

DESCRIPTION

Title of Invention

REFRIGERATOR

Technical Field

5 [0001]

The present invention relates to refrigerators and particularly to a structure of a door included in a refrigerator.

Background Art

[0002]

10 Hitherto methods of increasing the internal volume of a refrigerator without increasing the installation size of the refrigerator include a method in which the thickness of a heat-insulating material forming part of a housing of the refrigerator is reduced. However, the strength of each door depends on the thickness of the heat-insulating material provided in the door. If the thickness of the heat-insulating
15 material provided in the door is reduced, the strength of the door is reduced.

Therefore, in a refrigerator having a door including a heat-insulating material having a reduced thickness, the door may be gradually deformed as a result of repeated opening and closing of the door. If the door of the refrigerator is deformed, a gap is produced between a packing of the door and the body of the refrigerator. In such an
20 event, cooling air in a compartment leaks to the outside, or heat on the outside of the compartment is taken into the compartment. Consequently, the heat-insulating performance of the refrigerator cannot be maintained. Accordingly, a refrigerator has been proposed in which a door thereof includes an outer plate and an inner plate that are arranged at an interval in which heat-insulating foam is provided, and a
25 reinforcing plate made of metal is embedded in the heat-insulating foam (see Patent Literature 1, for example).

Citation List

Patent Literature

[0003]

30 Patent Literature 1: Japanese Unexamined Patent Application Publication No.

9-170870

Summary of Invention

Technical Problem

[0004]

5 The known refrigerator employs a configuration in which leg portions of the metal reinforcing plate and flange portions of the outer plate are in contact with each other. However, since the area of contact between the reinforcing plate and the outer plate is small, the reinforcing plate cannot satisfactorily exert its effect of reinforcement for preventing the deformation of the door. To provide a required strength to the door of the refrigerator, the thickness of the metal reinforcing plate provided in the door of the refrigerator may be changed. However, if the thickness of the metal reinforcing plate is increased, the weight of the door of the refrigerator increases, leading to deformation or buckling of a hinge provided on the body of the refrigerator. Moreover, the increased weight of the door of the refrigerator increases the load carried by a worker who assembles the door in a manufacturing process.

[0005]

 The present invention is to solve the above problems and provides a refrigerator including a door having a satisfactory strength with no increase in the thickness of a reinforcing plate provided in the door, even if the thickness of a heat-insulating structure of the refrigerant is reduced.

Solution to Problem

[0006]

 A refrigerator according to an embodiment of the present invention includes a heat-insulating box body having an open part, and a box-shaped door provided in such a manner as to open and close the open part of the heat-insulating box body. The door includes an outer wall forming an outer peripheral wall of the door, an inner wall provided opposite to the outer wall and forming a wall on a side facing the open part, and a reinforcing plate provided between the outer wall and the inner wall and fixed to the inner wall. The inner wall includes a projecting portion projecting from each of left and right ends of the inner wall toward the open part of the heat-insulating

box body; and a flat-plate portion having a flat plate shape and connecting the projecting portions provided at the left and right ends of the inner wall to each other. The reinforcing plate includes a flat portion having a flat plate shape with one surface facing the outer wall and an other surface facing the flat-plate portion; first side-plate portions folded upright from each of left and right ends of the flat portion and extending into its associated one of the projecting portions; and second side-plate portions extending upright from ends of the first side-plate portions and each positioned inside corresponding one of the projecting portions, the ends being opposite to the flat portion.

Advantageous Effects of Invention [0007]

According to the embodiment of the present invention, the inner wall of the door includes the projecting portions. Furthermore, the reinforcing plate includes the first side-plate portions folded upright from each of the left and right ends of the flat portion and extending into its associated one of the projecting portions; and the second side-plate portions extending upright from the ends of the first side-plate portions and each positioned inside corresponding one of the projecting portions, the ends being opposite to the flat portion. In the refrigerator, since the reinforcing plate includes the first side-plate portions and the second side-plate portions that are preferably positioned in its associated one of the projecting portions, the reinforcing plate has a shape folded at a plurality of positions in the depth direction of the door. Such a folded shape increases the strength of the door. Thus, the refrigerator including the door whose strength is not reduced even if the thickness of the heat-insulating material provided therein is reduced can be obtained.

Brief Description of Drawings [0008]

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

[Fig. 2] Fig. 2 is an exploded view of a refrigerator-compartment door included in the refrigerator according to Embodiment 1 of the present invention.

[Fig. 3] Fig. 3 is a sectional view of the refrigerator-compartment door illustrated in Fig. 1, taken along line A-A.

[Fig. 4] Fig. 4 is a front view of a reinforcing plate included in the refrigerator-compartment door of the refrigerator according to Embodiment 1 of the present invention.

[Fig. 5] Fig. 5 is a sectional view of the reinforcing plate illustrated in Fig. 4, taken along line C-C.

[Fig. 6] Fig. 6 is a schematic enlarged view illustrating part B of the refrigerator-compartment door illustrated in Fig. 3.

[Fig. 7] Fig. 7 is a diagram illustrating a direction of a force applied to the refrigerator-compartment door of the refrigerator when the door is opened.

[Fig. 8] Fig. 8 includes diagrams for comparing the direction of a force with which the reinforcing plate is fixed.

[Fig. 9] Fig. 9 is a sectional view illustrating part of a refrigerator-compartment door of a refrigerator according to Embodiment 2 of the present invention.

[Fig. 10] Fig. 10 is a sectional view illustrating part of a refrigerator-compartment door of a refrigerator according to Embodiment 3 of the present invention.

[Fig. 11] Fig. 11 is a sectional view illustrating part of a refrigerator-compartment door of a refrigerator according to Embodiment 4 of the present invention.

Description of Embodiments

[0009]

Embodiment 1

Fig. 1 is a perspective view of a refrigerator according to Embodiment 1 of the present invention. Referring to Fig. 1, the X axis represents the width direction of a refrigerator 1, the Y axis represents the depth direction of the refrigerator 1, and the Z axis represents the vertical direction of the refrigerator 1. More specifically, the refrigerator 1 will be described defining the X1 side and the X2 side of the X axis as the left side and the right side, respectively; the Y1 side and the Y2 side of the Y axis

as the front side and the rear side, respectively; and the Z1 side and the Z2 side of the Z axis as the upper side and the lower side, respectively. Relative positions (such as vertical positions) of elements described herein are defined on the basis of a state of the refrigerator 1 that is installed for use. In the following description, the width direction (the X-axis direction), the depth direction (the Y-axis direction), and the vertical direction (the Z-axis direction) of the refrigerator 1 correspond to the respective directions of a refrigerator-compartment door 9.

[0010]

The refrigerator 1 illustrated in Fig. 1 is a refrigerator employing an indirect refrigeration method and includes a heat-insulating box body 2 having open parts and including an outer box made of steel plate and an inner box made of resin. The heat-insulating box body 2 includes a heat-insulating material that is foamed between the outer box and the inner box. A storage space in the heat-insulating box body 2 is sectioned into a plurality of compartments. Specifically, as illustrated in Fig. 1, the following five compartments are provided: a refrigerator compartment 3, an ice-making compartment 4, a versatile compartment 5, a freezer compartment 6, and a vegetable compartment 7. The refrigerator compartment 3, the ice-making compartment 4, the versatile compartment 5, the freezer compartment 6, and the vegetable compartment 7 are separated from one another by partition members and are thermally insulated from one another. The positions of the compartments are arbitrary. For example, the vegetable compartment 7 may be provided at the position of the freezer compartment 6, and the freezer compartment 6 may be provided at the position of the vegetable compartment 7. The type and the number of compartments included in the refrigerator 1 are not limited to those described herein. The refrigerator 1 only needs to include one or more compartments.

[0011]

The ranges of temperature in the compartments are set to values that vary with the kinds of food to be stored therein and the usages thereof. The refrigerator compartment 3 is set to be at a refrigeration temperature range (for example, about 3 to 5 degrees C) and serves as storage for things to be refrigerated, such as food.

The ice-making compartment 4 is provided thereinside with an ice-making machine and serves as storage for ice made by the ice-making machine. The versatile compartment 5 is a storage whose temperature range is changeable in accordance with the usage thereof. The freezer compartment 6 is set to be at a freezing temperature range of below 0 degrees C (for example, -18 degrees C or below) and serves as storage for freezing and storing things thereinside. The vegetable compartment 7 is set to be at another refrigeration temperature range (for example, about 3 to 7 degrees C) that is higher than that of the refrigerator compartment 3, and serves as storage especially suitable for refrigerating vegetables.

[0012]

The refrigerator 1 includes box-shaped doors provided in such a manner as to open and close the open parts of the heat-insulating box body 2. Specifically, the refrigerator compartment 3, the ice-making compartment 4, the versatile compartment 5, the freezer compartment 6, and the vegetable compartment 7 are provided with a refrigerator-compartment door 8 and a refrigerator-compartment door 9, an ice-making-compartment door 10, a versatile-compartment door 11, a freezer-compartment door 12, and a vegetable-compartment door 13, respectively, with which the open parts of the respective compartments are opened or closed. When any of these doors is opened or closed, a corresponding one of the refrigerator compartment 3, the ice-making compartment 4, the versatile compartment 5, the freezer compartment 6, and the vegetable compartment 7 becomes open to the outside or is isolated from the outside. The refrigerator-compartment door 8 and the refrigerator-compartment door 9 together form a hinged double rotational door. The ice-making-compartment door 10, the versatile-compartment door 11, the freezer-compartment door 12, and the vegetable-compartment door 13 are each a drawer-type door. The refrigerator compartment 3 may be provided with a single-part rotational door, instead of a hinged double door.

[0013]

The refrigerator-compartment door 8 and the refrigerator-compartment door 9 will be described in further detail. The heat-insulating box body 2 is provided with a

hinge 14 by which the refrigerator-compartment door 8 is pivotally supported so that it can open and close. The hinge 14 connects the heat-insulating box body 2 and the refrigerator-compartment door 8 to each other. The heat-insulating box body 2 is further provided with a hinge 15 by which the refrigerator-compartment door 9 is

5 pivotally supported so that it can open and close. The hinge 15 connects the heat-insulating box body 2 and the refrigerator-compartment door 9 to each other. The refrigerator-compartment door 8 and the refrigerator-compartment door 9 can be opened or closed by pulling or pushing a handle 16 provided in each of lower parts of the refrigerator-compartment door 8 and the refrigerator-compartment door 9.

10 [0014]

Fig. 2 is an exploded view of the refrigerator-compartment door included in the refrigerator according to Embodiment 1 of the present invention. Fig. 3 is a sectional view of the refrigerator-compartment door illustrated in Fig. 1, taken along line A-A. Referring to Figs. 2 and 3, a configuration of the refrigerator-compartment door 9

15 included in the door of the refrigerator compartment 3 will now be described. The refrigerator-compartment door 8 basically has the same configuration as the refrigerator-compartment door 9, and description of the refrigerator-compartment door 9 also applies to the refrigerator-compartment door 8. Therefore, description of the refrigerator-compartment door 8 is omitted. The refrigerator-compartment door 9 is

20 a box-shaped door and includes an outer wall 18 forming an outer peripheral wall of the refrigerator-compartment door 9, and an inner wall 19 provided opposite to the outer wall 18 and forming a wall on a side facing the open part of the heat-insulating box body 2. The refrigerator-compartment door 9 further includes a reinforcing plate 20 provided between the outer wall 18 and the inner wall 19 and fixed to the inner

25 wall 19.

[0015]

The outer wall 18 includes an outer frame 18b and a toughened glass plate 18a. The outer frame 18b is a resin frame and has a rectangular shape when seen from the front side of the refrigerator-compartment door 9. The outer frame 18b has a

30 certain thickness in the front-rear direction (the Y-axis direction) of the refrigerator-

compartment door 9, thereby forming upper, lower, left, and right walls of the refrigerator-compartment door 9. The toughened glass plate 18a has a flat plate shape and is obtained through treatment, such as thermal toughening or chemical toughening, performed for higher strength against scars and impacts. The

5 toughened glass plate 18a may be laminated in terms of design. The toughened glass plate 18a is pasted and fixed to the outer frame 18b by using, for example, double-sided adhesive tape. The outer wall 18 only needs to form the outer peripheral wall of the refrigerator-compartment door 9 and does not necessarily need to include the outer frame 18b and the toughened glass plate 18a described above.

10 For example, the outer wall 18 may be configured as follows. The left and right edges of the toughened glass plate 18a may be bent to form left and right glass side walls of the refrigerator-compartment door, while the upper and lower edges of the toughened glass plate 18a may be provided with resin members forming upper and lower frames. As another alternative, the outer wall 18 may be formed of a steel plate having bent edges on the left and right sides and provided with a resin frame fitted between the edges from the upper or lower side of the steel plate.

15 [0016]

The inner wall 19 is a resin plate. The inner wall 19 includes projecting portions 19a and a flat-plate portion 19b. The projecting portions 19a project from each of the left and right ends of the inner wall 19 toward the open part of the heat-insulating box body 2 and extend from end to end in the vertical direction of the refrigerator-compartment door 9. The flat-plate portion 19b has a flat plate shape and connects the projecting portions 19a provided at the left and right ends of the inner wall 19 to each other. The projecting portion 19a at each of the left and right ends of the inner wall 19 includes a first side-wall part 19a1 folded upright from the corresponding one of left and right ends of the flat-plate portion 19b and extending toward the open part of the heat-insulating box body 2. The first side-wall parts 19a1 at the left and right ends of the flat-plate portion 19b face each other. The projecting portion 19a at the left and right ends of the inner wall 19 each further include a second side-wall part 19a2 folded upright from an end of the corresponding one of the

first side-wall parts 19a1, the end being opposite to the flat-plate portion 19b. The second side-wall parts 19a2 face the outer wall 18. The projecting portion 19a at each of the left and right ends of the inner wall 19 further includes a third side-wall part 19a3 folded upright from an end of corresponding one of the second side-wall parts 19a2, the end being opposite to the associated one of the first side-wall parts 19a1. Each of the third side-wall parts 19a3 extends toward the outer wall 18 and faces the associated one of the first side-wall parts 19a1. Each of peripheral edges 19c of the inner wall 19 is in contact with a peripheral edge 18c of the outer wall 18. The inner wall 19 and the outer wall 18 define a space 21 therebetween. The space 21 is filled with heat-insulating foam such as urethane foam.

[0017]

Fig. 4 is a front view of the reinforcing plate included in the refrigerator-compartment door of the refrigerator according to Embodiment 1 of the present invention. Fig. 5 is a sectional view of the reinforcing plate illustrated in Fig. 4, taken along line C-C. Referring to Figs. 3 to 5, the reinforcing plate 20 will now be described. The reinforcing plate 20 is a metal plate having a plurality of bends and is fixed to the inner wall 19 by using, for example, double-sided adhesive tape so that the refrigerator-compartment door 9 becomes less likely to be distorted. As illustrated in Fig. 3, the reinforcing plate 20 includes a flat portion 20a having a flat plate shape with one surface facing the outer wall 18 and the other surface facing the flat-plate portion 19b. As illustrated in Fig. 3, the flat portion 20a of the reinforcing plate 20 is in contact with the flat-plate portion 19b of the inner wall 19. As illustrated in Fig. 5, the reinforcing plate 20 further includes a first side-plate portion 20b folded upright from each of the left and right ends of the flat portion 20a and extending into its associated one of the projecting portions 19a. Each of the first side-plate portions 20b extends along associated one of the first side-wall parts 19a1 of the projecting portions 19a toward the associated one of the second side-wall parts 19a2. The first side-plate portions 20b extend from end to end in the vertical direction of the refrigerator-compartment door 9. The reinforcing plate 20 further includes second side-plate portions 20c each extending upright from corresponding one of ends of the

first side-plate portions 20b, the ends being opposite to the flat portion 20a. The second side-plate portions 20c are each positioned inside corresponding one of the projecting portions 19a. At least part of each of the second side-plate portions 20c faces its associated one of the second side-wall parts 19a2. Each of the second side-plate portions 20c connected to the corresponding one of the first side-plate portions 20b extends in a direction away from the other of the second side-plate portions 20c. Each of the second side-plate portions 20c extends from end to end in the vertical direction of the refrigerator-compartment door 9. As illustrated in Figs. 4 and 5, the second side-plate portions 20c each have a flat plate shape. The refrigerator-compartment door 9 is configured such that each of the second side-plate portions 20c of the reinforcing plate 20 is spaced apart from corresponding one of the second side-wall parts 19a2 of the projecting portions 19a.

[0018]

As illustrated in Fig. 4, the second side-plate portions 20c each have a plurality of holes 25 extending through the reinforcing plate 20. The holes 25 are arranged in a line in the vertical direction of the refrigerator-compartment door 9. The holes 25 illustrated in Fig. 4 are each an oblong hole whose major axis extends in the vertical direction of the refrigerator-compartment door 9. The holes 25 each only need to be a through hole and may be in any other shape such as a circular shape, an oblong shape whose minor axis extends in the vertical direction of the refrigerator-compartment door 9, a rectangular shape, or an oblong rectangular shape. The holes 25 of each of the second side-plate portions 20c illustrated in Fig. 4 are arranged in a single line from end to end in the vertical direction of the refrigerator-compartment door 9. The holes 25 do not necessarily need to be arranged in a single line from end to end in the vertical direction of the refrigerator-compartment door 9 and may be arranged in a plurality of lines each extending from end to end in the vertical direction of the refrigerator-compartment door 9.

[0019]

Fig. 6 is a schematic enlarged view illustrating part B of the refrigerator-compartment door illustrated in Fig. 3. The refrigerator-compartment door 9 is

formed by pouring a heat-insulating material into the box-shaped outer wall 18, placing the inner wall 19 with the reinforcing plate 20 fixed thereto over the outer wall 18 filled with the heat-insulating material, and pressing the outer wall 18 and the inner wall 19 against each other for integration. In this process, the heat-insulating material in the outer wall 18 flows through the holes 25 into the inner wall 19. Then, as represented by arrow F passing through the hole 25, the heat-insulating material spreads over the entirety of a space 21a provided in each of the projecting portions 19a and over the entirety of a space 21b provided between each of the first side-wall parts 19a1 of the inner wall 19 and a corresponding one of the first side-plate portions 20b of the reinforcing plate 20. The space 21a is defined by the first side-wall part 19a1, the second side-wall part 19a2, and the third side-wall part 19a3.

[0020]

Fig. 7 is a diagram illustrating a direction of a force applied to the refrigerator-compartment door of the refrigerator when the door is opened. Now, a force applied to the refrigerator-compartment door 9 when a user opens the refrigerator-compartment door 9 will be described. The user can open the refrigerator-compartment door 9 by pulling the handle 16 provided in the lower part of the refrigerator-compartment door 9. In this process, the refrigerator-compartment door 9 rotates on a rotational axis defined by the hinge 15 of the heat-insulating box body 2 that is fitted in a shaft hole 24 provided in the refrigerator-compartment door 9. The handle 16 receives a pull P with which the user pulls the refrigerator-compartment door 9. That is, the force of opening the refrigerator-compartment door 9 is greatest at the handle 16. Considering the position of the handle 16 provided in the lower part of the refrigerator-compartment door 9, the pull P applied to the refrigerator-compartment door 9 that starts to be opened by a human hand includes a force acting in a direction from the handle 16 obliquely upward relative to the rotational axis of the refrigerator-compartment door 9. Referring to Fig. 6 again, to bear the pull P, the reinforcing plate 20 includes the first side-plate portions 20b folded upright from the left and right ends of the flat portion 20a, and the second side-plate portions 20c extending upright from the ends of the first side-plate portions 20b. Since the

reinforcing plate 20 includes the first side-plate portions 20b and the second side-plate portions 20c that are preferably positioned in its associated one of the projecting portions 19a, the reinforcing plate 20 has a shape folded at a plurality of positions in the depth direction of the refrigerator-compartment door 9. Such a folded shape increases the strength of the refrigerator-compartment door 9. Furthermore, the reinforcing plate 20 including the first side-plate portions 20b and the second side-plate portions 20c has an increased moment of inertia of area relative to the pull P applied to the refrigerator-compartment door 9. Accordingly, the flexural rigidity of the refrigerator-compartment door 9 is increased. Thus, the strength of the refrigerator-compartment door 9 can be increased.

[0021]

Fig. 8 includes diagrams for comparing the direction of a force with which the reinforcing plate is fixed. The left diagram in Fig. 8 illustrates a configuration in which each second side-plate portion 20c of the reinforcing plate 20 has no holes 25. The right diagram in Fig. 8 illustrates a configuration in which each second side-plate portion 20c of the reinforcing plate 20 has the holes 25. The left and right diagrams in Fig. 8 are provided for comparison of the direction of the force with which the reinforcing plate 20 is fixed, on the basis of the presence/absence of the holes 25 in the second side-plate portion 20c of the reinforcing plate 20. The space 21, the space 21a, and the space 21b illustrated in Fig. 8 are filled with the heat-insulating material. Arrows illustrated in Fig. 8 represent a pressure applied from the heat-insulating material, and the pressure corresponds to the force of fixing the reinforcing plate. As illustrated in the left diagram in Fig. 8, in the configuration with no holes 25 in the second side-plate portion 20c, the reinforcing plate 20 is fixed while being held by a force P1 (including a pressure and a frictional force) applied to the surfaces of the reinforcing plate 20. In contrast, as illustrated in the right diagram in Fig. 8, in the configuration with the holes 25 in the second side-plate portion 20c, the reinforcing plate 20 is fixed while being held by the force P1 (including a pressure and a frictional force) applied to the surfaces of the reinforcing plate 20 and by a force P2 (including a pressure and a frictional force) applied to the edge of each of the holes 25. That is,

in the configuration with the holes 25 in the second side-plate portions 20c, the force P2 (including a pressure and a frictional force) acting on the edges of the holes 25 is added, whereby the force of fixing the reinforcing plate 20 can be increased.

[0022]

5 To summarize, since the reinforcing plate 20 of the refrigerator 1 includes the first side-plate portions 20b and the second side-plate portions 20c that are preferably positioned in its associated one of the projecting portions 19a, the reinforcing plate 20 has a shape folded at a plurality of positions in the depth direction of the refrigerator-compartment door 9, and such a folded shape increases the strength of the
10 refrigerator-compartment door 9. Furthermore, the reinforcing plate 20 of the refrigerator 1 including the first side-plate portions 20b and the second side-plate portions 20c has an increased moment of inertia of area relative to the pull P applied to the refrigerator-compartment door 9. Accordingly, the flexural rigidity of the refrigerator-compartment door 9 is increased, whereby the strength of the refrigerator-compartment door 9 can be increased. Thus, the refrigerator 1 including the
15 refrigerator-compartment door 9 whose strength is not reduced even if the thickness of the heat-insulating material provided therein is reduced can be obtained.

[0023]

20 Furthermore, in the refrigerator 1, since the second side-plate portions 20c each have the holes 25, the reinforcing plate 20 is fixed while being held by the force P1 (including a pressure and a frictional force) applied to the surfaces of the reinforcing plate 20 and by the force P2 (including a pressure and a frictional force) applied to the edges of the holes 25. That is, the refrigerator-compartment door 9 additionally receives the force P2 (including a pressure and a frictional force) applied
25 to the edges of the holes 25. Thus, the force of fixing the reinforcing plate 20 can be increased. Consequently, the peel strength between the heat-insulating material and the reinforcing plate of the refrigerator-compartment door 9 increases, which increases the strength of the refrigerator-compartment door 9 as an assembled component. Therefore, the refrigerator-compartment door 9 can be made less likely
30 to be distorted, and the refrigerator 1 including the refrigerator-compartment door 9

whose strength is not reduced even if the thickness of the heat-insulating material provided therein is reduced can be obtained.

[0024]

Furthermore, in the refrigerator 1, since the holes 25 of the second side-plate portions 20c provide paths for spreading the heat-insulating material, a required amount of heat-insulating material can be made to spread over the entirety of the space 21a and the space 21b provided between the reinforcing plate 20 and the inner wall 19. Since the heat-insulating material can be made to spread over the entirety of the spaces provided in the refrigerator-compartment door 9 having a box shape, high heat-insulating performance of the refrigerator 1 can be maintained. In addition, the refrigerator-compartment door 9 can be made less likely to be distorted, and a satisfactory strength of the refrigerator-compartment door 9 can be maintained even if the thickness of the heat-insulating material provided therein is reduced.

[0025]

Furthermore, the refrigerator-compartment door 9 of the refrigerator 1 is configured such that each of the second side-plate portions of the reinforcing plate is spaced apart from the corresponding one of the second side-wall parts of the projecting portions. Hence, there is no need to increase the length of the first side-plate portions 20b. Consequently, the weight of the refrigerator-compartment door 9 can be reduced, and the material cost of the reinforcing plate 20 can be reduced.

[0026]

Embodiment 2

Fig. 9 is a sectional view illustrating part of a refrigerator-compartment door of a refrigerator according to Embodiment 2 of the present invention. Elements that are the same as those included in the refrigerator 1 illustrated in Figs. 1 to 8 are denoted by corresponding ones of the reference numerals, and description thereof is omitted. The refrigerator according to Embodiment 2 of the present invention differs from the refrigerator 1 according to Embodiment 1 only in the configuration of the reinforcing plate.

[0027]

A reinforcing plate 120 of the refrigerator according to Embodiment 2 of the present invention is a metal plate having a plurality of bends and is fixed to the inner wall 19 by using, for example, double-sided adhesive tape so that the refrigerator-compartment door 9 becomes less likely to be distorted. The reinforcing plate 120 includes a flat portion 20a having a flat plate shape with one surface facing the outer wall 18 and the other surface facing the flat-plate portion 19b. The flat portion 20a of the reinforcing plate 120 is in contact with the flat-plate portion 19b of the inner wall 19. The reinforcing plate 120 further includes a first side-plate portion 20b folded upright from each of the left and right ends of the flat portion 20a and extending into its associated one of the projecting portions 19a. Each of the first side-plate portions 20b extends along the associated one of the first side-wall parts 19a1 of the projecting portions 19a toward the associated one of the second side-wall parts 19a2. The first side-plate portions 20b extend from end to end in the vertical direction of the refrigerator-compartment door 9. The reinforcing plate 120 further includes second side-plate portions 20c each extending upright from corresponding one of ends of the first side-plate portions 20b, the ends being opposite to the flat portion 20a. The second side-plate portions 20c are each positioned inside corresponding one of the projecting portions 19a. At least part of each of the second side-plate portions 20c faces its associated one of the second side-wall parts 19a2. Each of the second side-plate portions 20c connected to the first side-plate portion 20b extends in a direction away from the other of the second side-plate portions 20c. The second side-plate portions 20c extend from end to end in the vertical direction of the refrigerator-compartment door 9. The second side-plate portions 20c each have a flat plate shape. The refrigerator-compartment door 9 is configured such that each of the second side-plate portions 20c of the reinforcing plate 120 is spaced apart from the corresponding one of the second side-wall parts 19a2 of the projecting portions 19a. Each of the second side-plate portions 20c has a plurality of holes extending through the reinforcing plate 120.

[0028]

As illustrated in Fig. 9, the reinforcing plate 120 further includes a frontward

edge portion 20d folded upright from each of ends of the second side-plate portions 20c, the end being opposite to associated one of the first side-plate portions 20b. Each of the frontward edge portions 20d extends toward the outer wall 18 while facing corresponding one of the first side-plate portions 20b. Each of the frontward edge portions 20d are connected to the associated one of the second side-plate portions 20c and extend from end to end in the vertical direction of the refrigerator-compartment door 9.

[0029]

To summarize, the reinforcing plate 120 of the refrigerator 1 according to Embodiment 2 of the present invention includes the first side-plate portions 20b folded upright from the left and right ends of the flat portion 20a, the second side-plate portions 20c folded upright from the ends of associated one of the first side-plate portions 20b, and the frontward edge portions 20d folded upright from the ends of associated one of the second side-plate portions 20c. Since the reinforcing plate 120 of the refrigerator 1 additionally includes the frontward edge portions 20d, the reinforcing plate 120 has a shape that is folded at more positions. Such a folded shape increases the strength of the refrigerator-compartment door 9 and also increases the moment of inertia of area relative to the pull P applied to the refrigerator-compartment door 9. Accordingly, the flexural rigidity of the refrigerator-compartment door 9 is further increased. Thus, the strength of the refrigerator-compartment door 9 can be increased.

[0030]

Furthermore, since the reinforcing plate 120 of the refrigerator 1 according to Embodiment 2 additionally includes the frontward edge portions 20d, the force of fixing the position of the reinforcing plate 120 by using the heat-insulating material is further increased. Consequently, the peel strength between the heat-insulating material and the reinforcing plate of the refrigerator-compartment door 9 increases, which increases the strength of the refrigerator-compartment door 9 as an assembled component. Therefore, the refrigerator-compartment door 9 can be made less likely to be distorted, and the refrigerator 1 including the refrigerator-compartment door 9

whose strength is not reduced even if the thickness of the heat-insulating material provided therein is reduced can be obtained.

[0031]

Embodiment 3

Fig. 10 is a sectional view illustrating part of a refrigerator-compartment door of a refrigerator according to Embodiment 3 of the present invention. Elements that are the same as those included in the refrigerator 1 illustrated in Figs. 1 to 9 are denoted by corresponding ones of the reference numerals, and description thereof is omitted. The refrigerator according to Embodiment 3 of the present invention differs from the refrigerator 1 according to Embodiment 1 only in the configuration of the reinforcing plate.

[0032]

A reinforcing plate 220 of the refrigerator according to Embodiment 3 of the present invention is a metal plate having a plurality of bends and is fixed to the inner wall 19 by using, for example, double-sided adhesive tape so that the refrigerator-compartment door 9 becomes less likely to be distorted. The reinforcing plate 220 includes a flat portion 20a having a flat plate shape with one surface facing the outer wall 18 and the other surface facing the flat-plate portion 19b. The flat portion 20a of the reinforcing plate 220 is in contact with the flat-plate portion 19b of the inner wall 19. The reinforcing plate 220 further includes first side-plate portions 20b folded upright from each of the left and right ends of the flat portion 20a and extending into its associated one of the projecting portions 19a. The first side-plate portions 20b extend along associated one of the first side-wall parts 19a1 of the projecting portions 19a toward the associated one of the second side-wall parts 19a2. The first side-plate portions 20b extend from end to end in the vertical direction of the refrigerator-compartment door 9. The reinforcing plate 220 further includes second side-plate portions 20c each extending upright from corresponding one of ends of the first side-plate portions 20b, the ends being opposite to the flat portion 20a. The second side-plate portions 20c are each positioned inside corresponding one of the projecting portions 19a. At least part of each of the second side-plate portions 20c faces its

associated one of the second side-wall parts 19a2. Each of the second side-plate portions 120c connected to the corresponding one of the first side-plate portions 20b extends in a direction away from the other of the second side-plate portions 120c. The second side-plate portions 120c extend from end to end in the vertical direction of the refrigerator-compartment door 9. The refrigerator-compartment door 9 is configured such that each of the second side-plate portions 120c of the reinforcing plate 220 is spaced apart from the associated one of the second side-wall parts 19a2 of the projecting portions 19a.

[0033]

The second side-plate portions 20c of the reinforcing plate 20 included in the refrigerator 1 according to Embodiment 1 each have a flat plate shape. In contrast, the second side-plate portions 120c of the reinforcing plate 220 included in the refrigerator 1 according to Embodiment 3 are each folded to have an inverted-V shape projecting toward the outer wall 18. The second side-plate portions 120c each have a plurality of holes 25 extending through the reinforcing plate 220.

[0034]

To summarize, the reinforcing plate 220 of the refrigerator 1 according to Embodiment 3 of the present invention includes the first side-plate portions 20b folded upright from the left and right ends of the flat portion 20a, and the second side-plate portions 120c folded upright from the ends of the first side-plate portions 20b. Furthermore, the second side-plate portions 120c of the reinforcing plate 220 each have an inverted-V shape projecting toward the outer wall 18. Therefore, the reinforcing plate 220 has a shape that is folded at more positions. Such a folded shape increases the strength of the refrigerator-compartment door 9 and also increases the moment of inertia of area relative to the pull P applied to the refrigerator-compartment door 9 of the refrigerator 1. Accordingly, the flexural rigidity of the refrigerator-compartment door 9 is further increased. Thus, the strength of the refrigerator-compartment door 9 can be increased. Therefore, the refrigerator including the door whose strength is not reduced even if the thickness of the heat-insulating material provided therein is reduced can be obtained.

[0035]

Furthermore, in the refrigerator 1 according to Embodiment 3, since the reinforcing plate 220 includes the second side-plate portions 120c each having an inverted-V shape, the force of fixing the position of the reinforcing plate 220 by using the heat-insulating material is further increased. Consequently, the peel strength between the heat-insulating material and the reinforcing plate of the refrigerator-compartment door 9 increases, which increases the strength of the refrigerator-compartment door 9 as an assembled component. Therefore, the refrigerator-compartment door 9 can be made less likely to be distorted, and the refrigerator 1 including the refrigerator-compartment door 9 whose strength is not reduced even if the thickness of the heat-insulating material provided therein is reduced can be obtained.

[0036]

Embodiment 4

Fig. 11 is a sectional view illustrating part of a refrigerator-compartment door of a refrigerator according to Embodiment 4 of the present invention. Elements that are the same as those included in the refrigerator 1 illustrated in Figs. 1 to 10 are denoted by corresponding ones of the reference numerals, and description thereof is omitted. The refrigerator according to Embodiment 4 of the present invention differs from the refrigerator 1 according to Embodiment 1 in the configuration of the reinforcing plate and in that the inner wall has grooves for fixing the reinforcing plate.

[0037]

The inner wall 19 has grooves 19d at the two ends thereof. The grooves 19d are each provided between a corresponding one of the projecting portions 19a and a corresponding one of the peripheral edges 19c. The grooves 19d are open toward the outer wall 18 and are depressed toward the open part of the heat-insulating box body 2. The grooves 19d extend from end to end in the vertical direction of the refrigerator-compartment door 9. The grooves 19d are connected to associated one of the third side-wall parts 19a3 of the projecting portions 19a.

[0038]

A reinforcing plate 320 included in the refrigerator according to Embodiment 4 of the present invention is a metal plate having a plurality of bends and is fixed to the inner wall 19 so that the refrigerator-compartment door 9 becomes less likely to be distorted. The reinforcing plate 320 includes a flat portion 20a having a flat plate shape with one surface facing the outer wall 18 and the other surface facing the flat-plate portion 19b. The flat portion 20a of the reinforcing plate 320 is in contact with the flat-plate portion 19b of the inner wall 19. The reinforcing plate 320 further includes a first side-plate portion 20b folded upright from each of the left and right ends of the flat portion 20a and extending into its associated one of the projecting portions 19a. Each of the first side-plate portions 20b extends along the associated one of the first side-wall parts 19a1 of the projecting portions 19a toward the associated one of the second side-wall parts 19a2. The first side-plate portions 20b extend from end to end in the vertical direction of the refrigerator-compartment door 9. The reinforcing plate 320 further includes second side-plate portions 20c each extending upright from corresponding one of ends of the first side-plate portions 20b, the ends being opposite to the flat portion 20a. The second side-plate portions 20c are each positioned inside corresponding one of the projecting portions 19a. At least part of each of the second side-plate portions 20c faces its associated one of the second side-wall parts 19a2. Each of the second side-plate portions 20c connected to the associated one of the first side-plate portions 20b extend in a direction away from the other of the second side-plate portions 20c. The second side-plate portions 20c extend from end to end in the vertical direction of the refrigerator-compartment door 9. The second side-plate portions 20c each have a flat plate shape. The refrigerator-compartment door 9 is configured such that each of the second side-plate portions 20c of the reinforcing plate 320 is spaced apart from associated one of the second side-wall parts 19a2 of the projecting portions 19a. The second side-plate portions 20c each have a plurality of holes 25 extending through the reinforcing plate 320.

[0039]

As illustrated in Fig. 11, the reinforcing plate 320 further includes rearward edge

portions 20e folded upright from and end of the associated one of the second side-plate portions 20c, the end being opposite to the associated one of the first side-plate portions 20b. The rearward edge portions 20e extend toward the open part of the heat-insulating box body 2. Each of the rearward edge portions 20e is connected to the associated one of the second side-plate portions 20c and extends from end to end in the vertical direction of the refrigerator-compartment door 9. The reinforcing plate 320 is fixed to the inner wall 19 with tips 20e1 of the rearward edge portions 20e being positioned in associated one of the grooves 19d.

[0040]

To summarize, to bear the pull P, the reinforcing plate 320 of the refrigerator 1 according to Embodiment 4 of the present invention includes the first side-plate portions 20b folded upright from the left and right ends of the flat portion 20a, the second side-plate portions 20c folded upright from the ends of the first side-plate portions 20b, and the rearward edge portions 20e folded upright from the second side-plate portions 20c. Since the reinforcing plate 320 of the refrigerator 1 additionally includes the rearward edge portions 20e, the reinforcing plate 320 has a shape folded at more positions. Such a folded shape increases the strength of the refrigerator-compartment door 9 and also increases the moment of inertia of area relative to the pull P applied to the refrigerator-compartment door 9. Accordingly, the flexural rigidity of the refrigerator-compartment door 9 is further increased. Thus, the strength of the refrigerator-compartment door 9 can be increased.

[0041]

Furthermore, since the reinforcing plate 320 of the refrigerator 1 according to Embodiment 4 additionally includes the rearward edge portions 20e, the force of fixing the position of the reinforcing plate 320 by using the heat-insulating material is further increased. Consequently, the peel strength between the heat-insulating material and the reinforcing plate of the refrigerator-compartment door 9 increases, which increases the strength of the refrigerator-compartment door 9 as an assembled component. Therefore, the refrigerator-compartment door 9 can be made less likely to be distorted, and the refrigerator 1 including the refrigerator-compartment door 9

whose strength is not reduced even if the thickness of the heat-insulating material provided therein is reduced can be obtained.

[0042]

Furthermore, in the refrigerator 1 according to Embodiment 4, the inner wall 19 has the grooves 19d, and the reinforcing plate 20 is fixed to the inner wall 19 with the tips 20e1 each being positioned in the associated one of the grooves 19d. Therefore, the reinforcing plate 20 can be fixed to the inner wall 19 with a smaller amount of double-sided adhesive tape. Accordingly, the material cost required for manufacturing the refrigerator-compartment door 9 of the refrigerator 1 can be reduced.

[0043]

Furthermore, in the refrigerator 1 according to Embodiment 4, the inner wall 19 has the grooves 19d, and the reinforcing plate 20 is fixed to the inner wall 19 with the tips 20e1 each being positioned in the associated one of the grooves 19d. Therefore, the reinforcing plate 20 and the inner wall 19 can be easily positioned relative to each other in the assembling process. Accordingly, with the refrigerator 1, the ease of work performed by the worker in the process of assembling the reinforcing plate 20 and the inner wall 19 together can be increased.

[0044]

Embodiments of the present invention are not limited to Embodiments 1 to 4 described above, and various changes may be made thereto. For example, while Embodiments 1 to 4 described above each concern the refrigerator-compartment door 9, the configuration is also applicable to any of the other compartment doors including the freezer-compartment door and the vegetable-compartment door.

Furthermore, while Embodiments 1 to 4 each concern a case where the reinforcing plate 20 is fixed to the inner wall 19 by using double-sided adhesive tape, the double-sided adhesive tape may be replaced with any other adhesive element such as thermoplastic adhesive (hot-melt adhesive). Moreover, while the description of the present invention is sectioned into descriptions of Embodiments 1 to 4, the present invention may be embodied as a direct combination of any of Embodiments 1 to 4.

Reference Signs List

[0045]

1 refrigerator 2 heat-insulating box body 3 refrigerator compartment 4
ice-making compartment 5 versatile compartment 6 freezer compartment 7
5 vegetable compartment 8 refrigerator-compartment door 9 refrigerator-
compartment door 10 ice-making-compartment door 11 versatile-compartment
door 12 freezer-compartment door 13 vegetable-compartment door 14
hinge 15 hinge 16 handle 18 outer wall 18a toughened glass plate 18b
outer frame 18c peripheral edge 19 inner wall 19a projecting portion 19a1
10 first side-wall part 19a2 second side-wall part 19a3 third side-wall part 19b
flat-plate portion 19c peripheral edge 19d groove 20 reinforcing plate 20a
flat portion 20b first side-plate portion 20c second side-plate portion 20d
frontward edge portion 20e rearward edge portion 20e1 tip 21 space 21a
space 21b space 24 shaft hole 25 hole 120 reinforcing plate 120c
15 second side-plate portion 220 reinforcing plate 320 reinforcing plate

CLAIMS

[Claim 1]

A refrigerator comprising:

a heat-insulating box body having an open part; and

5 a box-shaped door provided in such a manner as to open and close open part of the heat-insulating box body,

the door including

an outer wall forming an outer peripheral wall of the door;

10 an inner wall provided opposite to the outer wall and forming a wall on a side facing the open part; and

a reinforcing plate provided between the outer wall and the inner wall and fixed to the inner wall,

the inner wall including

15 a projecting portion projecting from each of left and right ends of the inner wall toward the open part of the heat-insulating box body; and

a flat-plate portion having a flat plate shape and connecting the projecting portions provided at the left and right ends of the inner wall to each other,

the reinforcing plate including

20 a flat portion having a flat plate shape with one surface facing the outer wall and an other surface facing the flat-plate portion;

a first side-plate portion folded upright from each of left and right ends of the flat portion and extending into its associated one of the projecting portions; and

25 a second side-plate portion extending upright from one end of the first side-plate portions and positioned inside its associated one of the projecting portions, the end being opposite to the flat portion.

[Claim 2]

The refrigerator of claim 1,

wherein each of the projecting portions includes

30 a first side-wall part folded upright from corresponding one of the left and right ends of the flat-plate portion and extending toward the open part of the heat-

insulating box body;

a second side-wall part folded upright from an end of the first side-wall part and facing the outer wall, the end being opposite to the flat-plate portion; and

a third side-wall part folded upright from an end of the second side-wall part and extending toward the outer wall, the end being opposite to the first side-wall part, and

wherein the first side-plate portion of the reinforcing plate extends along the first side-wall part toward its associated one of the second side-wall parts, and at least part of the second side-plate portion faces the second side-wall part.

[Claim 3]

The refrigerator of claim 2, wherein the door is configured such that the second side-plate portion of the reinforcing plate is spaced apart from the second side-wall part of the projecting portion.

[Claim 4]

The refrigerator of claim 2 or 3, wherein the second side-plate portion has a plurality of holes extending through the reinforcing plate and arranged from end to end in a vertical direction of the door.

[Claim 5]

The refrigerator of any one of claims 1 to 4, wherein the second side-plate portion is folded to have an inverted-V shape projecting toward the outer wall.

[Claim 6]

The refrigerator of any one of claims 1 to 5,
wherein the reinforcing plate further includes

a frontward edge portion folded upright from an end of the second side-plate portion and extending toward the outer wall while facing the first side-plate portion, the end being opposite to the first side-plate portion.

[Claim 7]

The refrigerator of any one of claims 1 to 5,
wherein the inner wall further has

a groove provided between the projecting portion and a peripheral edge

of the inner wall in such a manner as to be depressed toward the open part of the heat-insulating box body,

wherein the reinforcing plate further includes

5 a rearward edge portion folded upright from an end of the second side-plate portion and extending toward the open part of the heat-insulating box body, the end being opposite to the first side-plate portion, and

wherein the reinforcing plate is fixed to the inner wall with a tip of the rearward edge portion being positioned in the groove.