerator of claim 8, 14, or 16,

wherein the foam heat insulating material is a rigid urethane foam and bending elastic modulus of the rigid urethane foam is set to 15 MPa or more.

[Claim 18]

The refrigerator of any one of claims 1 to 17, further comprising

a door for closing the opening portion of the storage compartment,

the door being formed by a door outer shell formed by a door frame member and a door inner plate and a glass plate member provided with the door outer shell,

wherein the door includes a vacuum heat insulating material provided in a door internal space formed by the glass plate member and the door outer shell and a foam heat insulating material charged, applied, or sealed in the door internal space, and

wherein density of the foam heat insulating material to be charged, applied, or sealed between the glass plate member and the vacuum heat insulating material is set to more than 60 kg/m3 and 100 kg/m3 or less after foaming, and the thickness thereof is set to less than 10 mm.

[Claim 19]

The refrigerator of claim 12

wherein a thickness of the lateral wall is 20 mm or more and 40 mm or less and thickness of the foam heat insulating material is less than 10 mm after foaming.

[Claim 20]

The refrigerator of any one of claims 1 to 19,

wherein the storage compartment has both a refrigerator compartment and a freezer compartment, and

wherein a cooler for the freezer compartment and a cooler for the refrigerator compartment are provided, and the cooler for refrigerator compartment is provided on the rear of the refrigerator compartment.

[Claim 21]

The refrigerator of claim 3 or 4,

wherein the air passage is an elliptical shape, which is elongated in the width direction.

[Claim 22]

The refrigerator of claim 3 or 4,

wherein the air passage is an air passage assembly composed of the cover member and an air passage component fixed or held to the cover member.

FIG. 1

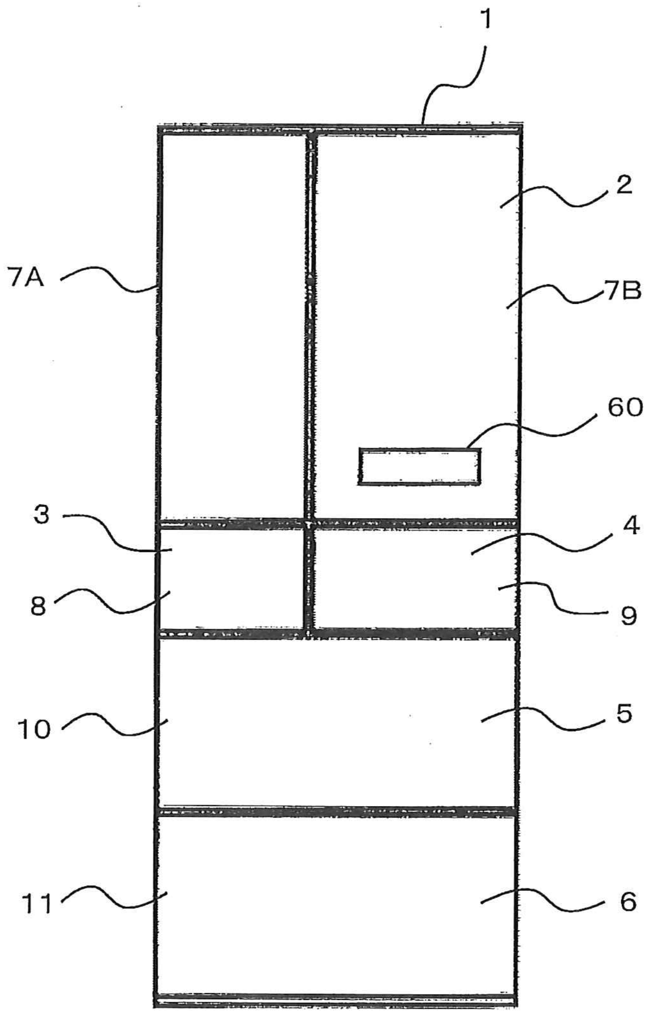
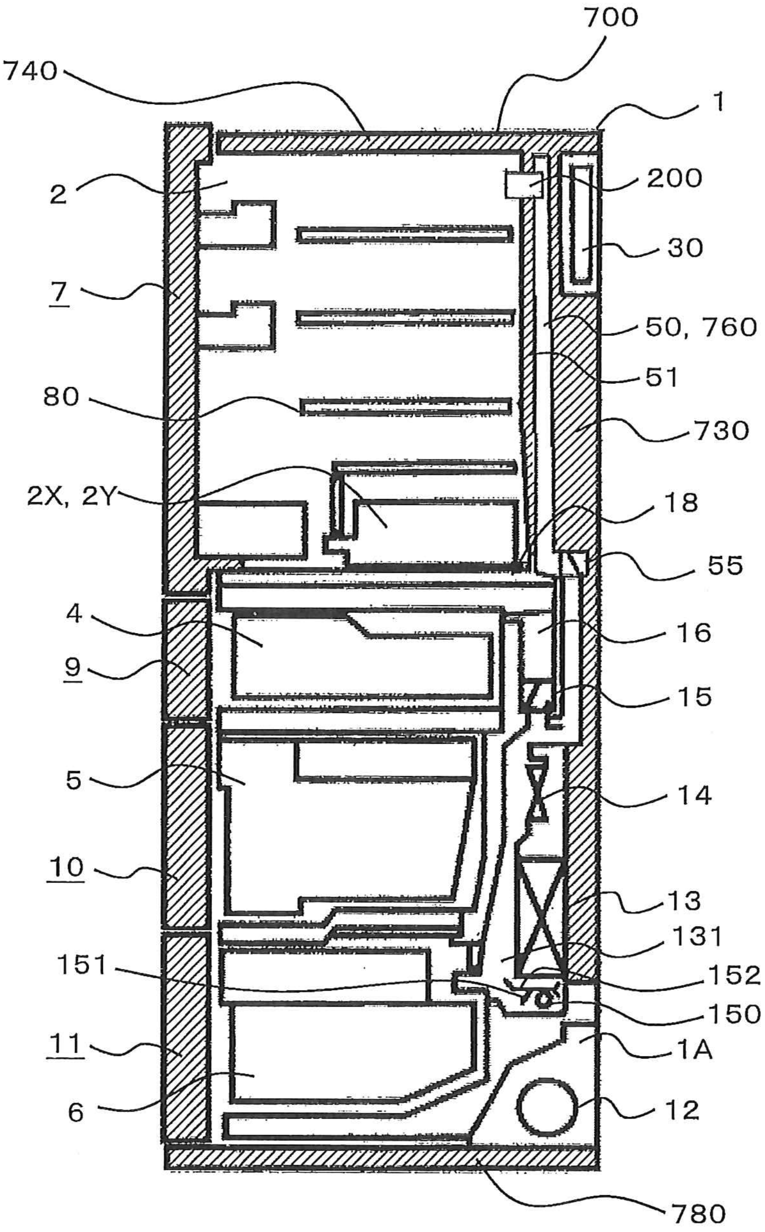


FIG. 2


700
740
1
2
200
30
7
50, 760
51
80
730
2X, 2Y
18
55
4
16
9
15
5
14
10
13
131
151
152
150
11
1A
6
12
780

F I G. 3

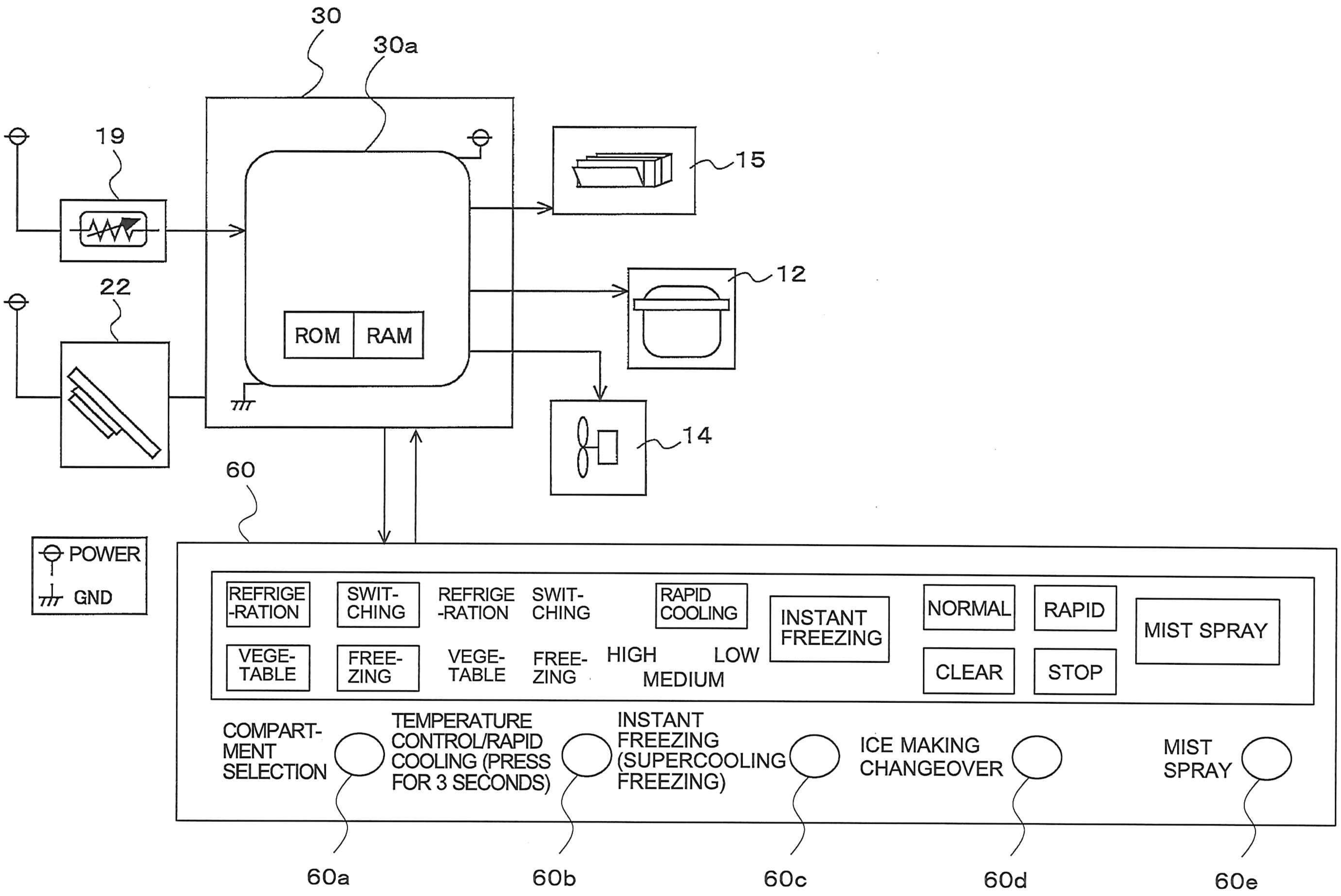
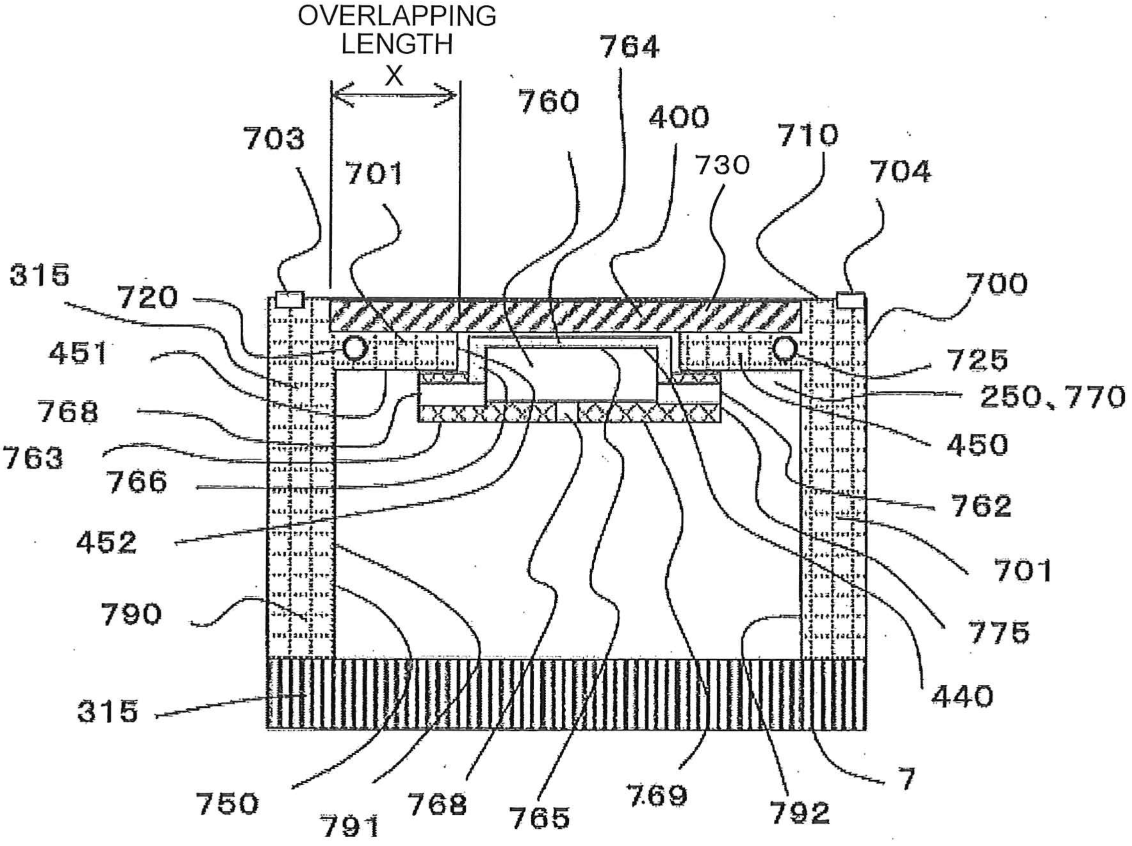

30
30a
19
22
ROM
RAM
15
12
14
60
POWER
GND
REFRIGE-RATION
SWIT-CHING
REFRIGE-RATION
SWIT-CHING
RAPID COOLING
INSTANT FREEZING
NORMAL
RAPID
MIST SPRAY
VEGE-TABLE
FREE-ZING
VEGE-TABLE
FREE-ZING
HIGH
MEDIUM
LOW
CLEAR
STOP
COMPART-MENT SELECTION
TEMPERATURE CONTROL/RAPID COOLING (PRESS FOR 3 SECONDS)
INSTANT FREEZING (SUPERCOOLING FREEZING)
ICE MAKING CHANGEOVER
MIST SPRAY
60a
60b
60c
60d
60e

FIG. 4


OVERLAPPING LENGTH
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764
760
400
703
701
730
710
704
315
720
700
451
725
250、770
768
450
763
766
762
452
701
775
790
440
315
7
750
791
768
765
769
792

FIG. 5

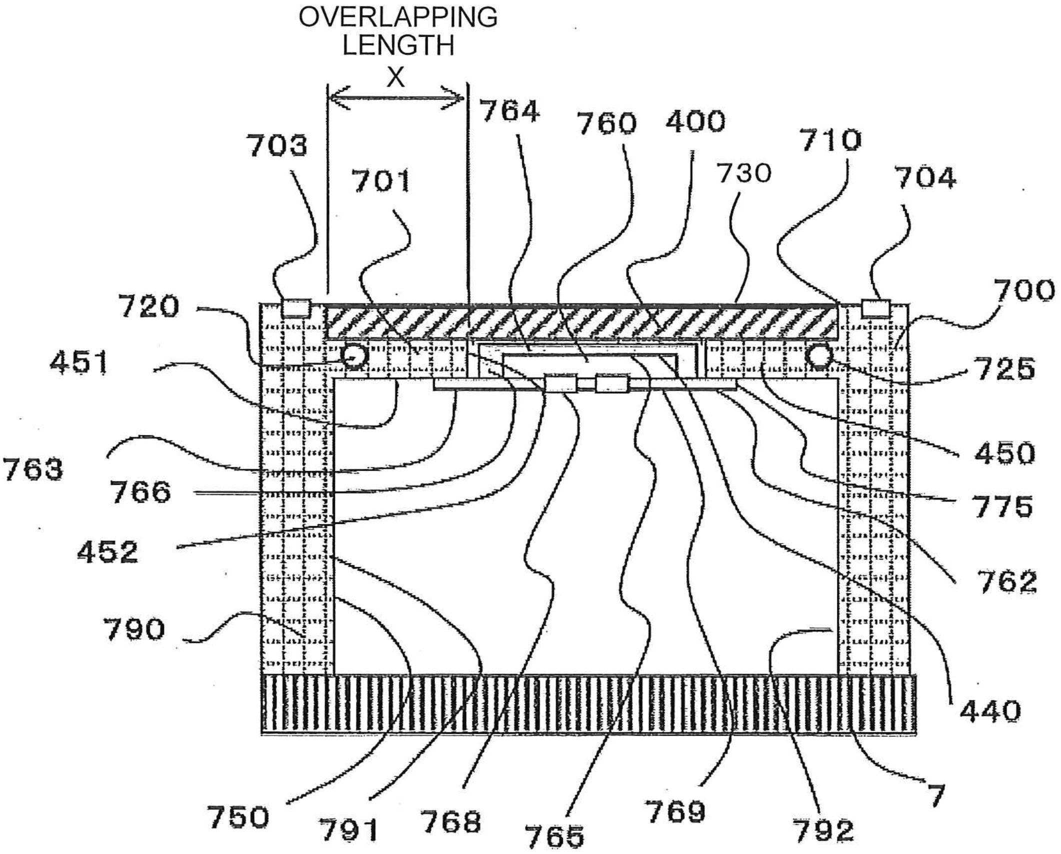

OVERLAPPING LENGTH
X
764
760
400
703
701
730
710
704
720
700
451
725
450
763
766
775
452
762
790
440
7
750
791
768
765
769
792

FIG. 6

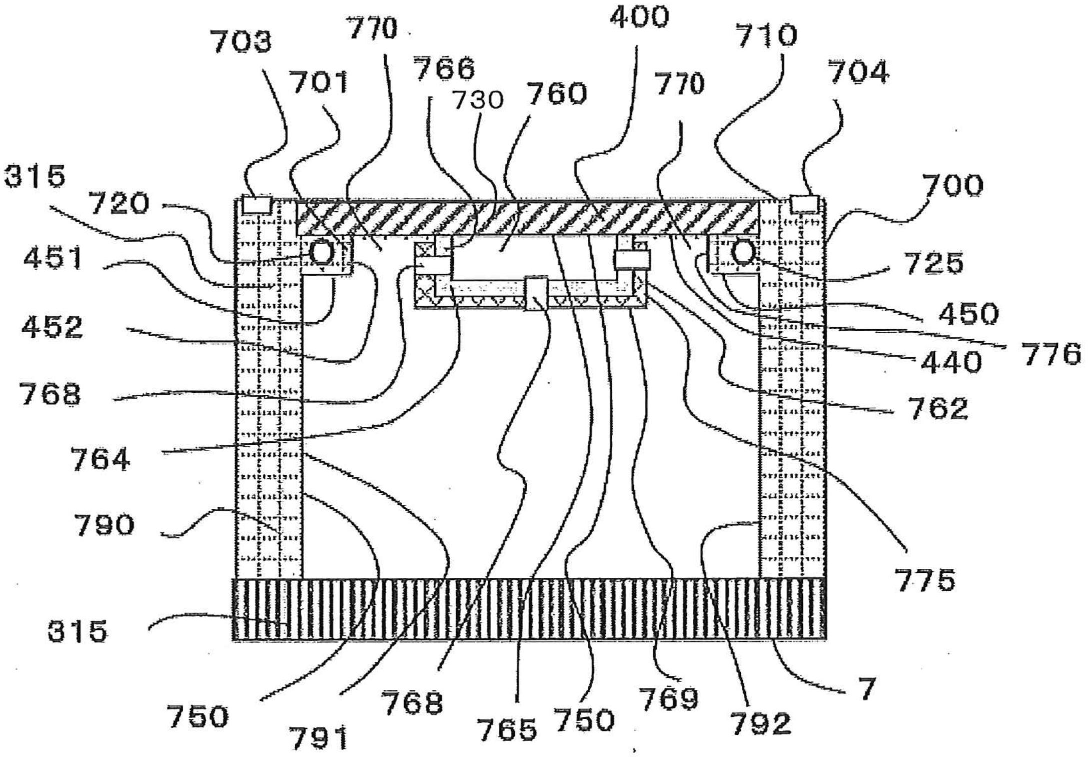
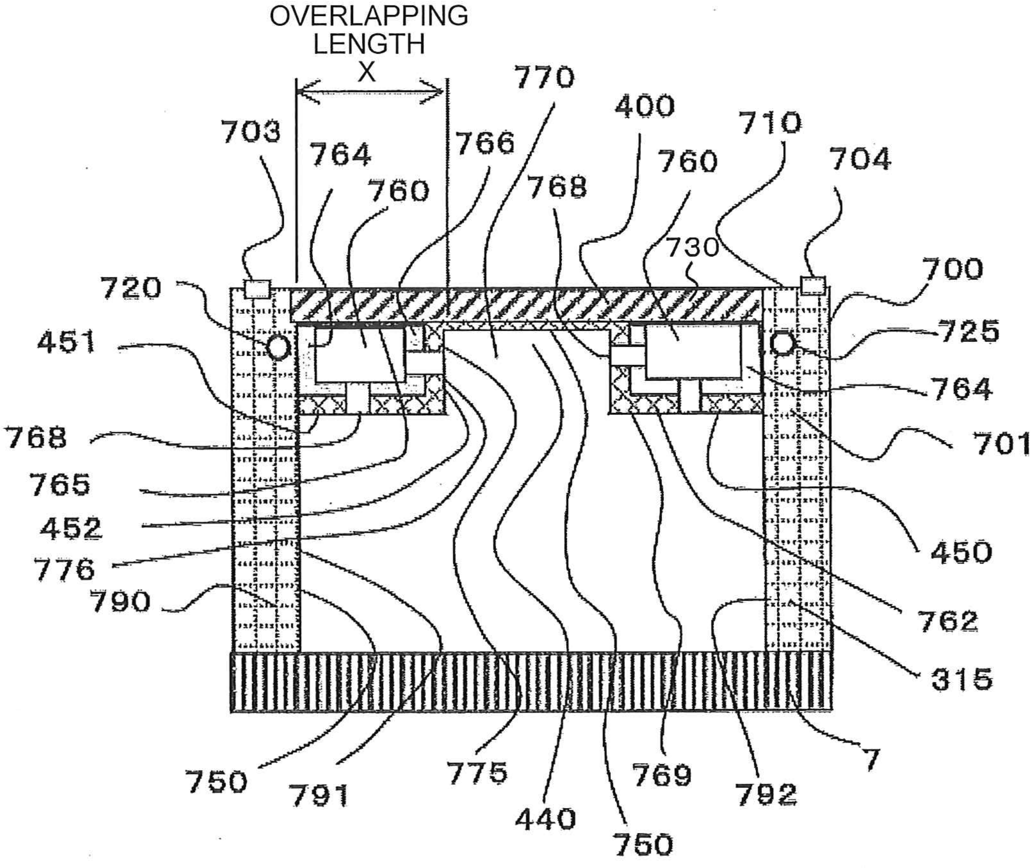

703
770
701
766
730
760
400
710
770
704
315
720
700
451
725
450
452
440
776
768
762
764
790
775
315
7
750
791
768
765
750
769
792

FIG. 7


OVERLAPPING LENGTH X
770
400
710
703
764
766
760
768
760
704
730
720
700
451
725
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790
762
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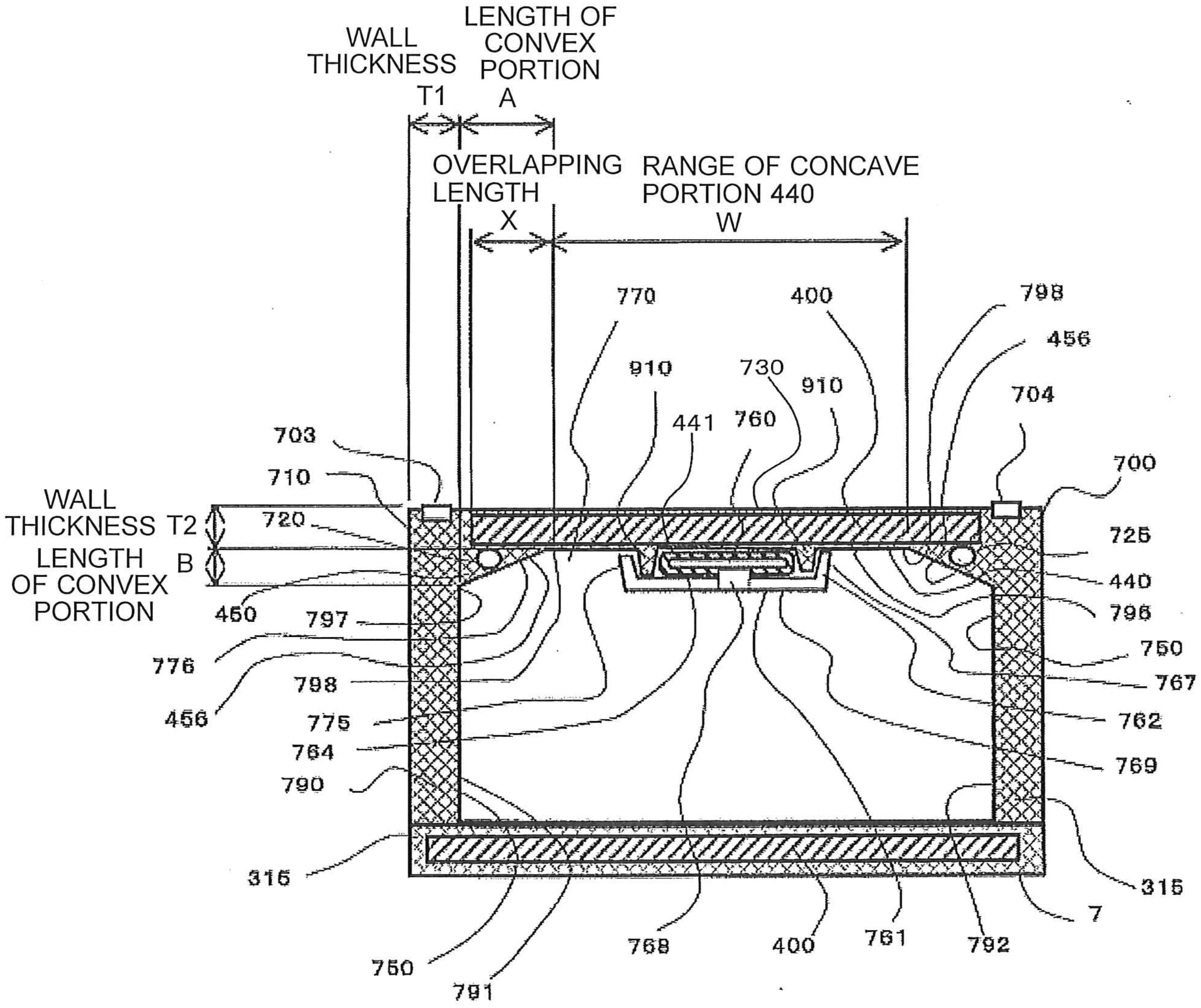
769
792
440
750

FIG. 8


WALL THICKNESS T1
LENGTH OF CONVEX PORTION A
OVERLAPPING LENGTH X
RANGE OF CONCAVE PORTION 440 W
WALL THICKNESS T2
LENGTH OF CONVEX PORTION B
770
400
798
456
910
730
910
704
441
760
703
700
710
725
720
440
450
797
796
750
776
767
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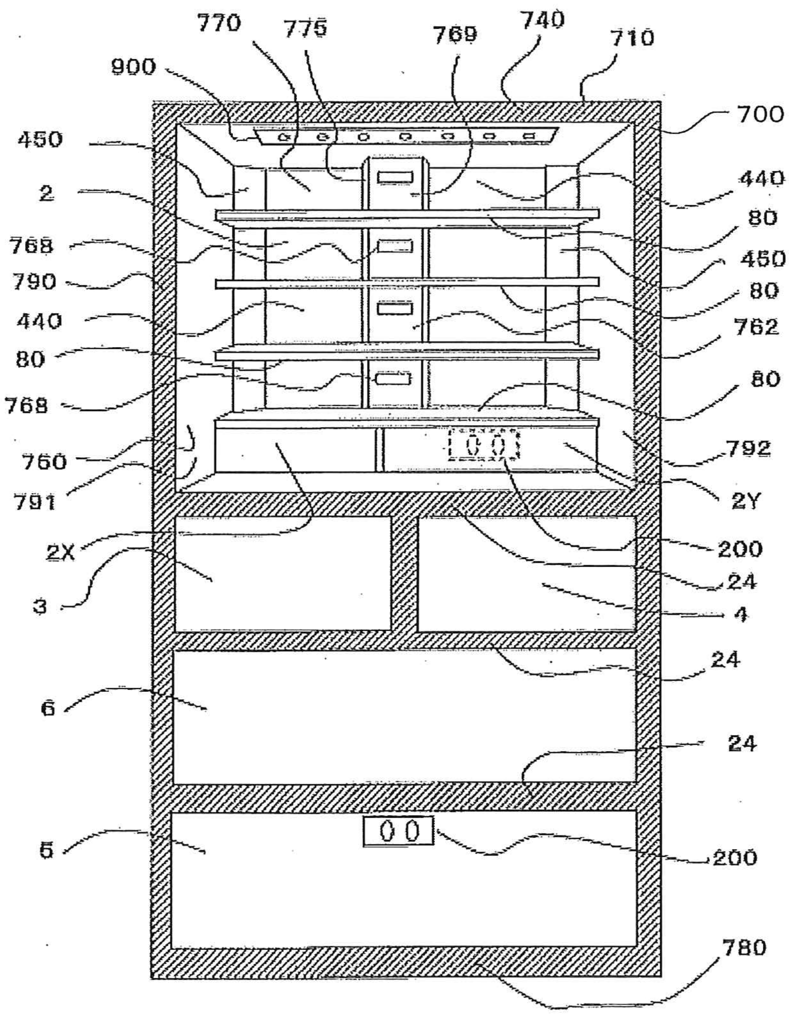
762
775
764
769
790
316
315
7
750
791
768
400
761
792

FIG. 9


770
775
769
740
710
900
700
450
440
2
80
768
450
790
80
440
762
80
80
768
792
760
2Y
791
200
2X
24
3
4
24
6
24
5
200
780
0 0
0 0

F I G. 1 0

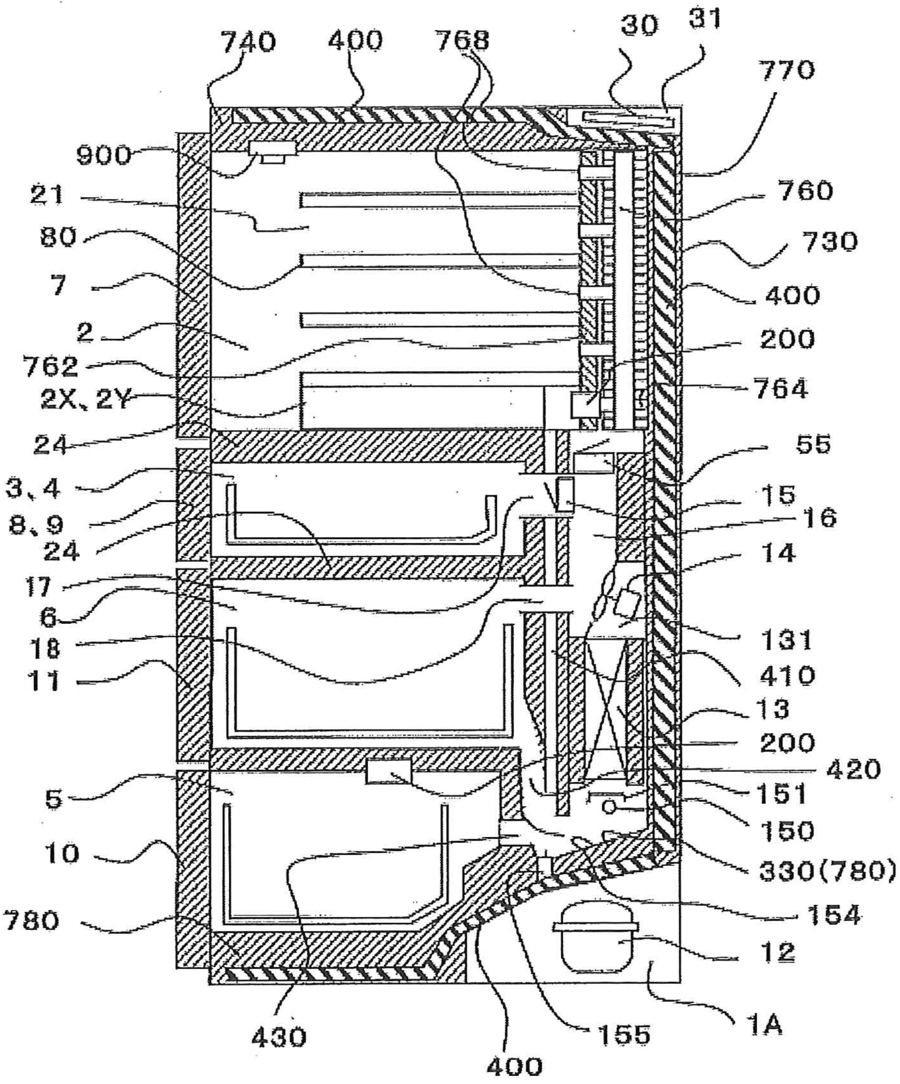
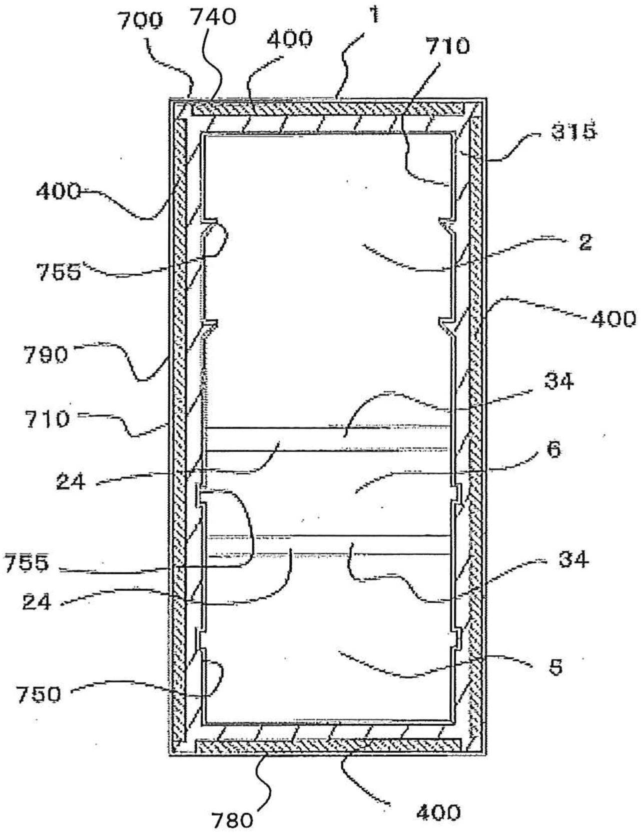

740
400
768
30
31
770
900
21
80
7
2
762
2X、2Y
24
760
730
400
200
764
55
3、4
8、9
24
15
16
14
17
6
18
11
131
410
13
200
420
151
150
330(780)
5
10
780
154
12
1A
430
400
155

FIG. 11


700
740
400
1
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315
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2
755
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790
34
710
6
24
755
34
24
5
750
780
400

FIG. 12

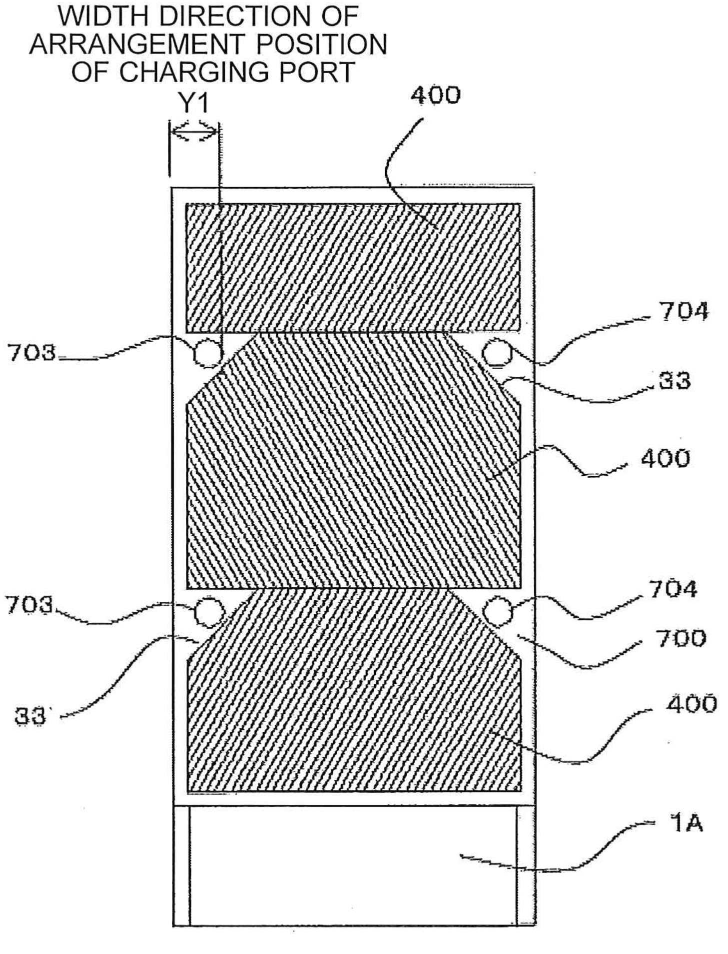

WIDTH DIRECTION OF ARRANGEMENT POSITION OF CHARGING PORT
Y1
400
704
703
33
400
704
703
700
33
400
1A

FIG. 13

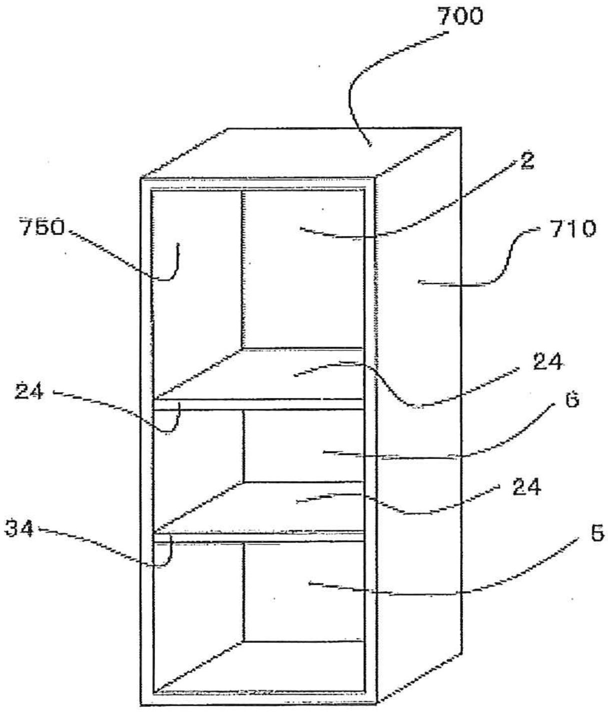


FIG. 14

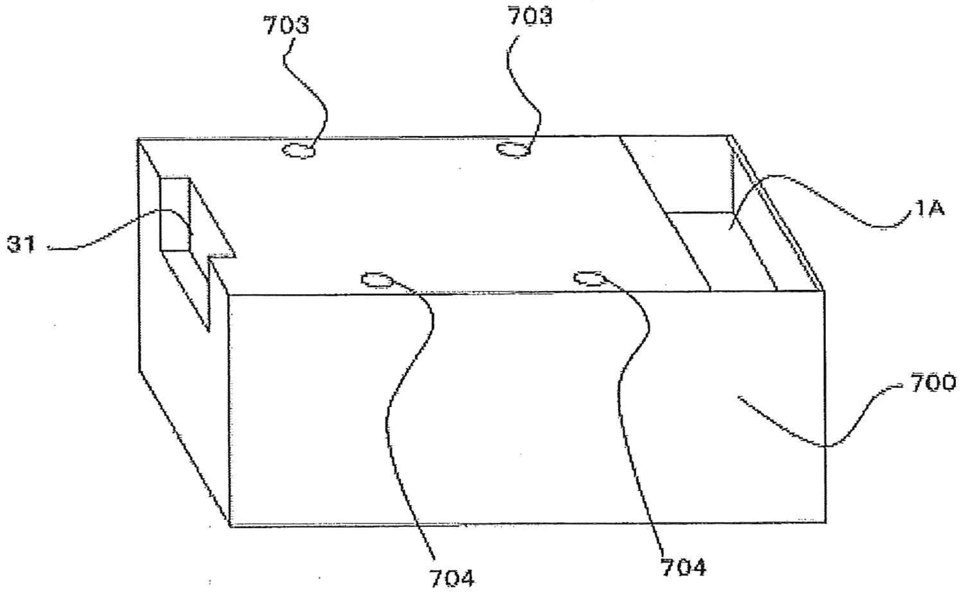


FIG. 15

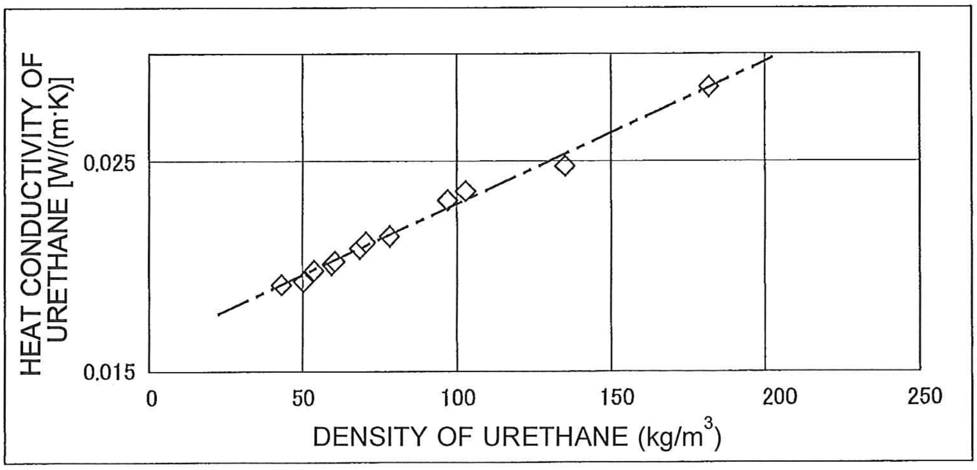


FIG. 16

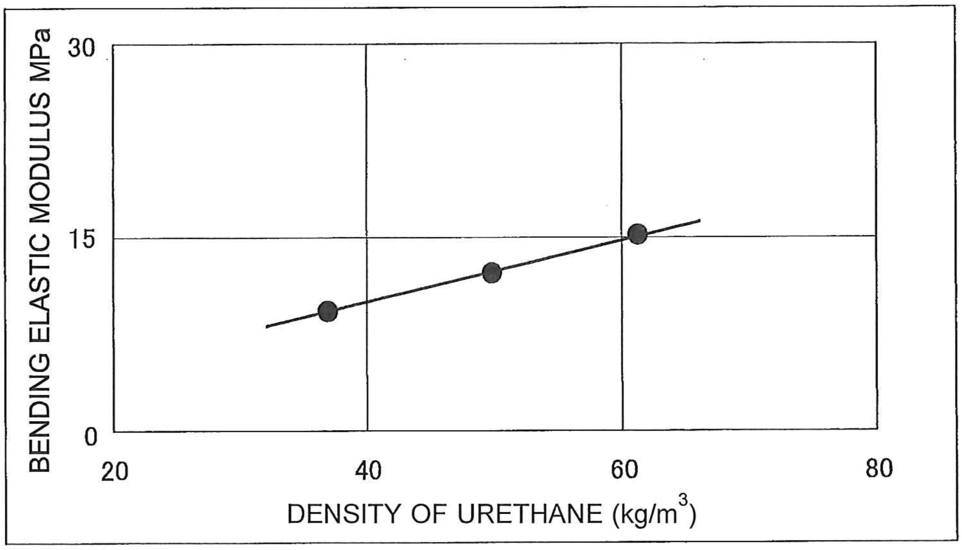


FIG. 17

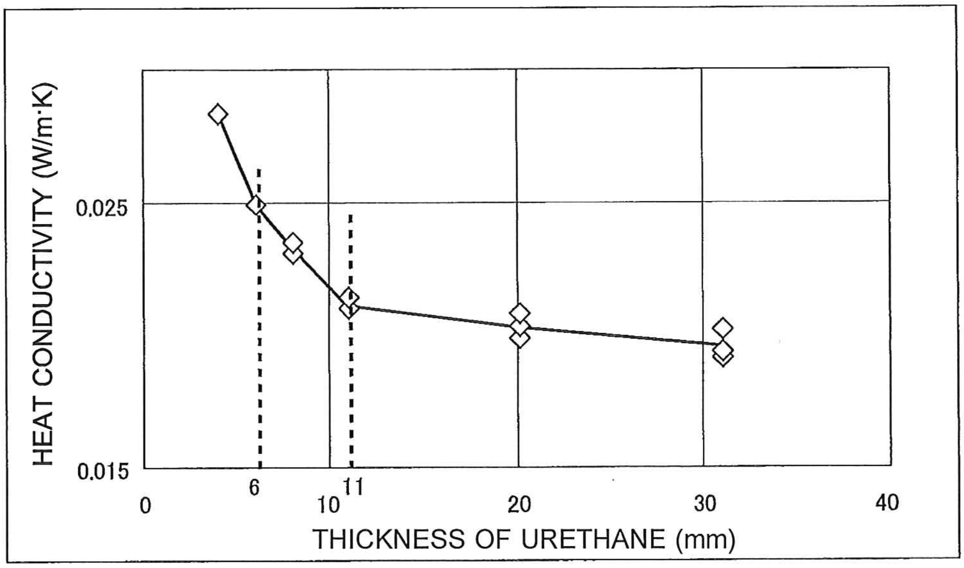


FIG. 18

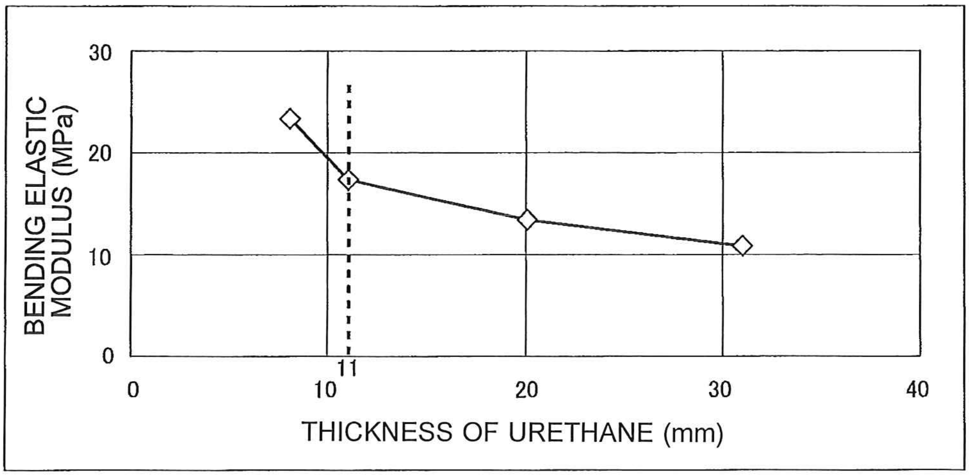


FIG. 19

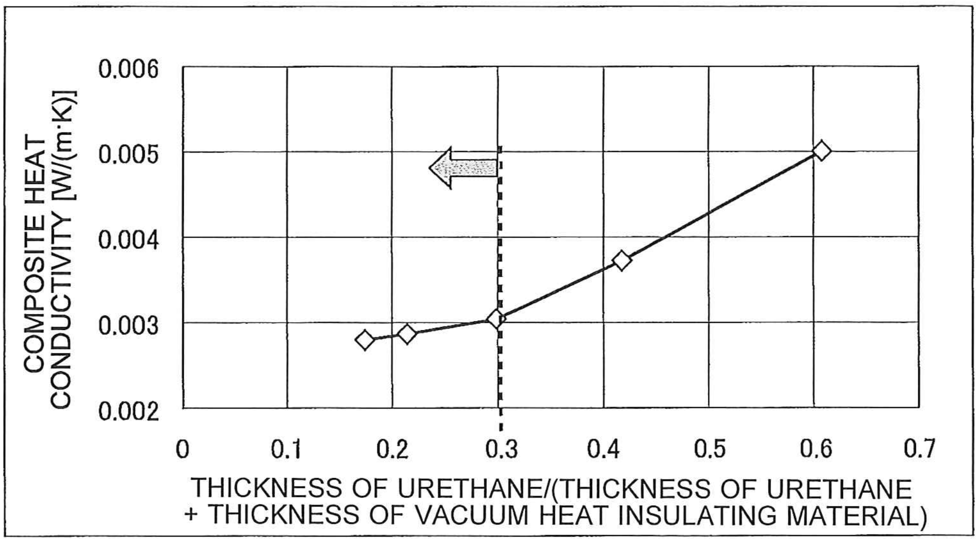
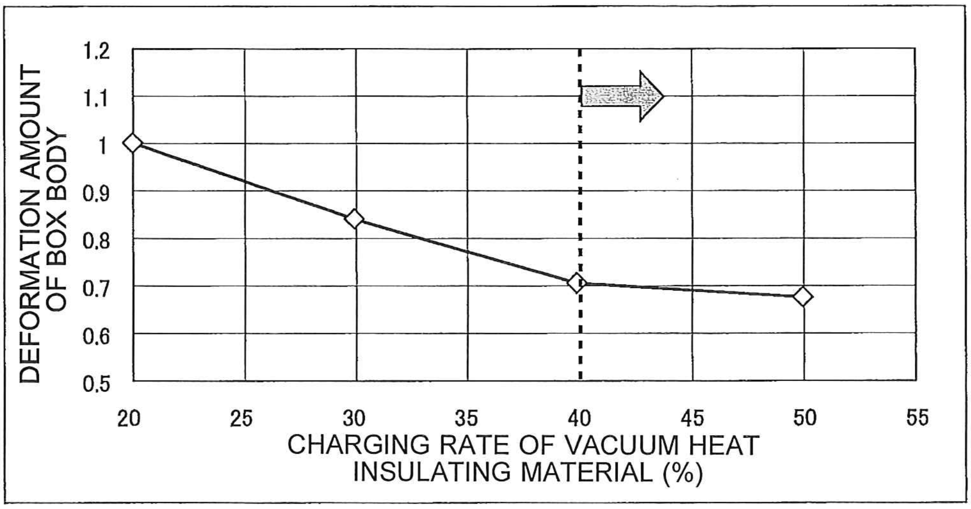
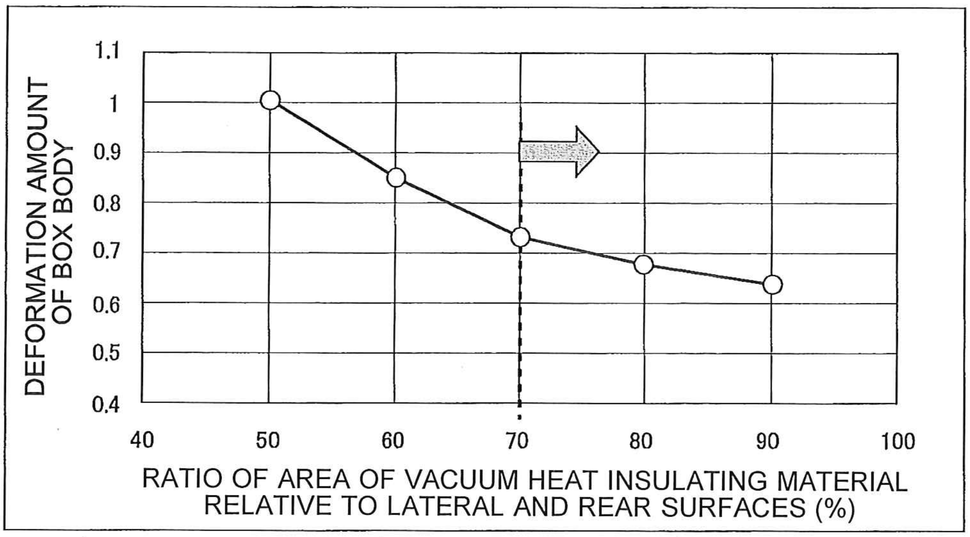


FIG. 20



F I G. 2 1


DEFORMATION AMOUNT OF BOX BODY
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
40
50
60
70
80
90
100
RATIO OF AREA OF VACUUM HEAT INSULATING MATERIAL RELATIVE TO LATERAL AND REAR SURFACES (%)

F I G. 2 2

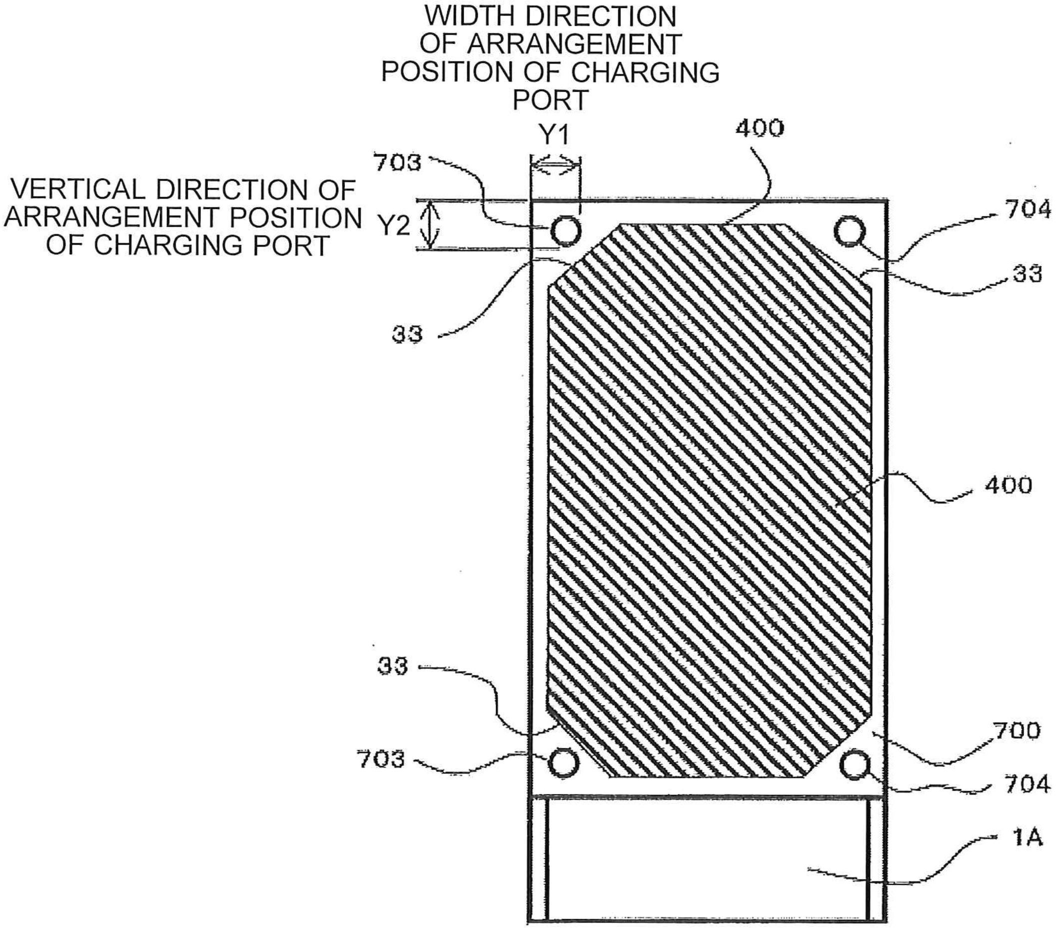

WIDTH DIRECTION OF ARRANGEMENT POSITION OF CHARGING PORT
Y1
400
703
VERTICAL DIRECTION OF ARRANGEMENT POSITION OF CHARGING PORT
Y2
704
33
33
400
33
703
700
704
1A

FIG. 23A

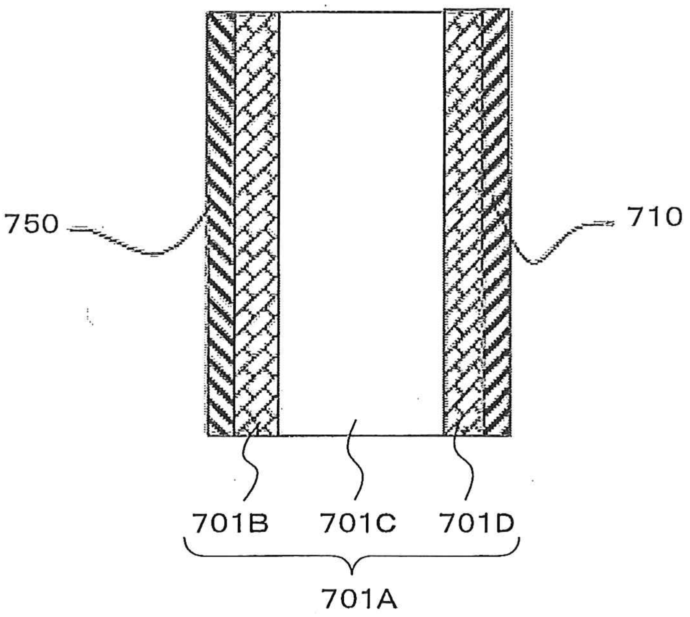


FIG. 23B

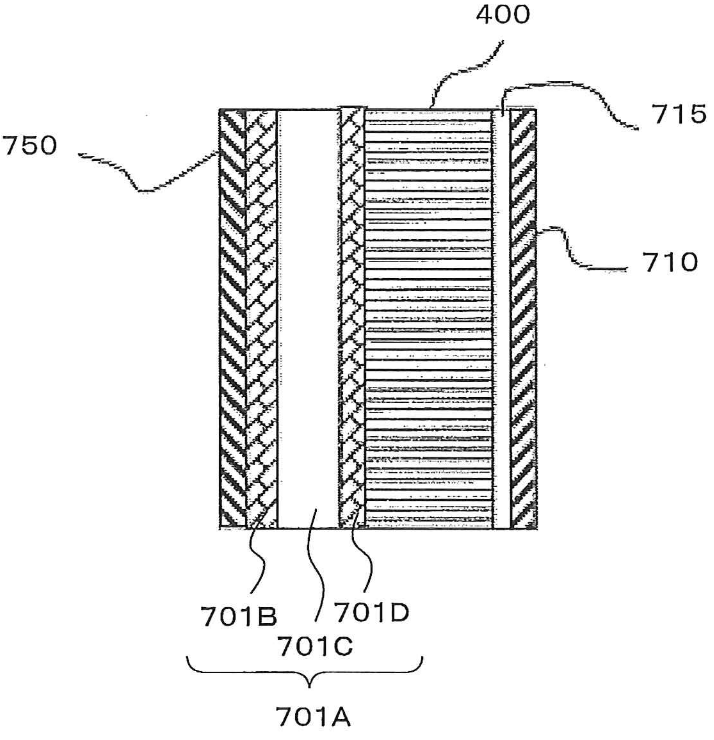


FIG. 24

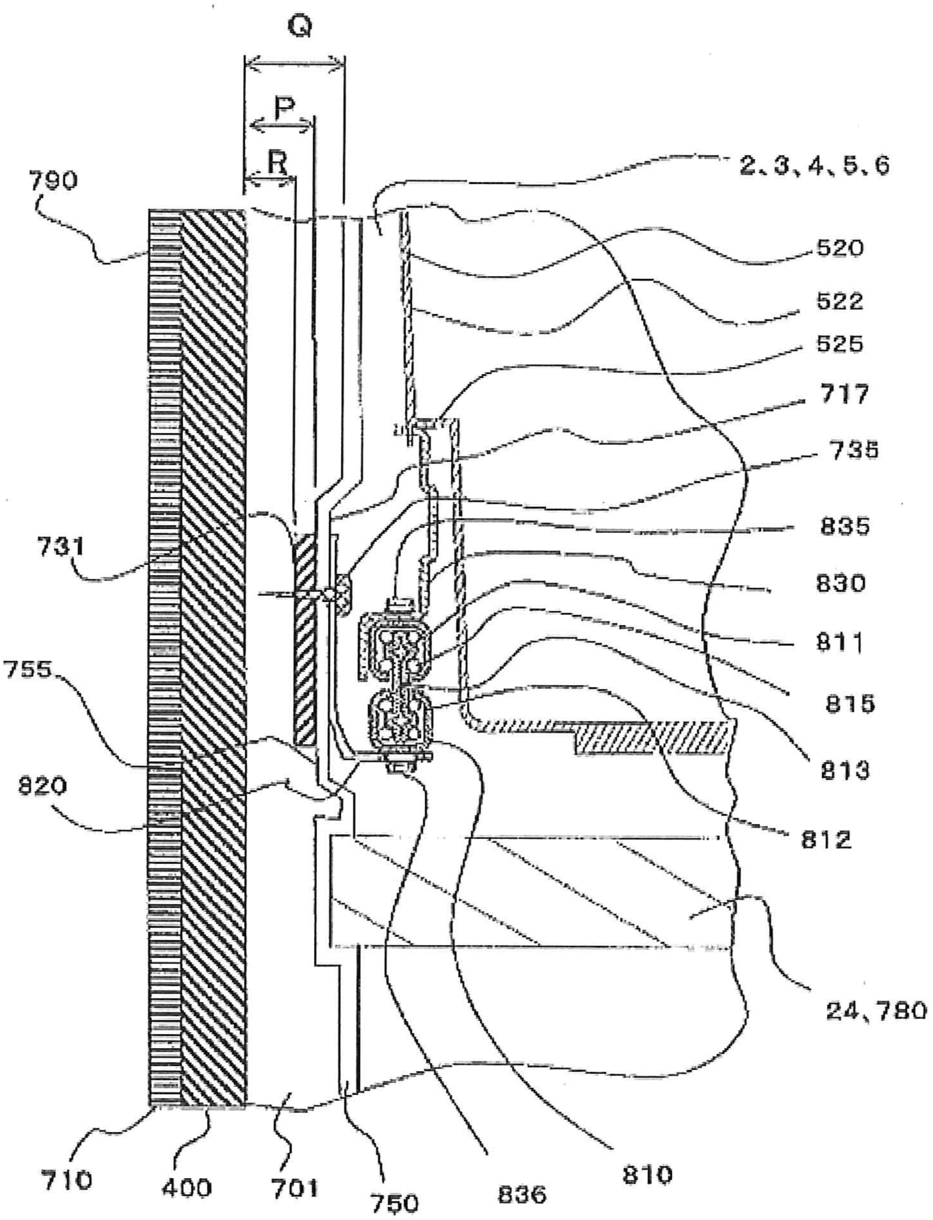
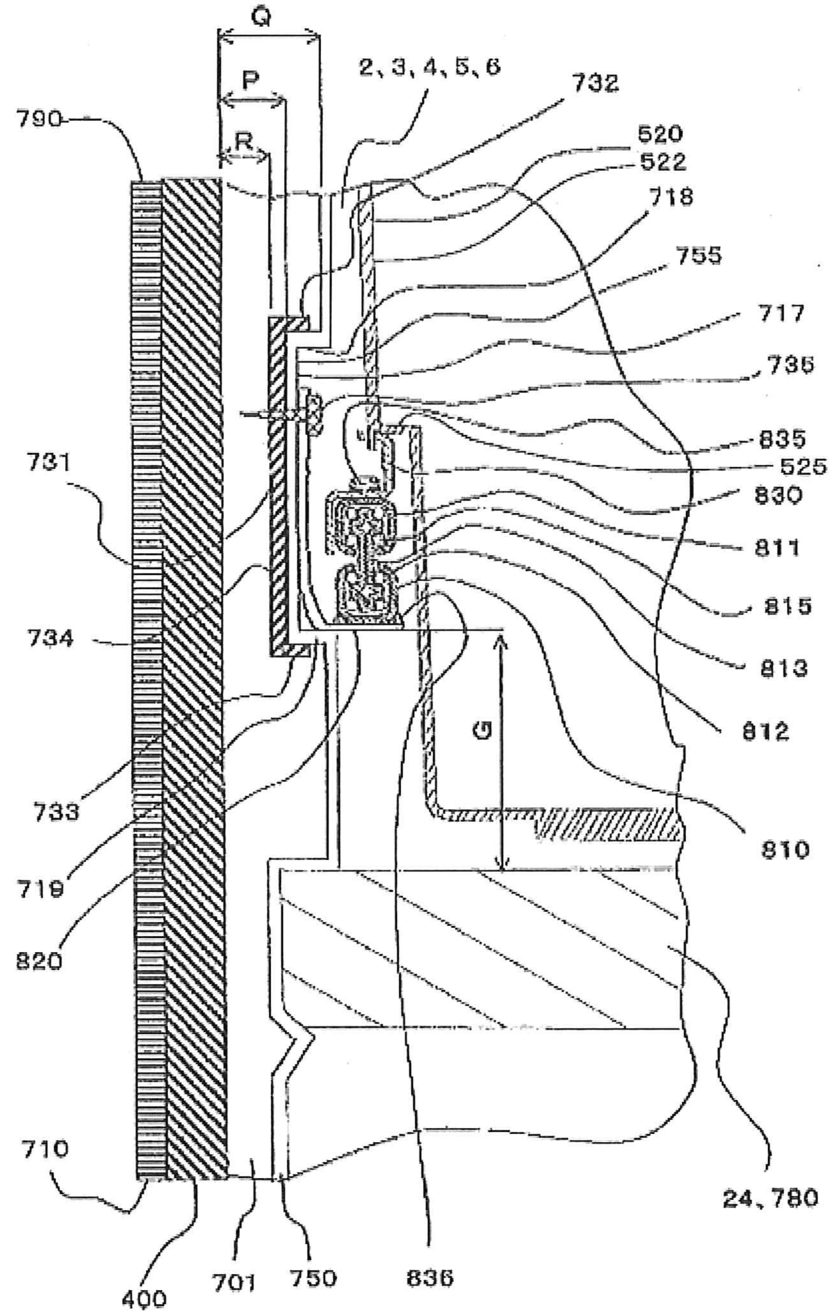

Q
P
R
790
2、3、4、5、6
520
522
525
717
735
835
830
811
815
813
812
731
755
820
24、780
710
400
701
750
836
810

FIG. 25


Q
P
R
2、3、4、5、6
732
790
520
522
718
755
717
736
835
525
830
811
815
813
812
810
731
734
733
719
820
G
24、780
710
400
701
750
836

F I G. 2 6

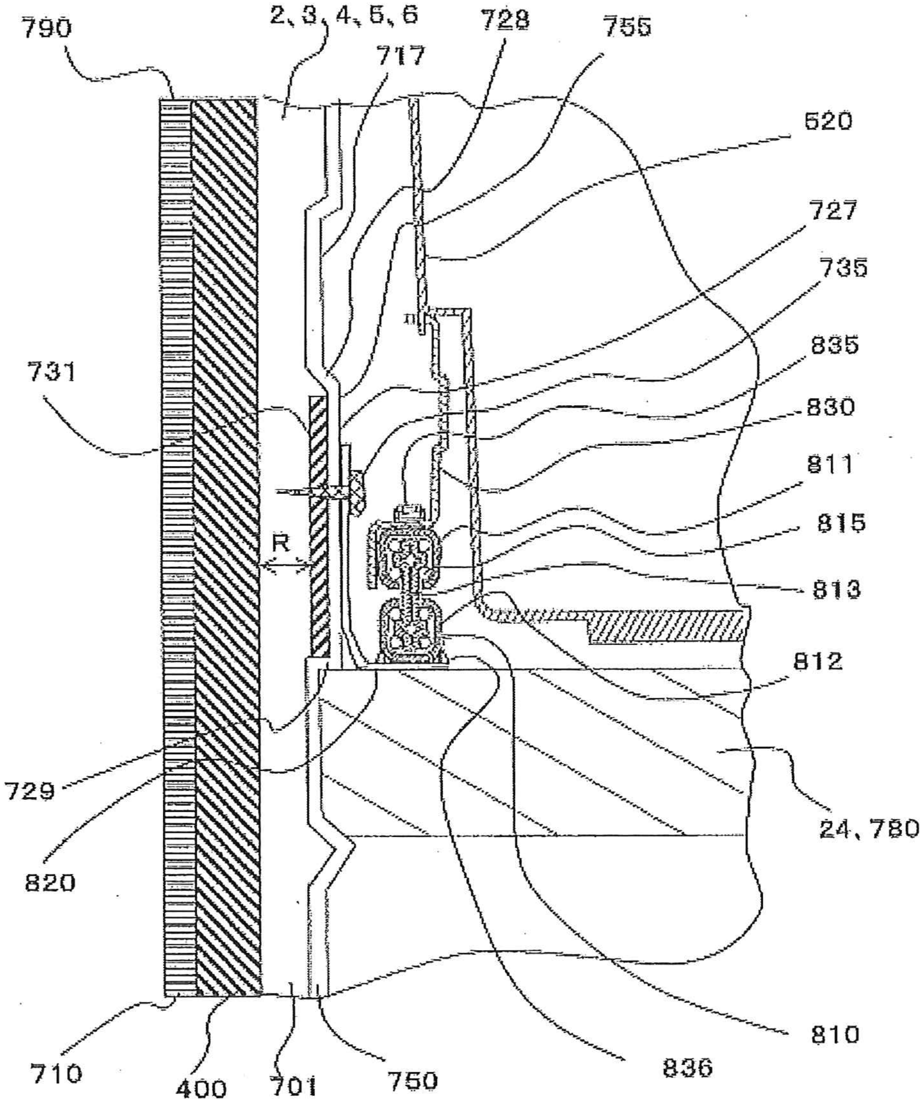
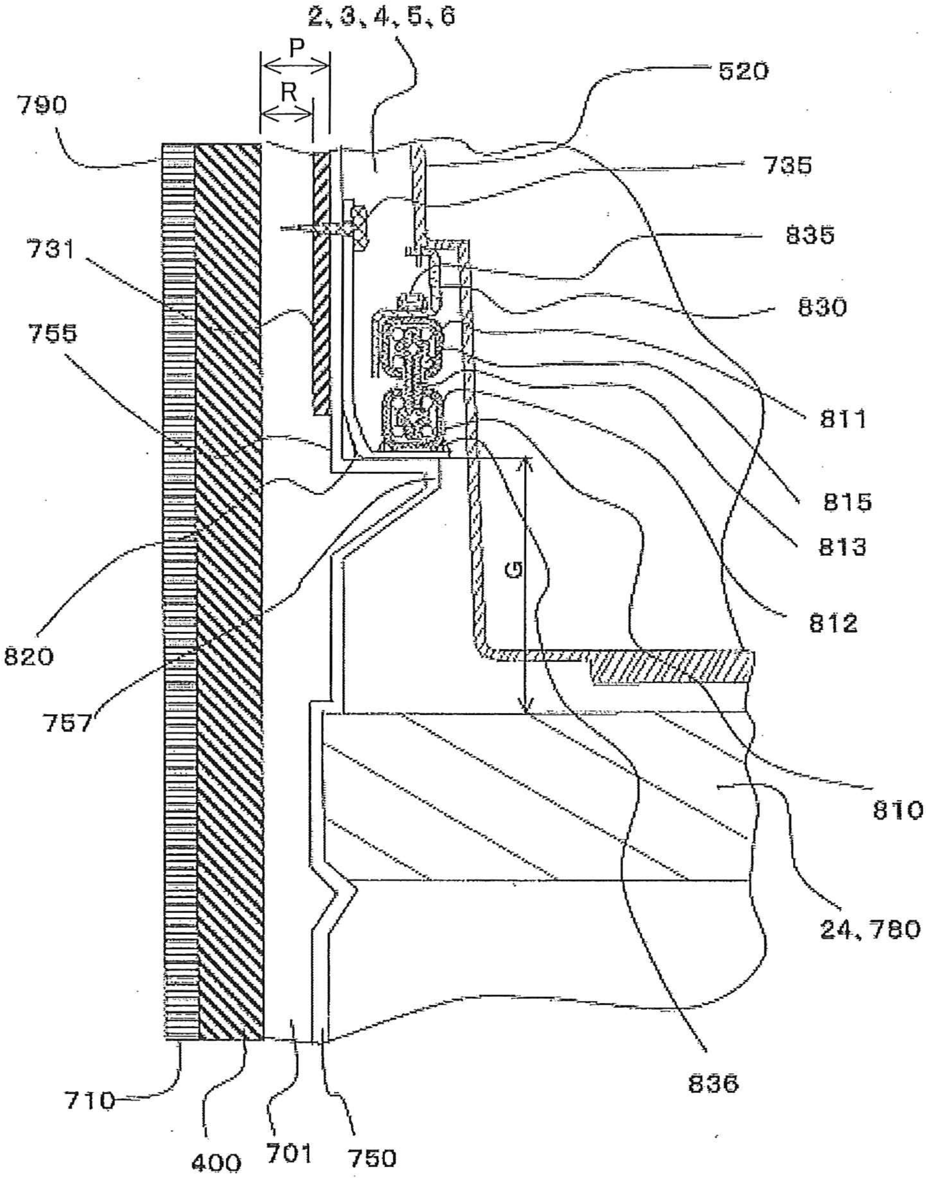

790
2、3、4、5、6
717
728
755
520
727
735
835
830
811
815
813
812
731
R
729
820
24、780
810
836
710
400
701
750

FIG. 27


2、3、4、5、6
P
R
520
790
735
835
731
830
755
811
815
813
G
812
820
757
810
24、780
836
710
400
701
750