

DESCRIPTION

Title of Invention

STORAGE CABINET AND REFRIGERATOR

Technical Field

5 [0001]

The present invention relates to a storage cabinet and a refrigerator, and more particularly to a storage cabinet and a refrigerator including a pivotable door for opening and closing an opening of a box-shaped structure of the storage cabinet or the refrigerator.

10 Background Art

[0002]

Refrigerators have thus far been known in which glass is employed in a front panel of a refrigerating compartment door. For example, Patent Literature 1 discloses a refrigerator door including a front panel made of glass, fitted in a subframe located on the front face of a frame, and a reinforcing member connecting between a left sidewall and a right sidewall of the frame, the reinforcing member serving to prevent the panel from coming off owing to deformation of the frame originating from thermal contraction of a foamed material. Patent Literature 1 also discloses a refrigerator door in which the front panel is adhered to the subframe of the frame via a double-sided tape.

Citation List

Patent Literature

[0003]

Patent Literature 1: Japanese Unexamined Patent Application Publication
25 No. 2013-160388

Summary of Invention

Technical Problem

[0004]

Now, there is a demand for a thicker front panel of the storage compartment door. For example, when a material of a relatively low strength, such as glass, is employed as panel member to achieve a better visual appearance, it is conceivable to make the panel member thicker to prevent the panel member from being readily broken. However, when the front panel of an increased thickness is adhered to the frame via a double-sided tape as in the case of the refrigerator according to Patent Literature 1, the following problem may be incurred. In the case where the storage cabinet is installed close to a wall surface of a kitchen such that, for example, a clearance of 5 mm is defined between the side face of the storage cabinet and the wall surface, the corner portion or the front panel of the storage compartment door interferes with the wall surface when the storage compartment door is opened, and the door is restricted from being opened to 90 degrees. In such a case, the shelves or cases in the refrigerator may be unable to be drawn out of the refrigerator.

[0005]

The present invention has been accomplished in view of the foregoing problem, and provides a storage cabinet and a refrigerator that allow the door to be opened to 90 degrees or more, despite the storage cabinet or refrigerator being installed with the side face disposed close to a wall.

Solution to Problem

[0006]

In an aspect, the present invention provides a storage cabinet comprising: a box-shaped structure having a front opening; a door that closes the front opening; and an upper hinge provided at an upper position of the opening, and a lower hinge provided at a lower position of the opening, each of the upper hinge and the lower hinge including a shaft that pivotably supports the door from the

upper or lower position, the door including a frame and a front panel fixed to a front face of the frame, the frame including a side frame portion having a rectangular shape as viewed from a front side, and composed of a top side portion, a bottom side portion, a left side portion, a right side portion, and a front portion to which the front panel is attached, the front portion being provided on a front side of the side frame portion, the frame including a relief portion formed in a corner, the corner being formed between adjacent one, with respect to the shaft, of the left and right side portions and the front portion, wherein in a horizontal cross-sectional view of the storage cabinet, the relief portion includes a distal point at which the relief portion is most away from the shaft, and a length of an imaginary line segment extending, from a thickest portion of the front panel to, and orthogonally to, another imaginary line segment extending orthogonally to the adjacent one, with respect to the shaft, of the left and right side portions from the shaft is smaller than a distance between the shaft and the distal point of the relief portion, and adjacent one, with respect to the shaft, of the left and right edge portions of the front panel is located inside a circle around the shaft as a center, the circle having a radius equal to the distance between the distal point of the relief portion and the shaft.

[0007]

In another aspect, the present invention provides a storage cabinet comprising: a box-shaped structure having a front opening; a door that closes the front opening; and an upper hinge provided at an upper position of the opening, and a lower hinge provided at a lower position of the opening, each of the upper hinge and the lower hinge including a shaft that pivotably supports the door from the upper or lower positions, the door including a frame and a front panel fixed to a front face of the frame, the frame including a side frame portion

having a rectangular shape as viewed from a front side, and composed of a top side portion, a bottom side portion, a left side portion, and a right side portion, and a front portion to which the front panel is attached, the front portion being provided on a front side of the side frame portion, the frame including a relief portion formed in a corner, the corner being formed between adjacent one, with respect to the shaft, of the left and right side portions and the front portion, wherein the relief portion is located, when the storage cabinet is installed with a side face opposed to a wall surface, inside a circle around the shaft as a center, the center having a radius equal to a length of a line segment connecting between the shaft and the wall surface and extending orthogonally to the wall surface, in a horizontal cross-sectional view of the storage cabinet, a length of an imaginary line segment extending, from a thickest portion of the front panel, orthogonally to another imaginary line segment extending orthogonally to adjacent one, with respect to the shaft, of the left and right side portions from the shaft is smaller than the length of a line segment connecting between the shaft and the wall surface and extending orthogonally to the wall surface, and an end portion of adjacent one, with respect to the shaft, of the left and right side edge portions of the front panel is located closer to a center of the opening than the relief portion is to the center.

[0008]

In still another aspect, the present invention provides A refrigerator comprising: a box-shaped structure having a refrigerating compartment, a front opening formed on the refrigerating compartment; a refrigerant compartment door that closes the front opening; an upper hinge provided at an upper position of the opening, and a lower hinge provided at a lower position of the opening, the upper hinge and the lower hinge each including a shaft that pivotably supports the door from the upper or lower position; and a refrigerant circuit including a

refrigeration cycle configured to generate a cooling air to cool inside of the refrigerating compartment, the refrigerant compartment door including a frame and a front panel fixed to a front face of the frame, the frame including a side frame portion having a rectangular shape as viewed from a front side, and
5 composed of a top side portion, a bottom side portion, a left side portion, a right side portion, and a front portion to which the front panel is attached, the front portion being provided on a front side of the side frame portion, the frame including a relief portion formed in a corner, the corner being formed between adjacent one, with respect to the shaft, of the left and right side portions and the
10 front portion, wherein in a horizontal cross-sectional view of the refrigerator, the relief portion includes a distal point at which the relief portion is most away from the shaft, and a length of an imaginary line segment extending, from a thickest portion of the front panel to, and orthogonally to, another imaginary line segment extending orthogonally to adjacent one, with respect to the shaft, of the left and
15 right side portions is smaller than a distance between the shaft and the distal point of the relief portion, and adjacent one, with respect to the shaft, of the left and right edge portions of the front panel is located inside a circle around the shaft as a center, the circle having a radius equal to the distance between the distal point of the relief portion and the shaft.

Advantageous Effects of Invention

[0009]

The storage cabinet and the refrigerator configured as above allow the door to be opened to 90 degrees or more, even when the storage cabinet or
25 refrigerator is installed with the side face disposed close to a wall.

Brief Description of Drawings

[0010]

[Fig. 1] Fig. 1 is a front view of a refrigerator according to Embodiments 1 to 3 of the present invention.

[Fig. 2] Fig. 2 is a cross-sectional view of the refrigerator shown in Fig. 1.

[Fig. 3] Fig. 3 is an exploded perspective view of the refrigerating
5 compartment doors shown in Fig. 1.

[Fig. 4A] Fig. 4A is a partially cut-away perspective view of a frame of the refrigerating compartment left door shown in Fig. 1.

[Fig. 4B] Fig. 4B is an enlarged view of a portion in a broken-line circle F in Fig. 4A.

10 [Fig. 5] Fig. 5 is an exploded perspective view of a left frame member and a bottom frame member constituting the frame shown in Fig. 4A.

[Fig. 6] Fig. 6 is a plan view of the refrigerator shown in Fig. 1, with side faces located adjacent to a wall.

15 [Fig. 7] Fig. 7 is a cross-sectional view of the refrigerating compartment left and right doors shown in Fig. 1.

[Fig. 8] Fig. 8 is an enlarged view of a portion in a broken-line circle Z in Fig. 7.

20 [Fig. 9A] Fig. 9A is a horizontal cross-sectional view of a portion in the vicinity of a relief portion of a frame corner portion, the relief portion being formed in a chamfered shape.

[Fig. 9B] Fig. 9B is a horizontal cross-sectional view of the portion in the vicinity of the relief portion formed in a different chamfered shape from that of Fig. 9A.

25 [Fig. 10] Fig. 10 is a horizontal cross-sectional view of the portion in the vicinity of the relief portion of the frame corner portion, the relief portion being formed in an arcuate shape.

[Fig. 11] Fig. 11 is a horizontal cross-sectional view of the portion in the

vicinity of the relief portion of the frame corner portion, the relief portion being formed in a wave shape.

[Fig. 12] Fig. 12 is a cross-sectional view of the operation panel shown in Fig. 1.

5 [Fig. 13] Fig. 13 is a cross-sectional view of the operation panel including a transparent electrode.

[Fig. 14] Fig. 14 is a perspective view of the erect box shown in Fig. 12 and Fig. 13.

10 [Fig. 15] Fig. 15 is an exploded perspective view of a door closing device and a hinge supporting the refrigerating compartment door shown in Fig. 1.

[Fig. 16A] Fig. 16A is a plan view of the door closing device shown in Fig. 15.

[Fig. 16B] Fig. 16B is a cross-sectional view taken along a line B-B in Fig. 16A.

15 [Fig. 17A] Fig. 17A is a side view of the door closing device shown in Fig. 15.

[Fig. 17B] Fig. 17B is a cross-sectional view taken along a line A-A in Fig. 17A.

20 [Fig. 18A] Fig. 18A is a horizontal cross-sectional view of a portion in the vicinity of a relief portion of a frame corner portion according to Embodiment 2 of the present invention, the relief portion being formed in a chamfered shape.

[Fig. 18B] Fig. 18B is a horizontal cross-sectional view of the portion in the vicinity of the relief portion formed in a different chamfered shape from that of Fig. 18A.

25 [Fig. 19] Fig. 19 is a horizontal cross-sectional view of a portion in the vicinity of a relief portion of a frame corner portion according to Embodiment 2 of the present invention, the relief portion being formed in an arcuate shape.

[Fig. 20] Fig. 20 is a horizontal cross-sectional view of a portion in the vicinity of a relief portion of a frame corner portion according to Embodiment 2 of the present invention, the relief portion being formed in a wave shape.

[Fig. 21] Fig. 21 is a horizontal cross-sectional view of the portion in the vicinity of the relief portion, formed when the front face of the front panel is formed with a curved horizontal cross-sectional shape.

[Fig. 22] Fig. 22 is a side view of a door closing device according to Embodiment 3 of the present invention.

[Fig. 23] Fig. 23 is an exploded perspective view of the door closing device shown in Fig. 22.

Description of Embodiments

Embodiment 1

[0011]

Fig. 1 is a front view of a refrigerator, illustrating a storage cabinet according to Embodiment 1 of the present invention. Hereafter, description will be given on the assumption that the storage cabinet is a refrigerator 1. The refrigerator 1 includes a refrigerating compartment 2 provided on an uppermost stage. The refrigerating compartment 2 has a rectangular opening formed on the front side, which is opened and closed by a refrigerating compartment left door 3 and a refrigerating compartment right door 4. An upper hinge 70 and a lower hinge 45 are respectively provided at an upper position and a lower position of the opening of the refrigerating compartment 2. The refrigerating compartment left door 3 is supported by the lower hinge 45 provided at the left lower position of the refrigerating compartment 2 and the upper hinge 70 provided at the left upper position of the refrigerating compartment 2, so as to pivot about a shaft 45a of the lower hinge 45 (see Fig. 15) and a shaft of the upper hinge 70 (not shown, same shape as shaft 45a of lower hinge). Likewise,

the refrigerating compartment right door 4 is supported by the lower hinge 45 provided at the right lower position of the opening of the refrigerating compartment 2 and the upper hinge 70 provided at the left upper position of the opening of the refrigerating compartment 2, so as to pivot about the shaft of the lower hinge 45 and the upper hinge 70. A door closing device (see Fig. 15) is attached to the lower hinge 45. An operation panel 5 for adjusting the temperature and so forth is provided on the front face of the refrigerating compartment left door 3. Under the refrigerating compartment 2, a switchable compartment 6 and an ice compartment 8 are provided. The switchable compartment 6 can be utilized, for example, as a freezing compartment or a soft freezing compartment, by switching a target temperature. The switchable compartment 6 can be opened and closed as desired, with a switchable compartment door 7 provided on the front face. The ice compartment 8 is openable and closable as desired, with an ice compartment door 9 provided on the front face. A freezing compartment 10 is provided under the switchable compartment 6 and the ice compartment 8. The freezing compartment 10 can be opened and closed as desired, with a freezing compartment door 11 provided on the front face. A vegetable compartment 12 is provided under the freezing compartment 10. The vegetable compartment 12 can be opened and closed as desired, with a vegetable compartment door 13 provided on the front face.

[0012]

Fig. 2 is a cross-sectional view of the refrigerator shown in Fig. 1. Fig. 3 is an exploded perspective view of the refrigerating compartment left door 3 and the refrigerating compartment right door 4 of the refrigerator shown in Fig. 1.

Fig. 4A is a partially cut-away perspective view of a left door frame 28 of the refrigerating compartment left door 3 shown in Fig. 3. Fig. 4B is an enlarged view of a portion in a broken-line circle F in Fig. 4A. Fig. 5 is an enlarged

perspective view of a portion in the vicinity of a rib 28e of a left frame member 28a and a nail 28f of a bottom frame member 28d.

[0013]

A ceiling vacuum thermal insulator 14 is provided in an inner ceiling of the refrigerating compartment 2. A rear vacuum thermal insulator 15 is provided on an inner rear wall of the refrigerating compartment 2. The refrigerating compartment left door 3 includes a left door vacuum thermal insulator 16, and the refrigerating compartment right door 4 includes a right door vacuum thermal insulator 17. In addition, the freezing compartment door 11 includes a freezing compartment door vacuum thermal insulator 18, and the vegetable compartment door 13 includes a vegetable compartment door vacuum thermal insulator 19. These vacuum thermal insulators 14 to 19 serve to suppress heat invasion from outside into the refrigerator 1. The thermal conductivity λ of the vacuum thermal insulator is, for example, 0.0020 W/m·K. A non-illustrated urethane material is loaded between an inner box 27 and the ceiling vacuum thermal insulator 14, the rear vacuum thermal insulator 15, a refrigerator right side vacuum thermal insulator (not shown), and a refrigerator left side vacuum thermal insulator (not shown). The urethane material (not shown) is also loaded between the left door vacuum thermal insulator 16 and a left door inner plate 20, between the right door vacuum thermal insulator 17 and a right door inner plate 21, between the freezing compartment door vacuum thermal insulator 18 and a freezing compartment door inner plate 22, and between the vegetable compartment door vacuum thermal insulator 19 and a vegetable compartment door inner plate 23. The thermal conductivity λ of the urethane is, for example, 0.0200 W/m·K. A cooler 24 is provided inside the freezing compartment 10. The refrigerator 1 includes a refrigerant circuit composed of a compressor 26, a condenser (not shown), a capillary tube (not shown), and the cooler 24. The refrigerant circuit

constitutes a refrigeration cycle for generating cold air to be supplied to the refrigerating compartment 2. The compressor 26 compresses the refrigerant. The condenser condenses the compressed refrigerant. The capillary tube depressurizes the condensed refrigerant. The cooler 24 evaporates the depressurized refrigerant. Air around the cooler 24 is cooled by the heat removal effect that takes place when the refrigerant is evaporated. In addition, a fan 25 that supplies the air cooled by the cooler 24 to the refrigerating compartment 2, the switchable compartment 6, and the ice compartment 8 is provided in the freezing compartment 10.

[0014]

The left door frame 28 includes a left frame member 28a, a right frame member 28b, a top frame member 28c, and a bottom frame member 28d, which are connected to each other and built into a frame. The frame members 28a to 28d each include a front portion and a side portion formed so as to intersect with the front portion and extend toward the refrigerating compartment 2. The side frame constituted of the respective side portions of the frame members 28a to 28d will hereinafter be referred to as side frame portion. The side frame portion has a rectangular shape when viewed from the front side. The frame on the front side constituted of the respective front portions of the frame members 28a to 28d will hereinafter be referred to as front frame portion. The front portion and the side portion of each frame member are integrally formed, and a relief portion 28a3 is provided in a corner portion where the front portion and the side portion intersect with each other. As shown in Fig. 3, for example, the left frame member 28a includes a front portion 28a1 and a side portion 28a2, which are integrally formed, and a relief portion 28a3 is provided in a corner portion where the front portion 28a1 and the side portion 28a2 intersect with each other. A nail 28f is provided on each end portion of the bottom frame member 28d. The left

frame member 28a includes, at an end portion thereof, a rib 28e including a cavity 28h for introducing an end portion of the bottom frame member 28d, and a fitting hole 28g to be engaged with the nail 28f on the end portion of the bottom frame member 28d when the end portion is inserted into the cavity 28h. The

5 fitting hole 28g has a rectangular shape for example, in which case the rib 28e is formed in a rectangular plate shape, and the rectangular plate-shaped rib 28e is fitted in the fitting hole 28g of the rectangular shape. The end portion of the bottom frame member 28d is inserted into the cavity 28h of the left frame member 28a, and the nail 28f of the bottom frame member 28d is fitted in the

10 fitting hole 28g of the left frame member 28a. Accordingly, the left frame member 28a is restricted from being separated in the left or right direction. Likewise, the left frame member 28a includes, at the other end portion thereof, a similar rib (not shown) including a cavity for introducing an end portion of the top frame member 28c, and a fitting hole to be engaged with a nail on the end

15 portion of the top frame member 28c when the end portion is inserted into the cavity. The right frame member 28b also includes, at the respective end portions thereof, similar ribs (not shown) each including a cavity for introducing an end portion of the upper or bottom frame member, and a fitting hole to be engaged with a nail of the upper or bottom frame member. The top frame

20 member 28c also includes similar nails (not shown) located at the respective end portions. The fitting between the left frame member 28a and the top frame member 28c, the fitting between the right frame member 28b and the bottom frame member 28d, and the fitting between the right frame member 28b and the top frame member 28c are also realized in the same manner as above. The rib

25 28e is integral with the left frame member 28a or the right frame member 28b, and located adjacent to at least two inner surfaces of the left frame member 28a or the right frame member 28b.

[0015]

A reinforcing member 54 that prevents deformation of the left door frame 28 when the urethane is foamed is fixed to the respective inner surfaces of the side portions of the left frame member 28a and the right frame member 28b.

5 The reinforcing member 54 is provided along the longitudinal direction of the side portion. The reinforcing member 54 may have a channel-shaped horizontal cross-section including, as shown in Fig. 8 to be subsequently referred to, a base portion and a pair of lateral portions integrally formed with the base portion. Here, the shape of the reinforcing member 54 is not limited to the above, and the
10 reinforcing member 54 may be formed in a plate shape or column shape extending in the longitudinal direction. In the case of adopting the column-shaped reinforcing member 54, the cross-section perpendicular to the column axis may have a circular shape, or a polygonal shape such as a triangle or a square. The reinforcing member 54 may be provided over the entire length, or
15 over a part thereof, of the side portions of the left frame member 28a and the right frame member 28b. The length of the reinforcing member 54 in the longitudinal direction of the side portion may be determined so as to prevent the deformation of the left frame member 28a and the right frame member 28b. From the viewpoint of securing expected strength, it is desirable that the
20 reinforcing member 54 is provided so as to at least step over the center of the side portion between the end portions thereof in the longitudinal direction. The reinforcing member 54 may be formed of a metal, such as iron or aluminum.

[0016]

25 The left door frame 28 is built so as to have a rectangular shape having top and bottom and left and right sides, when viewed from the front side. The rear periphery of a left front panel 31a having a rectangular flat plate shape is adhered and fixed to the front frame portion of the left door frame 28, via a

double-sided tape 30. The front face of the left front panel 31a is entirely exposed. The left front panel 31a may be adhered so as to cover the entirety of the front frame portion of the left door frame 28, or to allow a part of the front frame portion of the left door frame 28 to be exposed when viewed from the front side. For example, whereas a front portion 28a1 of the left frame member 28a is rectangular when viewed from the front side, the left front panel 31a may be adhered such that the left side thereof is located on the right of the left side of the front portion 28a1 of the left frame member 28a. In this case, the front portion 28a1 of the left frame member 28a of the left door frame 28 is divided into a region where the left front panel 31a is adhered and a region where the left front panel 31a is not on, in other words where a part of the front portion 28a1 of the left frame member 28a is exposed when viewed from the front side. A left door inner plate 20 is provided on the back of the left front panel 31a. The left door frame 28 is fixed onto a front portion of the left door inner plate 20. A closed space defined by the left door inner plate 20, the left door frame 28, and the left front panel 31a contains the left door vacuum thermal insulator 16. A clearance formed in the closed space is loaded with urethane (not shown). The urethane not only serves for heat insulation, but also serves to stick and fix at least a part of the back surface of the left front panel 31a to the left door frame 28. The refrigerating compartment right door 4 is also configured in the same manner as above. In the case of the refrigerating compartment right door 4, whereas the front portion of the right frame member 29b is rectangular when viewed from the front side, the right front panel 31b may be adhered and fixed, for example, such that the right side thereof is located on the left of the right side of the front portion of the right frame member 29b. The left front panel 31a and the right front panel 31b may be formed of glass, a plastic material, or a metal such as aluminum.

[0017]

Fig. 6 is a plan view of the refrigerator 1 located adjacent to a wall. To be more specific, the refrigerator 1 is installed such that a left side face 60a of a box-shaped structure 60 of the refrigerator 1 and a left wall surface W are adjacent to each other, and that a right side face 60b of the box-shaped structure 60 and a right wall surface W' are adjacent to each other. Here, the left wall surface W and the right wall surface W' may be a wall surface inside or outside of a kitchen, a living room, or a bedroom, or a surface of another refrigerator or furniture such as a side board, which are independent from the refrigerator 1. Here, the left wall surface W and the right wall surface W' may not be continuous to each other.

Fig. 7 is a cross-sectional view of the refrigerating compartment left door 3 and the refrigerating compartment right door 4. Fig. 8 is an enlarged view of a portion in a broken-line circle Z in Fig. 7. A distance A represents a horizontal distance between the rotation axis Q of the rotation shaft of the refrigerating compartment left door 3 (hinge shaft, see Fig. 15) and side face of the left frame member 28a. In other words, the distance A represents the length of a perpendicular line segment extending from the rotation axis Q to the side portion 28a2 of the left frame member 28a. A distance B represents a distance between the rotation axis Q and a distal point P, which is most away from the rotation axis Q, in the relief portion 28a3 formed in the corner portion, in a horizontal cross-sectional view of the left frame member 28a. A distance C represents a length of a line segment extending from a position on a panel front face D of the left front panel 31a where the left front panel 31a is thickest in a horizontal cross-sectional view, to an imaginary line segment E extending from the rotation axis Q orthogonally to the left side portion of the left door frame 28 (side portion 28a2 of the left frame member 28a), in a direction orthogonal to the imaginary line segment E. In Fig. 6 to Fig. 8, the distance C may be expressed as the length of a line segment extending from the rotation axis Q of the

refrigerating compartment left door 3 to the front face of the left front panel 31a orthogonally thereto. A clearance t represents a distance between the side portion 28a2 of the left frame member 28a and the left wall surface W . The relief portion 28a3 is formed in the corner portion of the left frame member 28a, such that the distal point P is located inside a circle Y around the rotation axis Q as the center, the circle having a radius equal to $(A + t)$. The length C of the line segment extending from the position on the panel front face D of the left front panel 31a where the left front panel 31a is thickest in a horizontal cross-sectional view, to the imaginary line segment E extending from the rotation axis Q orthogonally to the left side portion of the left door frame 28, in a direction orthogonal to the imaginary line segment E , is shorter than the distance B between the rotation axis Q and the distal point P , which is most away from the rotation axis Q , in the relief portion 28a3. One of the left and right edge portions of the left front panel 31a corresponding to the rotation axis Q in the horizontal cross-sectional view, in other words the left end portion G is located inside a circle around the rotation axis Q as the center, the circle having a radius equal to the distance B between the rotation axis Q and the distal point P . Here, the left end portion G corresponds to the side face of the left front panel 31a, or the side constituting the side face. In Fig. 6 to Fig. 8, the horizontal distance C between the rotation axis Q and the front face of the left front panel 31a (length of the perpendicular line segment between the rotation axis Q and the front face of the left front panel 31a) is equal to or shorter than the radius of the circle Y $(A + t)$. The foregoing configuration allows the refrigerating compartment left door 3 to be opened to 90 degrees, without interference with the left wall surface W . The condition for enabling the refrigerating compartment left door 3 to be opened to 90 degrees or more without interference with the left wall surface W can be expressed in equations as $B \leq (A + t)$ and $C \leq (A + t)$. With such a configuration,

a shelf or a case in the refrigerating compartment 2 can be taken out. The relief portion 28a3 is formed in the corner portion where the front portion 28a1 and the side portion 28a2 of the left frame member 28a intersect with each other. The relief portion 28a3 may be formed, for example, in a chamfered shape or an arcuate shape. Alternatively, the relief portion 28a3 may be formed in a wave shape composed of a plurality of arcs connected to each other to form a wave shape, in a horizontal cross-sectional view of the left frame member 28a. The cross-sectional shapes in Fig. 7 and Fig. 8 represent the case where the corner portion is formed with the chamfered shape. Although the clearance t may vary depending on the installation condition of the refrigerator 1 by the user, the distances A, B, and C may be determined by presetting a certain predicted value. For example, in the case of assuming that the refrigerator 1 is installed such that the distance between the left side face 60a refrigerator 1 and the left wall surface W becomes 5 mm, in other words such that an installation allowance of 5 mm is secured, the distances A to C can be determined on the basis of the predicted value of the clearance t (minimum installation space) being 5 mm.

[0018]

The refrigerating compartment right door 4 is also configured in the same manner as above in terms of the relationship in distance and the relief portion.

A distance A' represents a horizontal distance between the rotation axis Q' of the rotation shaft of the refrigerating compartment right door 4 (hinge shaft, see Fig. 15) and side face of the right frame member 29b. In other words, the distance A' represents the length of a perpendicular line segment extending from the rotation axis Q' to the side portion of the right frame member 29b. A distance B' represents a distance between the rotation axis Q' and a distal point P', which is most away from the rotation axis Q', in the relief portion formed in the corner portion, in a horizontal cross-sectional view of the right frame member 29b.

A distance C' represents a length of a line segment extending from a position on a panel front face D' of the right front panel 31b where the right front panel 31b is thickest in a horizontal cross-sectional view, to an imaginary line segment extending from the rotation axis Q' orthogonally to the right side portion of the right door frame 29 (side portion of the right frame member 29b). In Fig. 6 to Fig. 8, the distance C' may be expressed as the length of a line segment extending from the rotation axis Q' of the refrigerating compartment right door 4 to the front face of the right front panel 31b orthogonally thereto. A clearance t' represents a distance between the side portion of the right frame member 29b and the right wall surface W . The relief portion is formed in the corner portion of the right frame member 29b, such that the distal point P' is located inside a circle around the rotation axis Q' as the center, the circle having a radius equal to $(A' + t')$. The length C' of the line segment extending from the position on the panel front face D' of the right front panel 31b where the right front panel 31b is thickest in a horizontal cross-sectional view, to the imaginary line segment extending from the rotation axis Q' orthogonally to the right side portion of the right door frame 29, is shorter than the distance B' between the rotation axis Q' and distal point P' , which is most away from the rotation axis Q' , in the relief portion. The right and right end portions of the right front panel 31b corresponding to the rotation axis Q' in the horizontal cross-sectional view, in other words the right end portion G is located inside a circle around the rotation axis Q' as the center, the circle having a radius equal to the distance B' between the rotation axis Q' and the distal point P' . In Fig. 6 to Fig. 8, the horizontal distance C' between the rotation axis Q' and the front face of the right front panel 31b (length of the perpendicular line segment between the rotation axis Q' and the front face of the right front panel 31b) is equal to or shorter than the radius $(A' + t')$ of the circle. The foregoing configuration allows the refrigerating compartment right door 4 to be opened to

90 degrees, without interference with the right wall surface W. The condition for enabling the refrigerating compartment right door 4 to be opened to 90 degrees or more without interference with the right wall surface W can be expressed in equations as $B' \leq (A' + t')$ and $C' \leq (A' + t')$. With such a configuration, a shelf or a case in the refrigerating compartment 2 can be taken out. The relief portion is formed in the corner portion where the front portion and the side portion of the right frame member 29b intersect with each other. The relief portion may be formed, for example, in a chamfered shape or an arcuate shape. Alternatively, the relief portion may be formed in a wave shape composed of a plurality of arcs connected to each other to form a wave shape, in a horizontal cross-sectional view of the right frame member 29b. The cross-sectional shape in Fig. 7 represents the case where the corner portion is formed with the chamfered shape. Although the clearance t' may vary depending on the condition of installation by the user of the refrigerator 1, the distances A' , B' , and C' may be determined by presetting a certain predicted value. For example, in the case of assuming that the refrigerator 1 is installed such that the distance between the right side face 60a refrigerator 1 and the right wall surface W becomes 5 mm, in other words such that an installation allowance of 5 mm is secured, the distances A' to C' can be determined on the basis of the predicted value of the clearance t' (minimum installation space) being 5 mm.

[0019]

Fig. 9A and Fig. 9B are horizontal cross-sectional views of a portion in the vicinity of the relief portion 28a3 in the corner portion 28a6 of the left door frame 28, the relief portion 28a3 being formed in a chamfered shape. The horizontal cross-sectional shape of the relief portion 28a3 is represented by a line segment connecting between an end portion 28a4 of the front portion 28a1 on the side of the corner portion and an end portion 28a5 of the side portion 28a2 on the side of

the corner portion, in the left frame member 28a. Fig. 9A is a cross-sectional view illustrating the case where, out of the end portion 28a4 of the front portion 28a1 on the side of the corner portion and the end portion 28a5 of the side portion 28a2 on the side of the corner portion, the end portion 28a5 is more away from the rotation axis Q of the refrigerating compartment left door 3. Fig. 9B is a cross-sectional view illustrating the case where the end portion 28a4 of the front portion 28a1 on the side of the corner portion is farther from the rotation axis Q of the refrigerating compartment left door 3. The distal point P in the relief portion 28a3 of the left frame member 28a is located inside the circle Y around the rotation axis Q as the center, the circle having a radius equal to $(A + t)$.

[0020]

Fig. 10 is a horizontal cross-sectional view of the portion in the vicinity of the relief portion 28a3 in the corner portion 28a6 of the left door frame 28, the relief portion 28a3 being formed in an arcuate shape. The horizontal cross-sectional shape of the relief portion 28a3 is represented by an arc connecting between the end portion 28a4 of the front portion 28a1 on the side of the corner portion and the end portion 28a5 of the side portion 28a2 on the side of the corner portion, in the left frame member 28a. The distal point P in the relief portion 28a3 of the left frame member 28a is located inside the circle Y around the rotation axis Q as the center, the circle having a radius equal to $(A + t)$.

[0021]

Fig. 11 is a horizontal cross-sectional view of the portion in the vicinity of the relief portion 28a3 in the corner portion 28a6 of the left door frame 28, the relief portion 28a3 being formed in a wave shape. The horizontal cross-sectional shape of the relief portion 28a3 is represented by a wave-shaped curve connecting between the end portion 28a4 of the front portion 28a1 on the side of the corner portion and the end portion 28a5 of the side portion 28a2 on the side

of the corner portion, in the left frame member 28a. The wave-shaped curve includes a plurality of arcs connected to each other in a wave shape. The distal point P in the relief portion 28a3 of the left frame member 28a is located inside the circle Y around the rotation axis Q as the center, the circle having a radius equal to $(A + t)$.

[0022]

Since the relief portion 28a3 is formed such that the distal point P in the relief portion 28a3 is located inside the circle Y in all the cases of the chamfered shape, the arcuate shape, and the wave shape, the refrigerating compartment left door 3 can be opened to 90 degrees. The same also applies to the refrigerating compartment right door 4.

[0023]

Hereunder, the configuration of the operation panel 5 will be described.

Fig. 12 is a cross-sectional view of the operation panel 5. In Fig. 12, the operation panel 5 includes a film 32 on which characters and illustrations are printed, an operation front panel 33 integrated with the film 32, a substrate 36, an LED39 for illuminating the characters and illustrations printed on the film, a light guide plate 35, an erect box 34 that prevents leakage of light, and a substrate fixer 37. The operation front panel 33 includes bosses formed on the back surface for positioning the erect box 34 and the substrate 36. The light guide plate 35 may be substituted with a light guide unit having the same function. The operation panel 5 is built up through integrating the film 32 on which characters and illustrations are printed with the operation front panel 33, fitting the erect box 34 in position on the back of the operation front panel 33, fitting the light guide plate 35 in the erect box 34 and then fitting the substrate 36 thereto, and fixing the substrate 36 with the substrate fixer 37. The operation panel 5 is of a static capacitance type, and therefore the substrate fixer 37 has to be

employed for bringing an electrode 40 on the substrate into close contact with a pressing position. Accordingly, as shown in Fig. 12, the substrate 36 is located in the back of the erect box 34, and the electrode 40 on the substrate is located right under the pressing position, and therefore the LED39, which is also located on the substrate, emits light from a position deviated from right under the pressing position. In addition, an operation panel base 38 is provided so as to support the operation panel 5. The operation panel base 38 is located between the left door vacuum thermal insulator 16 and the refrigerating compartment left door 3. The operation panel base 38 is tentatively fixed on the back of the refrigerating compartment left door 3 and then fixed with an aluminum tape before foaming. Then by fitting the operation panel 5 in the operation panel base 38 after the foaming, the operation panel 5 is arranged on the refrigerating compartment left door 3. Here, the operation panel 5 may be configured in different manners, for example a transparent electrode 41 may be employed.

[0024]

Hereunder, the operation panel 5 including the transparent electrode 41 will be described. Fig. 13 is a cross-sectional view of the operation panel 5 including the transparent electrode 41. The configuration of the operation panel 5 including the transparent electrode 41 is generally the same as that shown in Fig. 12, except for the position of the electrode. The transparent electrode 41 is an independent element as shown in Fig. 13, and hence may be located on the side of the operation front panel 33. Accordingly, the transparent electrode 41 can be illuminated by the LED39 on the substrate from a position right under the transparent electrode 41, and therefore the display regions of the characters and illustrations can be evenly illuminated. In addition, the electrode is integrated with the operation front panel 33 instead of being located on the substrate, which eliminates the need to employ the substrate fixer 37 for close contact, to the front

panel, of the electrode. Thus, in the case of the operation panel 5 including the transparent electrode 41, the transparent electrode 41 on which the characters and illustrations are printed is adhered to the front portion of the erect box 34, and then the light guide plate 35 and the substrate 36 are disposed and fixed on the back of the erect box 34. For the operation panel 5 including the transparent electrode 41 also, the operation panel base 38 is provided to support the operation panel 5. In this case also, the operation panel base 38 is located between the left door vacuum thermal insulator 16 and the refrigerating compartment left door 3. The operation panel base 38 is tentatively fixed on the back of the refrigerating compartment left door 3 and then fixed with an aluminum tape before foaming. Then by fitting the operation panel 5 in the operation panel base 38 after the foaming, the operation panel 5 is arranged on the refrigerating compartment left door 3. To fit the operation panel 5 in the operation panel base 38, for example the operation panel 5 may be inserted from a lateral position of the refrigerating compartment left door 3.

[0025]

Fig. 14 is a perspective view of the erect box. In the case where, for example, a guide for facilitating the insertion of the operation panel 5 is provided on the operation panel base 38, operation panel base 38 is deformed during the foaming process, which may make it difficult or impossible to insert the operation panel 5. However, providing a spring portion 42 on the upper face of the erect box 34 minimizes the impact of the deformation of the operation panel base 38. In addition, providing a rib 43 on the side face of the erect box 34 on the side of the insertion port of the operation panel 5 enables the left and right positions to be fixed after the insertion. Further, engaging a part of the erect box 34 around the rib 43 with the right frame member 28b facilitates the replacement of the substrate in a maintenance work, thereby improving the service work efficiency.

Here, the operation panel 5 may be installed in different manners from the above, for example may be fitted from the front side of the refrigerating compartment left door 3. In addition, the location of the operation panel 5 is not limited to the refrigerating compartment left door 3. The operation panel 5 may be located, for example, inside the refrigerating compartment 2.

[0026]

The operation panel 5 is formed of a thin panel, and hence the thickness of the refrigerating compartment left door 3 is barely increased by providing the operation panel on the front face of the refrigerating compartment left door 3. In particular, the thickness of the refrigerating compartment left door 3 remains unchanged in the case where the operation panel 5 is fitted in the front face of the refrigerating compartment left door 3 such that only the display surface, on which the characters and illustrations representing the operation details are printed, is exposed. Such a display surface corresponds to the upper surface of the film 32 in the operation panel 5 shown in Fig. 12, and to the upper surface of the operation front panel 33 in the operation panel 5 shown in Fig. 13.

Therefore, providing the operation panel 5 on the front face of the refrigerating compartment left door 3 still allows the refrigerating compartment left door 3 to be opened to 90 degrees or more, and also allows the user to operate the refrigerator 1 by simply touching the operation panel 5. Examples of the operation that can be performed through the operation panel 5 include switching to and from an energy saving mode, start or stop of quick ice making, and setting the switchable compartment 6 to a normal freezing mode or soft freezing mode.

[0027]

Fig. 15 is an exploded perspective view of the door closing device 44 and the lower hinge 45. Fig. 16A is a plan view of the door closing device 44. Fig. 16B is a cross-sectional view taken along a line B-B in Fig. 16A. Fig. 17A is a

side view of the door closing device 44. Fig. 17B is a cross-sectional view taken along a line A-A in Fig. 17A. The lower hinge 45 includes a vertical portion 45b having a plurality of screw holes 45d formed therein and a horizontal portion 45c integrally formed with the vertical portion 45b, and is formed generally in an L-shape. The lower hinge 45 is fixed to the lower position of the refrigerating compartment 2 by fixing the vertical portion 45b with screws to the lower position of the refrigerating compartment 2. A housing space 50c concave upward is provided on an end portion of a bottom frame member 50 in the longitudinal direction and at a position corresponding to the lower hinge 45, so as to accommodate the door closing device 44.

[0028]

The door closing device 44 includes a cam 46 made of a synthetic resin, internally fitted with the shaft 45a of the lower hinge 45 to be thereby unpivotably supported, and including at least a pair of recesses 46a symmetrically formed with respect to the shaft of the lower hinge 45, a blade spring 47 disposed such that end portions 47a directly hold the cam 46 from the respective sides and rotate along, while being pressed against, the outer circumferential surface of the cam 46, a spring retainer 48 retaining the blade spring 47 and fixed to the refrigerating compartment left door 3, and a base member 49 supporting the mentioned parts. The door closing device 44 is configured such that when the door is closed the end portions 47a of the blade spring 47 are respectively fitted in the recesses 46a of the cam 46 and hence the spring force is substantially released, and that when the refrigerating compartment left door 3 starts to be opened the end portions 47a are disengaged from the recesses 46a and gradually biased, and the spring force reaches maximum when the end portions 47a reach the outer circumferential surface of the cam 46. Conversely, when the refrigerating compartment left door 3 is closed, the spring force biased to the

maximum is suddenly released when the end portions 47a are fitted in the recesses 46a. The pair of recess 46a formed on the cam 46 of the door closing device 44 are located, when the end portions 47a of the blade spring 47 are fitted therein, at a position beyond the position where the motion of the refrigerating compartment left door 3 is delimited by the main body of the refrigerator 1, in the closing direction. It is a matter of course that the initial point of the pair of recess 46a formed on the cam 46 of the door closing device 44 is at a wider angular position than an opening angular position where the refrigerating compartment left door 3 is automatically closed owing to magnetizing force of a magnet gasket (not shown) provided along the periphery of the door inner plate. The door closing device 44 is configured such that the blade spring 47 is biased upon directly pressing the outer circumferential surface of the cam 46, in other words the cam 46 directly biases the blade spring 47, and therefore the force for closing the refrigerating compartment left door 3 is determined exclusively by the spring force of the blade spring 47 itself and the size and shape of the cam 46, and such force barely fluctuates. Such a configuration eliminates the need to adjust the spring force after incorporating the door closing device in the refrigerating compartment left door 3, and yet prevents the closing noise of the refrigerating compartment left door 3 from becoming too loud because of excessive spring force and also prevents the refrigerating compartment left door 3 from stopping halfway because of insufficient spring force, thus assuring that the refrigerating compartment left door 3 is normally closed. The refrigerating compartment right door 4 also includes the door closing device 44 and the lower hinge 45 of the same configuration, and therefore the same advantageous effects can be attained.

[0029]

In addition, since the blade spring 47 holds the cam 46 from both sides,

sufficient spring force can be secured. More specifically, there is no need to make the recess 46a of the cam 46 deeper so as to increase the motion range of the blade spring 47 to increase the closing force, or prepare a large space for increasing the height of the blade spring 47. Further, there is no need to increase the thickness of the spring, and therefore the processability can be kept from being degraded.

[0030]

As described thus far, in the refrigerator 1 according to Embodiment 1 the left front panel 31a is adhered to the front portion of the left door frame 28 via the double-sided tape 30. When compared with a conventional fixing method of holding the left front panel 31a with a resin material such as polypropylene (PP), the method of Embodiment 1 allows the thickness of the refrigerating compartment left door 3 to be reduced by an amount corresponding to the thickness of the resin material. Although the thickness of the refrigerating compartment left door 3 can also be reduced by reducing the thickness of the left door vacuum thermal insulator 16 or the urethane (not shown), in this case the heat insulation performance is degraded. In contrast, with the refrigerator 1 according to Embodiment 1, the increase in thickness of the refrigerating compartment left door 3 can be suppressed and the heat insulation can be secured, even when a material having a relatively low strength, such as glass, is employed in the left front panel 31a. In addition, the relief portion 28a3 is formed in the corner portion 28a6 of the left frame member 28a. Forming the relief portion 28a3 allows the refrigerating compartment left door 3 to be opened to 90 degrees or more, without the left frame member 28a interfering with the left wall surface W. Such a configuration enables the refrigerating compartment left door 3 to be opened to 90 degrees or more, even when the refrigerator 1 is installed with the left side face 60a thereof located close to the left wall surface W.

The refrigerating compartment right door 4 is configured in the same manner as above, and hence the same advantageous effects can be attained. Thus, each of the refrigerating compartment left door 3 and the refrigerating compartment right door 4 can be opened to 90 degrees or more, and therefore the case or shelf in the refrigerating compartment 2 can be easily drawn out therefrom.

[0031]

Since the relief portion 28a3 may be formed in various shapes such as the chamfered shape, arcuate shape, and wave shape, the degree of designing freedom can be increased, and the quality in appearance can also be upgraded by selecting an appropriate shape in consideration of the compatibility with the overall shape of the refrigerator 1. Further, forming the relief portion 28a3 as above allows the rotation axis Q to be located closer to the front face of the left front panel 31a, thereby facilitating the condition of $C \leq (A + t)$ for opening the refrigerating compartment left door 3 to 90 degrees or more to be satisfied. This also applies to the refrigerating compartment right door 4.

[0032]

The left frame member 28a and the right frame member 28b each include the ribs formed at the respective end portions, and the top frame member 28c and the bottom frame member 28d each include the nails formed at the respective end portions. Accordingly, fitting the ribs and the nails to each other so as to build the left door frame 28 provides the advantage in that the left frame member 28a and the right frame member 28b are prevented from coming off to the left or right. This also applies to the right door frame 29.

[0033]

In addition, since the reinforcing member 54 is fixed to the inside of the side portion of the left frame member 28a along the longitudinal direction, the left door frame 28 can be prevented from being deformed in the foaming process of

the urethane loaded in the clearance in the closed space of the refrigerating compartment left door 3. Further, since the urethane also serves to fix the rear face of the left front panel 31a to the left door frame 28, the fixing strength of the left front panel 31a is increased and consequently the left front panel 31a can be surely prevented from being separated from the left door frame 28. This also applies to the refrigerating compartment right door 4.

[0034]

Conventionally, a resin material has been used for holding the periphery of the front panel. In this case, the area of the front panel viewed from the front side of the refrigerator is reduced, and the appearance is impaired. In addition, when the front and back surfaces of the front panel are held by the resin, dust is deposited in the clearance and hence cleaning efficiency is degraded. In contrast, with the refrigerator 1 according to Embodiment 1 the area of the left front panel 31a viewed from the front side of the refrigerator 1 can be increased, so as to improve the appearance and the cleaning efficiency. Employing glass as material of the left front panel 31a further upgrades the quality of appearance. In addition, fixing the left front panel 31a so as to expose a part of the front portion of the left door frame 28 when viewed from the front side can also further improve the quality of appearance. This also applies to the refrigerating compartment right door 4.

[0035]

The refrigerator 1 according to Embodiment 1 includes the operation panel 5. The operation panel 5 is formed of a thin panel, and hence the thickness of the refrigerating compartment left door 3 is barely increased by providing the operation panel on the front face of the refrigerating compartment left door 3. In particular, the thickness of the refrigerating compartment left door 3 is not increased in the case where the operation panel 5 is fitted in the front face of the

refrigerating compartment left door 3 such that only the display surface, on which the characters and illustrations representing the operation details are printed, is exposed. Therefore, providing the operation panel 5 on the front face of the refrigerating compartment left door 3 still allows the refrigerating compartment left door 3 to be opened to 90 degrees or more, and also allows the user to operate the refrigerator 1 by simply touching the operation panel 5. The same advantageous effects can also be attained when the operation panel 5 is provided in the refrigerating compartment right door 4.

[0036]

The refrigerator 1 according to Embodiment 1 includes the door closing device 44. When the user takes out the food in the refrigerating compartment 2 and closes the door of the refrigerating compartment 2 after placing the food in the kitchen or on a table, the cooled air leaks outward while the refrigerating compartment left door 3, and the refrigerating compartment right door 4 are opened, incurring an increase in temperature in the refrigerating compartment 2. In such a case, the air volume is increased to cool the refrigerating compartment 2 where the temperature has increased, and it takes longer before the compressor 26 stops, which leads to an increase in power consumption. Accordingly, it is desirable that the refrigerating compartment left door 3 and the refrigerating compartment right door 4 are configured to be easily and surely closed. With the refrigerator 1 according to Embodiment 1, the refrigerating compartment left door 3 and the refrigerating compartment right door 4 can be opened to 90 degrees even when the refrigerator 1 is installed close to a wall surface, and also the refrigerating compartment left door 3 and the refrigerating compartment right door 4 can be easily and surely closed by the door closing device 44.

[0037]

Although Embodiment 1 represents the case where the refrigerating compartment left door 3 and the refrigerating compartment right door 4 are provided to open and close the refrigerating compartment 2, different configurations may be adopted. A single door for opening and closing the refrigerating compartment 2 may be provided, instead of the refrigerating compartment left door 3 and the refrigerating compartment right door 4. The same advantageous effects as those of Embodiment 1 can also be attained in the case of providing a single door for opening and closing the refrigerating compartment 2. In this case also, the thickness of the refrigerating compartment door and the relation of distance between the refrigerating compartment door and the wall surface shown in Fig. 7 to Fig. 11 can be equally applied.

[0038]

Although Embodiment 1 represents the case where the refrigerating compartment 2 is located on the uppermost stag, different configurations may be adopted. For example, the positions of the refrigerating compartment 2 and the freezing compartment 10 may be exchanged. Likewise, the positions of the switchable compartment 6 and the ice compartment 8 may be exchanged. Thus, the position of each of the compartments may be modified as desired. The same advantageous effects as those of Embodiment 1 can also be attained in the case of modifying the positions of the compartments. In this case also, the thickness of the refrigerating compartment door and the relation of distance between the refrigerating compartment door and the wall surface shown in Fig. 7 to Fig. 11 can be equally applied.

[0039]

Although the door closing device 44 is attached to the lower hinge 45 in Embodiment 1, it is not mandatory to provide the door closing device 44. In

addition, although the periphery of the rear surface of the left front panel 31a is adhered to the front frame portion of the left door frame 28 via the double-sided tape 30 in Embodiment 1, different methods may be adopted to fix the left front panel 31a. For example, an adhesive may be employed. This also applies to the right door.

Embodiment 2

[0040]

Hereunder, differences from Embodiment 1 will be described. Fig. 18A is a horizontal cross-sectional view of a portion in the vicinity of the relief portion 28a3 in the corner portion 28a6 of the left door frame 28 according to Embodiment 2 of the present invention, the relief portion 28a3 being formed in a chamfered shape. Fig. 18B is a horizontal cross-sectional view of the portion in the vicinity of the relief portion 28a3 formed in a different chamfered shape from that of Fig. 18A. Fig. 19 is a horizontal cross-sectional view of a portion in the vicinity of the relief portion 28a3 in the corner portion 28a6 of the left door frame 28 according to Embodiment 2 of the present invention, the relief portion being formed in an arcuate shape. Fig. 20 is a horizontal cross-sectional view of the relief portion 28a3 in the corner portion 28a6 of the left door frame 28 according to Embodiment 2 of the present invention, the relief portion being formed in a wave shape.

[0041]

The relief portion 28a3 is formed in the corner portion 28a6 of the left door frame 28. The length C of the line segment C1 extending from the position on the panel front face D of the left front panel 31a where the left front panel 31a is thickest in a horizontal cross-sectional view, to the imaginary line segment E extending from the rotation axis Q orthogonally to the left side portion of the left door frame 28 (side portion 28a2 of the left frame member 28a), in a direction

orthogonal to the imaginary line segment E, is shorter than the distance B between the rotation axis Q and the distal point P, which is most away from the rotation axis Q, in the relief portion 28a3. The left end portion G of the left front panel 31a on the side of the rotation axis Q, in the left and right sides of the left front panel 31a, is located inside the circle around the rotation axis Q as the center, the circle having a radius equal to the distance B between the rotation axis Q and the distal point P. This also applies to the refrigerating compartment right door 4.

[0042]

The foregoing configuration allows, when the refrigerator 1 is installed close to the left wall surface W with a clearance secured so as to avoid interference between the relief portion 28a3 in the corner portion 28a6 of the left door frame 28 with the left wall surface W when the refrigerating compartment left door 3 is opened, the refrigerating compartment left door 3 to be opened to 90 degrees or more, without the left front panel 31a interfering with the left wall surface W. The refrigerating compartment right door 4 may also be configured in the same manner, in which case the same advantageous effects can be attained.

Here, Embodiment 2 may further be arranged, as in Embodiment 1, so as to satisfy the conditions for opening the refrigerating compartment left door 3 to 90 degrees or more, namely $B \leq (A + t)$ and $C \leq (A + t)$. In this case also, the refrigerating compartment left door 3 can be opened to 90 degrees or more. The refrigerating compartment right door 4 may also be configured in the same manner, in which case the same advantageous effects can be attained.

[0043]

Fig. 21 is a horizontal cross-sectional view of the portion in the vicinity of the relief portion 28a3, formed when the front face of the left front panel 31a is

formed with a curved horizontal cross-sectional shape. The length C of the line segment C1 extending from the position on the panel front face D of the left front panel 31a where the left front panel 31a is thickest in a horizontal cross-sectional view, to the imaginary line segment E extending from the rotation axis Q

5 orthogonally to the left side portion of the left door frame 28 (side portion 28a2 of the left frame member 28a), in a direction orthogonal to the imaginary line segment E, is shorter than the distance B between the rotation axis Q and the distal point P, which is most away from the rotation axis Q, in the relief portion

28a3. The left end portion G of the left front panel 31a on the side of the

10 rotation axis Q, in the left and right sides of the left front panel 31a, is located inside the circle around the rotation axis Q as the center, the circle having a radius equal to the distance B between the rotation axis Q and the distal point P.

The refrigerating compartment right door 4 is also configured in the same manner, and provides the same advantageous effects.

15 Embodiment 3

[0044]

Fig. 22 is a side view of the door closing device 44 according to Embodiment 3. Fig. 23 is an exploded perspective view of the door closing device 44 shown in Fig. 22. Hereunder, description will be given referring also

20 to Fig. 15 and Fig. 16.
[0045]

The base member 49 is fitted to the bottom frame member 50 by being engaged with a housing stepped portion 50a and a stepped rib 50b, and a stopper 51 made of a steel plate is fastened with a screw 53 to a reinforcing plate

25 52 buried in the heat insulation material, so as to cover the base member 49. In addition, thinned portions, namely grooves 46b, 46c are formed on the outer surface of the cam 46, at positions that may interfere with end edges 47b, 47c of

the respective end portions (for holding the cam 46) of the blade spring 47, to prevent the cam 46 from contacting the end edges 47b, 47c of the blade spring 47. Further, stoppers 46d, 46e larger in outer diameter than a spring retainer shaft hole 48a and a base member shaft hole 49a for receiving the shaft of the cam 46 are provided at an upper and a lower position of the cam 46. The cam 46 is configured so as to avoid interference with the end edges 47b, 47c of the blade spring 47, even when the cam 46 is assembled upside down.

[0046]

In Embodiment 3, the cam 46 made of a synthetic resin is kept from contacting the end edges 47b, 47c of the blade spring 47 when the blade spring 47 rotates, and therefore linear contact between the end edges 47b, 47c of the blade spring 47 and the cam 46 can be avoided even when the cam 46 is displaced in the axial direction, to maintain the plane contact between the cam 46 and the blade spring 47. Such a configuration suppresses progress of local wear of the end edges 47b, 47c of the blade spring 47. Therefore, the sliding resistance stably remains unchanged from the initial stage and friction noise from the worn portion that may be generated when the blade spring 47 rotates can be suppressed, which contributes to extending the service life of the components. Such advantageous effects can also be attained, even when the end edges 47b, 47c of the blade spring 47 are disposed so as to contact the cam 46 as shown in Fig. 17, by rounding off the end edges 47b, 47c of the blade spring 47 for example by barrel grinding or surface striking.

Reference Signs List

[0047]

1: refrigerator, 2: refrigerating compartment, 3: refrigerating compartment left door, 4: refrigerating compartment right door, 5: operation panel, 6: switchable compartment, 7: switchable compartment door, 8: ice compartment, 9:

ice compartment door, 10: freezing compartment, 11: freezing compartment door,
12: vegetable compartment, 13: vegetable compartment door, 14: ceiling vacuum
thermal insulator, 15: rear vacuum thermal insulator, 16: left door vacuum thermal
insulator, 17: right door vacuum thermal insulator, 18: freezing compartment door
5 vacuum thermal insulator, 19: vegetable compartment door vacuum thermal
insulator, 20: left door inner plate, 21: right door inner plate, 22: freezing
compartment door inner plate, 23: vegetable compartment door inner plate, 24:
cooler, 25: fan, 26: compressor, 27: inner box, 28: left door frame, 28a: left frame
member, 28a1: front portion, 28a2: side portion, 28a3: relief portion, 28b: right
10 frame member, 28c: top frame member, 28d: bottom frame member, 28e: rib, 28f:
nail, 28g: fitting hole, 28h: cavity, 29: right door frame, 29b: right frame member,
30: double-sided tape, 31a: left front panel, 31b: right front panel, 32: film, 33:
operation front panel, 34: erect box, 35: light guide plate, 36: substrate, 37:
substrate fixer, 38: operation panel base, 39: LED, 40: electrode, 41: transparent
15 electrode, 42: spring portion, 43: rib, 44: door closing device, 45: lower hinge,
45a: shaft, 45b: vertical portion, 45c: horizontal portion, 45d: screw hole, 46: cam,
46a: recess, 46b: groove, 46c: groove, 46d: stopper, 46e: stopper, 47: blade
spring, 47a: end portion, 47b: end edge, 47c: end edge, 48: spring retainer, 48a:
spring retainer shaft hole, 49: base member, 49a: base member shaft hole, 50:
20 bottom frame member, 50a: housing stepped portion, 50b: stepped rib, 50c:
housing space, 51: stopper, 52: reinforcing plate, 53: screw, 54: reinforcing
member, 60: box-shaped structure, 70: upper hinge

CLAIMS

[Claim 1]

A storage cabinet comprising:

a box-shaped structure having a front opening;

5 a door that closes the front opening; and

an upper hinge provided at an upper position of the opening, and a lower hinge provided at a lower position of the opening, each of the upper hinge and the lower hinge including a shaft that pivotably supports the door from the upper or lower position,

10 the door including a frame and a front panel fixed to a front face of the frame,

the frame including

a side frame portion having a rectangular shape as viewed from a front side, and composed of

15 a top side portion,

a bottom side portion,

a left side portion,

a right side portion, and

20 a front portion to which the front panel is attached, the front portion being provided on a front side of the side frame portion,

the frame including a relief portion formed in a corner, the corner being formed between adjacent one, with respect to the shaft, of the left and right side portions and the front portion,

wherein in a horizontal cross-sectional view of the storage cabinet,

25 the relief portion includes a distal point at which the relief portion is most away from the shaft, and

a length of an imaginary line segment extending, from a

thickest portion of the front panel to, and orthogonally to, another imaginary line segment extending orthogonally to the adjacent one, with respect to the shaft, of the left and right side portions from the shaft is smaller than a distance between the shaft and the distal point of the relief portion, and

5 adjacent one, with respect to the shaft, of the left and right edge portions of the front panel is located inside a circle around the shaft as a center, the circle having a radius equal to the distance between the distal point of the relief portion and the shaft.

[Claim 2]

10 A storage cabinet comprising:
 a box-shaped structure having a front opening;
 a door that closes the front opening; and
 an upper hinge provided at an upper position of the opening, and a lower hinge provided at a lower position of the opening, each of the upper hinge and
15 the lower hinge including a shaft that pivotably supports the door from the upper or lower positions,

 the door including a frame and a front panel fixed to a front face of the frame,

 the frame including

20 a side frame portion having a rectangular shape as viewed from a front side, and composed of

 a top side portion,

 a bottom side portion,

 a left side portion, and

25 a right side portion, and

 a front portion to which the front panel is attached, the front portion being provided on a front side of the side frame portion,

the frame including a relief portion formed in a corner, the corner being formed between adjacent one, with respect to the shaft, of the left and right side portions and the front portion,

wherein the relief portion is located, when the storage cabinet is installed with a side face opposed to a wall surface, inside a circle around the shaft as a center, the center having a radius equal to a length of a line segment connecting between the shaft and the wall surface and extending orthogonally to the wall surface,

in a horizontal cross-sectional view of the storage cabinet, a length of an imaginary line segment extending, from a thickest portion of the front panel, orthogonally to another imaginary line segment extending orthogonally to adjacent one, with respect to the shaft, of the left and right side portions from the shaft is smaller than the length of a line segment connecting between the shaft and the wall surface and extending orthogonally to the wall surface, and

an end portion of adjacent one, with respect to the shaft, of the left and right side edge portions of the front panel is located closer to a center of the opening than the relief portion is to the center.

[Claim 3]

The storage cabinet of claim 1 or 2,

wherein a horizontal cross-sectional shape of the relief portion is one of a chamfered shape, an arcuate shape, and a wave shape.

[Claim 4]

The storage cabinet of any one of claims 1 to 3,

wherein a reinforcing member reinforcing strength of the left and right side portions is fixed to the left and right side portions along a longitudinal direction.

[Claim 5]

The storage cabinet of any one of claims 1 to 4,

wherein a door closing device configured to close the door is attached to the lower hinge.

[Claim 6]

The storage cabinet of claim 5,

5 wherein the door closing device includes

a cam fitted with the shaft of the lower hinge so as to be unpivotably supported, and including at least a pair of recesses symmetrically formed with respect to the shaft of the lower hinge;

10 a blade spring including end portions holding the cam from respective sides to be engaged with the respective recesses when the door is closed, the blade spring being disposed to rotate while pressing the end portions against and along an outer circumferential surface of the cam; and

a spring retainer retaining the blade spring and fixed to the door.

[Claim 7]

15 The storage cabinet of claim 6,

wherein the cam has a groove formed in a part of the outer circumferential surface corresponding to an end edge of the end portion of the blade spring.

[Claim 8]

The storage cabinet of any one of claims 1 to 7,

20 wherein the door includes

an inner plate provided on a rear side of the front panel,

a vacuum thermal insulator located in a closed space defined by the inner plate, the top side portion, the bottom side portion, the left side portion, the right side portion, and the front panel; and

25 urethane loaded in a clearance formed in the closed space,

wherein a rear side of the front panel is fixed to the side frame portion via the urethane.

[Claim 9]

The storage cabinet of any one of claims 1 to 8,
wherein the front portion includes

a front top portion,

5 a front bottom portion,

a front left portion, and

a front right portion, and

the frame is separable into a top frame member including the top side
portion of the side frame portion and the front top portion, a bottom frame
10 member including the bottom side portion of the side frame portion and the lower
front portion, a left frame member including the left side portion of the side frame
portion and the front left portion, and a right frame member including the right
side portion of the side frame portion and the front right portion,

the top side portion and the bottom side portion of the side frame portion
15 each include a nail respectively formed on an inner side of each of left and right
end thereof,

the left side portion and the right side portion of the side frame portion
each include a fitting hole respectively formed on an inner side of the left and
right end thereof, so as to be fitted with the respective nails, and

20 the frame is built up by

fitting the nail on one end of the top side portion in the fitting hole on
one end of the left side portion,

fitting the nail on the other end of the top side portion in the fitting
hole on one end of the right side portion,

25 fitting the nail on one end portion of the bottom side portion in the
fitting hole on the other end of the left side portion, and

fitting the nail on the other end of the bottom side portion in the

fitting hole on the other end of the right side portion.

[Claim 10]

The storage cabinet of any one of claims 1 to 9,
wherein the front panel is formed of glass.

5 [Claim 11]

A refrigerator comprising:

a box-shaped structure having

a refrigerating compartment,

a front opening formed on the refrigerating compartment;

10 a refrigerant compartment door that closes the front opening;

an upper hinge provided at an upper position of the opening, and a lower hinge provided at a lower position of the opening, the upper hinge and the lower hinge each including a shaft that pivotably supports the door from the upper or lower position; and

15 a refrigerant circuit including a refrigeration cycle configured to generate a cooling air to cool inside of the refrigerating compartment,

the refrigerant compartment door including a frame and a front panel fixed to a front face of the frame,

the frame including

20 a side frame portion having a rectangular shape as viewed from a front side, and composed of

a top side portion,

a bottom side portion,

a left side portion,

25 a right side portion, and

a front portion to which the front panel is attached, the front portion being provided on a front side of the side frame portion,

the frame including a relief portion formed in a corner, the corner being formed between adjacent one, with respect to the shaft, of the left and right side portions and the front portion,

wherein in a horizontal cross-sectional view of the refrigerator,

5 the relief portion includes a distal point at which the relief portion is most away from the shaft, and

a length of an imaginary line segment extending, from a thickest portion of the front panel to, and orthogonally to, another imaginary line segment extending orthogonally to adjacent one, with respect to the shaft, of the left and right side portions is smaller than a distance between the shaft and the distal point of the relief portion, and

10 adjacent one, with respect to the shaft, of the left and right edge portions of the front panel is located inside a circle around the shaft as a center, the circle having a radius equal to the distance between the distal point of the relief portion and the shaft.

15 [Claim 12]

The refrigerator of claim 11, further comprising an operation panel provided on a front face of the refrigerating compartment door, such that a surface of the operation panel is exposed.

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