

## DESCRIPTION

Title of Invention

REFRIGERATOR

Technical Field

5 [0001]

The present invention relates to refrigerators and, more specifically, to door structures of refrigerators.

Background Art

[0002]

10 A conventional refrigerator door, for example, a drawer-type door, includes a front plate and a rear plate disposed at a distance from each other. By installing a vacuum heat-insulating material between the front plate and the rear plate, the heat-insulating property of the drawer-type door is improved. The front plate and the rear plate have ends abutting on or partially overlapping each other at the right and left  
15 ends of the drawer-type door. The ends of the front plate and the rear plate enclose the entirety of a storage compartment without leaving a gap. A refrigerator has been proposed that has right and left projections provided close to the right and left ends on the inside of the drawer-type door and projecting deep into the storage compartment to improve heat-insulating performance of the storage compartment (for  
20 example, see Patent Literature 1).

[0003]

Furthermore, a refrigerator has been proposed in which projections are provided at the right and left ends of inner plates of double-opening doors, and a door pocket hung on each of the right and left projections is provided to increase the  
25 storage capacity of the storage compartment (for example, see Patent Literature 2).

Citation List

Patent Literature

[0004]

Patent Literature 1: Japanese Unexamined Patent Application Publication No.  
30 2014-66386

Patent Literature 2: Japanese Unexamined Patent Application Publication No.

2014-20572

Summary of Invention

Technical Problem

[0005]

However, the projections on the refrigerator doors disclosed in Patent Literature 1 and Patent Literature 2 are intended to improve the heat-insulating performance of the storage compartment or to increase the storage capacity of the storage compartment, and are not intended to improve the rigidity of the refrigerator door. To increase the internal volume of a refrigerator without increasing the installation size of the refrigerator, the thickness of the heat-insulating material forming a part of the housing of the refrigerator can be reduced. At this time, when the thicknesses of the heat-insulating materials in the doors of the refrigerators disclosed in Patent Literature 1 and Patent Literature 2 are reduced, the rigidity of the doors decreases, and the doors are deformed. As a result, gaps appear between magnetic gaskets provided on the doors and the main body of the refrigerator, thereby leaking chilled air.

[0006]

The present invention has been made in view of the above-described problem, and an object of the present invention is to obtain a refrigerator in which the rigidity of a door does not decrease even when the thickness of the heat-insulating material in the door is reduced.

Solution to Problem

[0007]

A refrigerator according to one embodiment of the present invention includes a box body having an opening at a front side of the box body, and a door that opens and closes the opening at the front side of the box body. The door includes an outer plate, an inner plate disposed to face the outer plate, a heat-insulating material disposed between the outer plate and the inner plate, a magnetic gasket attached to an outer edge of the inner plate on a side of the opening, a left projection provided on an inner side of the magnetic gasket, extending in a height direction, and projecting

toward the opening from a left portion of the inner plate, and a right projection provided on the inner side of the magnetic gasket, extending in the height direction, and projecting toward the opening from a right portion of the inner plate. In the left projection and the right projection, reinforcing members are provided to extend in the height direction.

#### Advantageous Effects of Invention

[0008]

According to one embodiment of the present invention, by providing the reinforcing members inside a right wall portion and a left wall portion of the inner plate of the door, the refrigerator can be obtained in which the rigidity of the door does not decrease even when the thickness of the heat-insulating material in the door is reduced.

#### Brief Description of Drawings

[0009]

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

[Fig. 2] Fig. 2 is an exploded view showing the configuration of a door according to Embodiment 1 of the present invention.

[Fig. 3] Fig. 3 is a schematic sectional view of the door according to Embodiment 1 of the present invention.

[Fig. 4] Fig. 4 is an enlarged view of a part enclosed by a dashed line in Fig. 3.

[Fig. 5] Fig. 5 shows an example in which a reinforcing member according to Embodiment 1 of the present invention is fixed to an inner-plate projection.

[Fig. 6] Fig. 6 shows an example in which the reinforcing member according to Embodiment 1 of the present invention is fixed to the inner-plate projection.

[Fig. 7] Fig. 7 schematically shows an example of deformation of the door.

[Fig. 8] Fig. 8 is a graph showing an example calculation of the relationship between the thickness of a heat-insulating material and the rigidity of the door.

[Fig. 9] Fig. 9 is an exploded view showing the configuration of a door according to Embodiment 2 of the present invention.

[Fig. 10] Fig. 10 is an enlarged sectional view of one end of the door.

[Fig. 11] Fig. 11 is a graph showing an example calculation of the relationship between the inner-plate-projection height and the rigidity of the door according to Embodiment 2 of the present invention.

5 [Fig. 12] Fig. 12 is an exploded view showing the configuration of a door according to Embodiment 3 of the present invention.

[Fig. 13] Fig. 13 is an enlarged sectional view of one end of the door.

[Fig. 14] Fig. 14 is an exploded view showing the configuration of a door according to Embodiment 4 of the present invention.

10 [Fig. 15] Fig. 15 is an enlarged sectional view of one end of the door.

#### Description of Embodiments

##### [0010]

Embodiments of a refrigerator 100 of the present invention will be described below with reference to the drawings. Note that the forms in the drawings are merely examples and do not limit the present invention. Furthermore, in the drawings, components denoted by the same reference signs are the same or corresponding components, and the same reference signs are used throughout the specification. In addition, in the drawings below, the dimensional relationships between components may differ from those in actuality.

##### 20 [0011]

#### Embodiment 1

Fig. 1 is a schematic perspective view of the refrigerator 100 according to Embodiment 1 of the present invention. As shown in Fig. 1, the refrigerator 100 includes a box body 9 that is open at the front, and double-opening doors 1a and 1b that close the opening in the box body 9. The door 1a and the door 1b pivot about hinges 6 and can be opened and closed by pulling and pushing handles 7 provided at the bottom of the door 1a and the door 1b. When the door 1a and the door 1b are not specifically distinguished from each other, they will be referred to as the doors 1.

##### [0012]

Fig. 2 is an exploded view showing the configuration of the door 1 according to Embodiment 1 of the present invention. As shown in Fig. 2, the door 1 includes a glass surface member 17, a frame cap 18, an inner plate 2, and a magnetic gasket 8, which are aligned from the front side of the refrigerator 100. The handle 7 is provided at the bottom of the frame cap 18. Reinforcing members 4 are provided on the side surfaces of the inner plate 2. Note that the glass surface member 17 corresponds to an "outer plate" in the present invention.

[0013]

Fig. 3 is a schematic sectional view of the door 1 according to Embodiment 1 of the present invention. As shown in Fig. 3, a urethane foam 5 is enclosed by the glass surface member 17 at the front side, the inner plate 2 at the rear side, and the frame caps 18 at the right and left sides. An inner-plate projection 3a and an inner-plate projection 3b extending in the height direction of the refrigerator 100 and projecting toward the opening are provided at the right and left ends of the inner plate 2, on the inner sides of the magnetic gasket 8. The reinforcing member 4 described below is provided between the inner-plate projection 3a and the urethane foam 5. Similarly, the reinforcing member 4 is provided between the inner-plate projection 3b and the urethane foam 5. Note that, when the inner-plate projection 3a and the inner-plate projection 3b are not specifically distinguished from each other, they will be referred to as the inner-plate projections 3.

[0014]

At this time, a case is assumed where the gap between the glass surface member 17 and the inner plate 2 is a door thickness 11 (the thickness of the heat-insulating material), the rigidity of the door 1, which is obtained from the geometrical moment of inertia of the door, is proportional to the cube of the door thickness 11. The heat-insulating material is formed of the urethane foam 5 and a vacuum heat-insulating material 16 described below, and the thickness of the heat-insulating material ranges from, for example, 15 mm to 20 mm. The reason is because, when the heat-insulating performance of the urethane foam 5 is not expected, the heat-insulating performance of the door 1 can be ensured by setting the thickness of the

urethane foam 5 to 5 mm and setting the thickness of the vacuum heat-insulating material 16 to 10 mm to 15 mm.

[0015]

Note that the inner-plate projection 3a corresponds to a "left projection" in the present invention. Furthermore, the inner-plate projection 3b corresponds to a "right projection" in the present invention.

[0016]

Fig. 4 is an enlarged view of a part enclosed by a dashed line in Fig. 3. As shown in Fig. 4, the reinforcing member 4 is joined to the inner-plate projection 3b via a joining member 12. The reinforcing member 4 is embedded in the urethane foam 5 and reinforces the rigidity of the door 1. The reinforcing member 4 is formed of a flat metal plate having a large bending modulus of elasticity, and the thickness of the reinforcing member 4 is, for example, 1 mm to 2 mm. The joining member 12 is an adhesive. As long as the reinforcing member 4 can be fixed to the inner-plate projection 3b, the geometrical moment of inertia increases, thus improving the rigidity of the door 1. Hence, double-sided tape, a hot-melt adhesive, or other joining materials may also be used.

[0017]

Figs. 5 and 6 show examples in which the reinforcing member 4 according to Embodiment 1 of the present invention is fixed to the inner-plate projection 3b. As shown in Fig. 5, the reinforcing member 4 may be fixed by being fitted into hook-shaped portions 13 provided on the inner-plate projection 3b, without using the joining member 12. Furthermore, as shown in Fig. 6, the reinforcing member 4 may be fixed by being pushed into ribs 14 provided on the inner-plate projection 3b. By fixing the reinforcing member 4 to the inner-plate projection 3b using the hook-shaped portions 13 or the ribs 14 as described above, the geometrical moment of inertia increases, thus improving the rigidity of the door 1.

[0018]

Fig. 7 schematically shows an example of deformation of the door 1. As shown in Figs. 1 and 7, while the door 1 is being opened, the handle 7 provided at a

corner substantially diagonal to the hinge 6 is pulled in the direction indicated by an arrow. At this time, when the rigidity of the door 1 is low, or when the door 1 is not provided with the reinforcing member 4, the door 1 is deformed, and a gap 10 appears between the magnetic gasket 8 and the box body 9. As a result, an inconvenience, such as leakage of chilled air from the refrigerator 100, occurs.

[0019]

Fig. 8 is a graph showing an example calculation of the relationship between the door thickness 11 (thickness of the heat-insulating material) and the rigidity of the door 1. As shown in Fig. 8, in a case where the refrigerator 100 is not provided with the reinforcing members 4, the displacement of the door 1 when the thickness of the heat-insulating material is 20 mm is assumed to be 1. As the thickness of the heat-insulating material increases from 20 mm, the displacement of the door 1 decreases, whereas, as the thickness of the heat-insulating material decreases from 20 mm, the displacement of the door 1 increases. Consequently, when the refrigerator 100 is not provided with the reinforcing members 4, the rigidity of the door 1 is decreased by reducing the thickness of the heat-insulating material.

[0020]

From the description above, in the refrigerator 100, by providing the reinforcing members 4 on the inner-plate projections 3, the rigidity of the door 1 is increased, thereby eliminating or reducing warping of the door 1. Hence, an inconvenience, such as leakage of chilled air from the refrigerator 100, can be prevented.

[0021]

Note that, although the inner-plate projection 3b has been described in Embodiment 1, the present invention is not limited to the description. Because the inner-plate projection 3a has the same structure as the inner-plate projection 3b, the explanation for the inner-plate projection 3b also applies to the inner-plate projection 3a. The same applies to Embodiments 2 to 4 described below.

[0022]

Embodiment 2

The basic configuration of the refrigerator 100 according to Embodiment 2 is the same as that of the refrigerator 100 according to Embodiment 1. Hence, Embodiment 2 will be described below, focusing on the difference from Embodiment 1. Embodiment 2 differs from Embodiment 1 in that the rigidity of the door 1 is increased not by providing the reinforcing members 4, but by increasing the height of the inner-plate projections 3.

[0023]

Fig. 9 is an exploded view showing the configuration of the door 1 according to Embodiment 2 of the present invention. As shown in Fig. 9, the door 1 includes the glass surface member 17, the frame cap 18, the inner plate 2, and the magnetic gasket 8, which are aligned from the front side of the refrigerator 100. The handle 7 is provided at the bottom of the frame cap 18.

[0024]

Fig. 10 is an enlarged sectional view of one end of the door 1. As shown in Fig. 10, an inner-plate-projection height 15, which is the height of the inner-plate projection 3b, is at least three times the heat-insulating-material thickness 11. As has been described above, from the geometrical moment of inertia of the door, the rigidity of the door 1 is proportional to the cube of the door thickness 11. When the door thickness 11 is reduced in order to increase the internal volume of the refrigerator 100, the rigidity of the door 1 decreases (see Fig. 8). Hence, by making the inner-plate-projection height 15, which is the height of the inner-plate projection 3b, at least three times the heat-insulating-material thickness 11, instead of increasing the door thickness 11, the geometrical moment of inertia of the door 1 is increased, thus improving the rigidity of the door 1. Note that, to maintain the storage capacity of the storage pocket attached to the door 1, the upper limit of the inner-plate-projection height 15, which is the height of the inner-plate projection 3b, is set to four times the heat-insulating-material thickness 11.

[0025]

Fig. 11 is a graph showing an example calculation of the relationship between the inner-plate-projection height 15 according to Embodiment 2 of the present

invention and the rigidity of the door 1. The thickness of the heat-insulating material is assumed to be 20 mm, the thickness of the heat-insulating material multiplied by 3, namely, 60 mm, is used as the reference of the inner-plate-projection height 15, and the displacement of the door 1 when the inner-plate-projection height 15 is 60 mm is assumed to be 1. As the inner-plate-projection height 15 increases from 60 mm, the displacement of the door 1 decreases, whereas, as the inner-plate-projection height 15 decreases from 60 mm, the displacement of the door 1 increases. Consequently, the rigidity of the door 1 is decreased by making the inner-plate-projection height 15 less than 60 mm.

[0026]

From the description above, by making the inner-plate-projection height 15, which is the height of the inner-plate projection 3, at least three times the door thickness 11, the rigidity of the door 1 is increased, thereby eliminating or reducing warping of the door 1. Hence, an inconvenience, such as leakage of chilled air from the refrigerator 100, can be prevented.

[0027]

#### Embodiment 3

The basic configuration of the refrigerator 100 according to Embodiment 3 is the same as that of the refrigerator 100 according to Embodiment 1. Hence, Embodiment 3 will be described below, focusing on the difference from Embodiment 1. Embodiment 3 differs from Embodiment 1 in that the heat-insulating material is formed of the urethane foam 5 and the vacuum heat-insulating material 16.

[0028]

Fig. 12 is an exploded view showing the configuration of the door 1 according to Embodiment 3 of the present invention. As shown in Fig. 12, the door 1 includes the glass surface member 17, the frame cap 18, the vacuum heat-insulating material 16, the inner plate 2, and the magnetic gasket 8, which are aligned from the front side of the refrigerator 100. The handle 7 is provided at the bottom of the frame cap 18. The reinforcing members 4 are provided on the side surfaces of the inner plate 2.

[0029]

Fig. 13 is an enlarged sectional view of one end of the door 1. As shown in Fig. 13, the urethane foam 5 and the vacuum heat-insulating material 16 are provided between the inner plate 2 and the glass surface member 17. The vacuum heat-insulating material 16 has approximately ten times higher heat-insulating property than the urethane foam 5. In other words, when the heat-insulating performance of the door 1 is to be maintained by using the vacuum heat-insulating material 16 as the heat-insulating material, the heat-insulating-material thickness 11 can be reduced to approximately one tenth, compared with a case where solely the urethane foam 5 is used as the heat-insulating material. Note that, to ensure the heat-insulating performance, the coverage of the door 1 with the vacuum heat-insulating material 16 needs to be 65% or more. The urethane foam 5, or a set of the urethane foam 5 and the vacuum heat-insulating material 16 corresponds to the "heat-insulating material" in the present invention.

[0030]

As has been described above, because the high heat-insulating performance of the vacuum heat-insulating material 16 enables reduction in the door thickness 11, decreasing the rigidity of the door 1, the door 1 needs to be reinforced. Hence, similarly to Embodiment 1, the reinforcing member 4 is provided on the inner-plate projection 3b of the door 1 to improve the rigidity of the door 1.

[0031]

From the description above, even when the vacuum heat-insulating material 16 is used as the heat-insulating material in addition to the urethane foam 5, by providing the reinforcing members 4 on the inner-plate projections 3 of the refrigerator 100, the rigidity of the door 1 is increased, thereby eliminating or reducing warping of the door 1. Hence, an inconvenience, such as leakage of chilled air from the refrigerator 100, can be prevented.

[0032]

Embodiment 4

The basic configuration of the refrigerator 100 according to Embodiment 4 is the same as that of the refrigerator 100 according to Embodiment 2. Hence,

Embodiment 4 will be described below, focusing on the difference from Embodiment 2. Embodiment 4 differs from Embodiment 2 in that the heat-insulating material is formed of the urethane foam 5 and the vacuum heat-insulating material 16.

[0033]

Fig. 14 is an exploded view showing the configuration of the door 1 according to Embodiment 4 of the present invention. As shown in Fig. 14, the door 1 includes the glass surface member 17, the frame cap 18, the vacuum heat-insulating material 16, the inner plate 2, and the magnetic gasket 8, which are aligned from the front side of the refrigerator 100. The handle 7 is provided at the bottom of the frame cap 18.

[0034]

Fig. 15 is an enlarged sectional view of one end of the door 1. As shown in Fig. 15, the urethane foam 5 and the vacuum heat-insulating material 16 are provided between the inner plate 2 and the glass surface member 17. The vacuum heat-insulating material 16 has approximately ten times higher heat-insulating property than the urethane foam 5. In other words, when the heat-insulating performance of the door 1 is to be maintained by using the vacuum heat-insulating material 16 as the heat-insulating material, the heat-insulating-material thickness 11 can be reduced to approximately one tenth, compared with a case where solely the urethane foam 5 is used as the heat-insulating material.

[0035]

Consequently, because the rigidity of the door 1 decreases, the door 1 needs to be reinforced. Hence, similarly to Embodiment 2, the rigidity of the door 1 is increased by making the inner-plate-projection height 15 of the inner-plate projection 3b at least three times the door thickness 11.

[0036]

From the description above, even when the vacuum heat-insulating material 16 is used as the heat-insulating material in addition to the urethane foam 5, by making the inner-plate-projection height 15, which is the height of the inner-plate projection 3b, at least three times the heat-insulating-material thickness 11, the rigidity of the door 1 is increased, thereby eliminating or reducing warping of the door 1. Hence,

an inconvenience, such as leakage of chilled air from the refrigerator 100, can be prevented.

[0037]

Although the present invention has been described above in the form of  
5 separate Embodiments 1 to 4, these Embodiments 1 to 4 may be directly combined to achieve the present invention.

#### Reference Signs List

[0038]

1 door, 1a door, 1b door, 2 inner plate, 3 inner-plate projection, 3a inner-plate  
10 projection, 3b inner-plate projection, 4 reinforcing member, 5 urethane foam, 6 hinge, 7 handle, 8 magnetic gasket, 9 box body, 10 gap, 11 door thickness, 12 joining member, 13 hook-shaped portion, 14 rib, 15 inner-plate-projection height, 16 vacuum heat-insulating material, 17 glass surface member, 18 frame cap, 100 refrigerator

## CLAIMS

### [Claim 1]

A refrigerator comprising:

a box body having an opening at a front side of the box body; and

5 a door configured to open and close the opening at the front side of the box body,

the door including

an outer plate constituted of a glass surface member,

an inner plate disposed to face the outer plate,

10 a heat-insulating material disposed between the outer plate and the inner plate, the heat-insulating material being constituted of a urethane foam and a vacuum heat-insulating material;

a magnetic gasket attached to an outer edge of the inner plate on a side of the opening,

15 a left projection provided on an inner side of the magnetic gasket, the left projection extending in a height direction and projecting toward the opening from a left portion of the inner plate, and

a right projection provided on the inner side of the magnetic gasket, the right projection extending in the height direction and projecting toward the opening from

20 a right portion of the inner plate,

a height of the left projection and the right projection being at least three times a thickness of the heat-insulating material and less than or equal to four times the thickness of the heat-insulating material.

### [Claim 2]

25 The refrigerator of claim 1, wherein in the left projection and the right projection, a reinforcing member is provided to extend in the height direction.

### [Claim 3]

The refrigerator of claim 2, wherein the reinforcing member is formed of a flat metal plate.

[Claim 4]

The refrigerator of any one of claims 1 to 3, wherein a thickness of the heat-insulating material is 15 mm to 20 mm.

[Claim 5]

- 5        The refrigerator of any one of claims 1 to 4, wherein the heat-insulating material comprises the vacuum heat-insulating material having a coverage of 65% or more.