DESCRIPTION

Title of Invention

HEAT-INSULATING CABINET AND REFRIGERATOR INCLUDING THE HEAT-INSULATING CABINET

Technical Field

[0001]

The present invention relates to a heat-insulating cabinet having a foam heat insulator and a vacuum heat insulator, and a refrigerator including the heat-insulating cabinet.

Background Art

[0002]

In recent years, various measures have been taken for resource saving, energy saving, and, especially, electric power saving to preserve the global environment and achieve safe nucleic power plants.

[0003]

In particular, from the viewpoints of energy saving and electric power saving, techniques of disposing a vacuum heat insulator in a heat-insulating cabinet have advanced. Japanese Patent No. 4778996 describes a technique which uses a single vacuum heat insulator in a bent state.

[0004]

Fig. 5 is a cross-sectional view illustrating the structure of a typical vacuum heat insulator.

A vacuum heat insulator 1 is structured to be kept in a vacuum by superposing two exterior packaging materials 4 to form a bag having an opening in a part of its outer peripheral portion, putting a core material 2 and a desiccant 3 in the bag, and welding a portion defining the opening after vacuuming the bag. Thus, the thermal conductivity of the vacuum heat insulator 1 becomes about 0.0020 W/mK, and the vacuum heat insulator 1 attains a satisfactory heat insulation performance about ten times as that of a foam heat insulator, such as a urethane foam material, which has hitherto been used as a heat insulator.

[0005]

For example, each of the exterior packaging materials 4 includes a seal layer 5 to be welded, a gas barrier layer 6 for preventing water vapor and the like from entering the vacuum heat insulator 1, and a protective layer 7 for preventing damage to the exterior packaging material 4. Among these constituent layers, the gas barrier layer 6 is made of aluminum. Upon examination of this structure, it was confirmed that a heat bridge phenomenon occurs in the vacuum heat insulator 1, in which when heat is transferred to one surface of the vacuum heat insulator 1, it is then transferred from an aluminum portion of the gas barrier layer 6 in the exterior packaging material 4 that forms the surface of the vacuum heat insulator 1 to an aluminum portion of the gas barrier layer 6 in the exterior packaging material 4 that forms the other surface of the vacuum heat insulator, that is, it enters the other surface of the vacuum heat insulator 1. Therefore, if a heat bridge phenomenon occurs, the effective area of the vacuum heat insulator 1 becomes smaller than it appears. Although the seriousness of the problem resulting from a heat bridge phenomenon varies depending on the type of exterior packaging materials 4, when the vacuum heat insulator 1 is disposed in a urethane foam material and the width of the vacuum heat insulator 1 is 200 mm or less, this has the opposite effect, in which entry of heat due to the heat bridge phenomenon becomes dominant over the effect of reducing, using the vacuum heat insulator 1, the amount of heat to enter.

[0006]

The heat bridge phenomenon can be suppressed by increasing the area of a single vacuum heat insulator, as a means for suppressing the heat bridge phenomenon. For this reason, when being mounted in a stepped portion, the vacuum heat insulator 1 is more efficiently used when the single vacuum heat insulator 1 is mounted in a bent state than when the vacuum heat insulator 1 is divided into a plurality of parts.

Citation List

Patent Literature

[0007]

Patent Literature 1: Japanese Patent No. 4778996

Summary of Invention

Technical Problem

[0008]

However, when the vacuum heat insulator 1 is directly attached on the wall surface of an inner box, an outer box, or the like that constitutes the heat-insulating cabinet, and the edge of the vacuum heat insulator 1 is in contact with this wall surface, an aluminum portion of the gas barrier layer 6 in the exterior packaging material 4 is likely to absorb from the edge of the vacuum heat insulator 1 heat trapped in this wall surface. Hence, a heat bridge phenomenon is likely to occur, so that the heat insulation performance of the heat-insulating cabinet deteriorates.

[0009]

The present invention has been made to solve the above-described problems, and has as its object to provide a heat-insulating cabinet that can suppress the occurrence of a heat bridge phenomenon in a vacuum heat insulator more than in the conventional technique and that can save more energy than in the conventional technique as well, and a refrigerator including the heat-insulating cabinet.

Solution to Problem

[0010]

A heat-insulating cabinet according to the present invention includes an inner box, an outer box, and a vacuum heat insulator and a foam heat insulator that fill the space between the inner box and the outer box. The heat-insulating cabinet has a part of its lower portion, which is recessed inwards and forms a machine chamber where a compressor is to be disposed. One bent vacuum heat insulator is disposed within a bottom portion of the heat-insulating cabinet and an upright wall of the machine chamber, standing upright from the bottom portion, and extends from the bottom portion to the upright wall. The outer box includes, in at least an area that forms the upright wall, at least one first projection projecting toward the inner box. The vacuum heat insulator extending from the bottom portion to the upright wall is provided between the inner box and the outer box while being in contact with the first

projection, and is disposed at a predetermined distance from the outer box, except for the first projection, within the upright wall.

[0011]

A refrigerator according to the present invention includes the heat-insulating cabinet of the present invention, and a cooling device including a compressor and configured to cool air to be supplied to a storage compartment provided in the heat-insulating cabinet. The compressor of the cooling device is disposed in the machine chamber.

Advantageous Effects of Invention

[0012]

In the present invention, the outer box is provided with the first projection projecting toward the inner box. Also, in the present invention, the vacuum heat insulator is provided between the inner box and the outer box while being in contact with the first projection in the area where the first projection is provided. For this reason, in the present invention, since the edge of the vacuum heat insulator disposed in that area is not in contact with the wall surfaces of the outer box and the inner box, a heat bridge phenomenon can be suppressed more than in the conventional technique. Consequently, according to the present invention, it is possible to obtain a heat-insulating cabinet that saves more energy than in the conventional technique, and a refrigerator including the heat-insulating cabinet.

[0013]

In particular, according to the present invention, the first projection is provided in the portion of the outer box that forms the upright wall of the machine chamber, and the vacuum heat insulator is provided in the upright wall between the inner box and the outer box while being in contact with the first projection. Note that the temperature of the upright wall of the machine chamber is likely to increase due to the presence of the compressor, and is, therefore, likely to be greatly different from that of the interior of the heat-insulating cabinet (the space on the inner peripheral side of the inner box, for example, the storage compartment in the refrigerator). In the present invention, since the amount of heat entering from the upright wall of the machine

chamber can be reduced, it is possible to obtain a heat-insulating cabinet that saves more energy than in the conventional technique, and a refrigerator including the heat-insulating cabinet.

[0014]

The present invention prevents contact of the edge of the vacuum heat insulator with the wall surfaces of the outer box and the inner box, without adding any new component. For this reason, according to the present invention, it is possible to obtain a heat-insulating cabinet that is less expensive and saves more energy than in the conventional technique, and a refrigerator including the heat-insulating cabinet.

Brief Description of Drawings

[0015]

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

[Fig. 2] Fig. 2 is a schematic view (perspective view) for explaining a process of fabricating a heat-insulating cabinet according to Embodiment 1 of the present invention.

[Fig. 3] Fig. 3 is an enlarged view (sectional side view) illustrating the main part of the refrigerator according to Embodiment 1, near its lower portion.

[Fig. 4] Fig. 4 is an enlarged view (sectional side view) illustrating the main part of a refrigerator according to Embodiment 2, near its lower portion.

[Fig. 5] Fig. 5 is a cross-sectional view illustrating the structure of a typical vacuum heat insulator.

Description of Embodiments

[0016]

Embodiments of a heat-insulating cabinet and a refrigerator including the heat-insulating cabinet according to the present invention will be described with reference to the accompanying drawings.

[0017]

Embodiment 1

Fig. 1 is a sectional side view of a refrigerator according to Embodiment 1 of

the present invention. The left side of Fig. 1 corresponds to the front side of a refrigerator 100.

A heat-insulating cabinet 8 in the refrigerator 100 according to Embodiment 1 includes an outer box 9 that mainly forms the outer peripheral surface of the heat-insulating cabinet 8, and a vacuum heat insulator 1 and a foam heat insulator 11 that fill the space between the inner peripheral surface of the outer box 9 and the outer peripheral surface of an inner box 10. The vacuum heat insulator 1 is provided in, for example, the ceiling portion, the right and left side walls, the rear side portion, and the bottom portion of the heat-insulating cabinet 8. The vacuum heat insulator 1 is implemented in the vacuum heat insulator illustrated in Fig. 5. The foam heat insulator 11 is implemented using, for example, a rigid urethane foam material.

[0018]

The inside of the heat-insulating cabinet 8 having this structure (that is, the inner peripheral surface of the inner box 10) is divided by a plurality of partition plates 21 to form some storage compartments 20 having different temperature zones, including, for example, a refrigerating compartment 22, a freezing compartment 23, and a vegetable compartment 24, in accordance with how the user uses them. These storage compartments 20 are open on their front surfaces, and the front openings of the storage compartments 20 are openably closed by doors 25.

[0019]

A part of the lower portion of the heat-insulating cabinet 8 on its rear side is recessed toward the front side (that is, the inner side of the heat-insulating cabinet 8) to form a machine chamber 13. In the machine chamber 13, a compressor 31 in a cooling device 30 (to be described below) is disposed.

[0020]

The cooling device 30 includes a compressor 31, a condensing pipe (not illustrated), a pressure reducing device (not illustrated; for example, an expansion valve or a capillary tube), a cooler 32, and so on. Of these components of the cooling device 30, the compressor 31 and the pressure reducing device are disposed in the machine chamber 13 provided in the lower portion of the heat-insulating cabinet

8 on its rear side. The condensing pipe is provided, for example, in the side surface portion of the heat-insulating cabinet 8. The cooler 32 is provided in a cooling chamber 35 surrounded by the inner box 10 and a fan grille 36. In the cooling chamber 35, a cooler fan 38 is also provided to blow air cooled by the cooler 32 to the storage compartments 20.

[0021]

For example, the heat-insulating cabinet 8 having this structure is fabricated as follows. First, the vacuum heat insulator 1 is bonded and fixed to the outer box 9 beforehand. Then, the outer box 9 and the inner box 10 are fixed, for example, by bonding. After that, as illustrated in Fig. 2, integrated foaming is performed by injecting the material of the foam heat insulator 11 in a liquid state from injection ports 18 provided on the rear side of the heat-insulating cabinet 8 in the state in which the rear surface of the heat-insulating cabinet 8 faces up, so that the space between the outer box 9 and the inner box 10 is filled with the foam heat insulator 11.

[0022]

As described above, the compressor 31 of the cooling device 30 is disposed in the machine chamber 13. With this arrangement, when the compressor 31 operates, the temperature in the machine chamber 13 increases. Therefore, it is feared that a large amount of heat may flow from the machine chamber 13 into the storage compartments 20 via an upright wall 14 on the front side of the machine chamber 13 (a wall standing upright from the bottom portion of the heat-insulating cabinet 8).

Accordingly, in the heat-insulating cabinet 8 of the refrigerator 100 according to Embodiment 1, the vacuum heat insulator 1 is provided as follows.

[0023]

Fig. 3 is an enlarged view (sectional side view) illustrating the main part of the refrigerator according to Embodiment 1, near its lower portion. The left side of Fig. 3 corresponds to the front side of the refrigerator 100.

As illustrated in Fig. 3, in the heat-insulating cabinet 8 according to Embodiment 1, the vacuum heat insulator 1 is provided in the upright wall 14 serving

as the front wall of the machine chamber 13 to enhance the heat insulation performance of the upright wall 14. When the vacuum heat insulator 1 is small, a heat bridge phenomenon is likely to occur. To prevent this, in the heat-insulating cabinet 8 of Embodiment 1, a vacuum heat insulator 1 provided in a bottom portion 15 and a vacuum heat insulator 1 provided in the upright wall 14 are formed as a single component. That is, the vacuum heat insulator 1 is bent nearly in an L-shape, and the vacuum heat insulator is disposed to extend from the bottom portion 15 to the upright wall 14. This can ensure a large total size of the vacuum heat insulator 1 disposed in the upright wall 14, and a relatively small area of the edge of the vacuum heat insulator 1 is disposed in the upright wall 14. Hence, it is possible to suppress the heat bridge phenomenon in the vacuum heat insulator 1.

[0024]

Since the area of the outer box 9 that forms the upright wall 14 faces the machine chamber 13, its temperature is high. For this reason, when the vacuum heat insulator 1 is attached on the area of the outer box 9 that forms the upright wall 14, it is feared that the edge of the vacuum heat insulator 1 may come into contact with the area of the outer box 9 that forms the upright wall 14, that the temperature of the area of the outer box 9 that forms the upright wall 14 may be absorbed from the edge, and that a heat bridge phenomenon may occur in the vacuum heat insulator 1. To prevent this, in Embodiment 1, at least one projection 16a projecting toward the inner box 10 is provided on the area of the outer box 9 that forms the upright wall 14. The distal end of the projection 16a is formed in, for example, an arc or a planar shape such that the vacuum heat insulator 1 is less likely to suffer damage even when it comes into contact with the vacuum heat insulator 1. A portion of the vacuum heat insulator 1 disposed in the upright wall 14 is attached on (in contact with) the projection 16a. With this structure, the vacuum heat insulator 1 is disposed at a predetermined distance from the outer box 9, except for the projection 16a, within the upright wall 14. Therefore, it is possible to prevent contact of the edge of the vacuum heat insulator 1 with the area of the outer box 9 that forms the upright wall 14 and to further suppress the heat bridge phenomenon in the vacuum heat insulator 1.

Note that the projection 16a corresponds to the first projection in the present invention.

[0025]

In Embodiment 1, at least one projection 16b is also provided in an area of the outer box 9 that forms the bottom portion 15 (four projections 16b are illustrated in Fig. 3), and projects toward the inner box 10. The distal end of the projection 16b is formed in, for example, an arc or a planar shape such that the vacuum heat insulator 1 is less likely to suffer damage even when it comes into contact with the vacuum heat insulator 1. A portion of the vacuum heat insulator 1 disposed in the bottom portion 15 is attached on (in contact with) the projection 16b. With this structure, the vacuum heat insulator 1 is disposed at a predetermined distance from the outer box 9, except for the projection 16b, within the bottom portion 15. It is, therefore, possible to prevent contact of the edge of the vacuum heat insulator 1 with the area of the outer box 9 that forms the bottom portion 15 and to further suppress the heat bridge phenomenon in the vacuum heat insulator 1.

Note that the projection 16b corresponds to the second projection in the present invention.

[0026]

As described above, in Embodiment 1, the vacuum heat insulator 1 is disposed at a predetermined distance from the outer box 9, except for the projection 16a, within the upright wall 14 to prevent contact of the edge of the vacuum heat insulator 1 with the area of the outer box 9 that forms the upright wall 14. With this arrangement, in the heat-insulating cabinet 8 and the refrigerator 100 including the heat-insulating cabinet 8 according to Embodiment 1, entry of heat from the machine chamber 13 into the storage compartments 20 via the upright wall 14 can be suppressed more than in the conventional technique, and energy can be saved more than in the conventional technique as well.

[0027]

In Embodiment 1, the vacuum heat insulator 1 is also disposed at a predetermined distance from the outer box 9, except for the projection 16b, within the

bottom portion 15 to prevent contact of the edge of the vacuum heat insulator 1 with the area of the outer box 9 that forms the bottom portion 15. With this arrangement, in the heat-insulating cabinet 8 and the refrigerator 100 including the heat-insulating cabinet 8 according to Embodiment 1, entry of heat from the outside into the storage compartments 20 via the bottom portion 15 can be suppressed more than in the conventional technique, and energy can be saved more than in the conventional technique as well.

[0028]

In Embodiment 1, when the vacuum heat insulator is spaced apart from the outer box 9 that forms the upright wall 14 and the bottom portion 15, the projections 16a and 16b provided on the outer box 9 are used. This obviates the need to add a new component when the vacuum heat insulator is spaced apart from the outer box 9 that forms the upright wall 14 and the bottom portion 15. Hence, the heat-insulating cabinet 8 and the refrigerator 100 including the heat-insulating cabinet 8 according to Embodiment 1 can be inexpensive and highly energy-saving.

[0029]

The number of projections 16a and 16b formed in Embodiment 1 is arbitrarily determined. One projection 16a and one projection 16b may be formed as long as the vacuum heat insulator can be spaced apart from the outer box 9 that forms the upright wall 14 and the bottom portion 15. In this case, it is preferable to oppose the projections 16a and 16b to the vicinities of the distal ends of the vacuum heat insulator 1. This makes it easier to prevent contact of the edge of the vacuum heat insulator 1 with the outer box 9.

[0030]

Embodiment 2

The structure in which the vacuum heat insulator 1 is disposed in the upright wall 14 and the bottom portion 15 of the heat-insulating cabinet 8 is not limited to that of Embodiment 1, but, for example, the following structure may be adopted. Structures that will not particularly be described in Embodiment 2 are similar to those of Embodiment 1, and the same reference numerals denote constituent elements

having the same functions and structures.

[0031]

Fig. 4 is an enlarged view (sectional side view) illustrating the main part of a refrigerator according to Embodiment 2, near its lower portion. The left side of Fig. 4 corresponds to the front side of a refrigerator 100.

A heat-insulating cabinet 8 of Embodiment 2 has a structure in which a projection 16b is not provided in an area of an outer box 9 that forms a bottom portion 15. In a vacuum heat insulator 1 extending from the bottom portion 15 to an upright wall 14, a tape-shaped heat insulator 19, for example, formed by a soft urethane foam material is wound around the vicinity of the distal end of the vacuum heat insulator 1 disposed in the bottom portion 15. For this reason, the portion of the vacuum heat insulator 1, which extends from the bottom portion 15 to the upright wall 14, disposed in the bottom portion 15 is bonded to (in contact with) the area of the outer box 9 that forms the bottom portion 15. In this case, since the heat insulator 19 is wound around the vicinity of the distal end of the portion of the vacuum heat insulator 1 disposed in the bottom portion 15, it is possible to prevent contact of the edge of the vacuum heat insulator 1 with the area of the outer box 9 that forms the bottom portion 15 and to suppress the heat bridge phenomenon.

[0032]

When a foam heat insulator 11 fills the space between the outer box 9 and an inner box 10, if the space to be filled with the foam heat insulator 11 is narrow, the rate of occurrence of areas unfilled with the foam heat insulator 11 sharply increases. For this reason, the space to be filled with the foam heat insulator 11 needs to have a minimum width (for example, 5 mm). When, as in Embodiment 1, the vacuum heat insulator 1 is provided in the bottom portion of the heat-insulating cabinet 8, both the spaces between the vacuum heat insulator 1 and the outer box 9 and between the vacuum heat insulator 1 and the inner box 10 need to be filled with the foam heat insulator 11. For this reason, when, as in Embodiment 1, the vacuum heat insulator 1 is provided in the bottom portion of the heat-insulating cabinet 8, a space with at least a width of, for example, 10 mm needs to be ensured in the direction of thickness

of the bottom portion 15 (up-down direction) between the outer box 9 and the inner box 10 in the bottom portion 15. In contrast, when, as in Embodiment 2, the vacuum heat insulator 1 is provided in the bottom portion of the heat-insulating cabinet 8, it is only necessary to fill only the space between the vacuum heat insulator 1 and the inner box 10 with the foam heat insulator 11. For this reason, when, as in Embodiment 2, the vacuum heat insulator 1 is provided in the bottom portion of the heat-insulating cabinet 8, it is only necessary to ensure a space with a width of, for example, 5 mm in the direction of thickness of the bottom portion 15 (up-down direction) between the outer box 9 and the inner box 10 in the bottom portion 15. Therefore, by forming the heat-insulating cabinet 8, as in Embodiment 2, the thickness of the bottom portion 15 can be made smaller than in Embodiment 1.

[0033]

In the above heat-insulating cabinet 8 structured as in Embodiment 2 and the refrigerator 100 including the heat-insulating cabinet 8, the vacuum heat insulator 1 is disposed at a predetermined distance from the outer box 9, except for the projection 16a, within the upright wall 14 to prevent contact of the edge of the vacuum heat insulator 1 with the area of the outer box 9 that forms the upright wall 14. For this reason, in the heat-insulating cabinet 8 and the refrigerator 100 including the heat-insulating cabinet 8 according to Embodiment 2 as well, entry of heat from a machine chamber 13 into storage compartments 20 via the upright wall 14 can also be suppressed more than in the conventional technique, and energy can be saved more than in the conventional technique as well, similarly to Embodiment 1.

[0034]

In Embodiment 2, the heat insulator 19 is wound around the vicinity of the distal end of the portion of the vacuum heat insulator 1 disposed in the bottom portion 15 to prevent contact of the edge of the vacuum heat insulator 1 with the area of the outer box 9 that forms the bottom portion 15. For this reason, in the heat-insulating cabinet 8 and the refrigerator 100 including the heat-insulating cabinet 8 according to Embodiment 2 as well, entry of heat from the outside into the storage compartments 20 via the bottom portion 15 can also be suppressed more than in the conventional

technique, and energy can be saved more than in the conventional technique as well.

[0035]

In the heat-insulating cabinet 8 and the refrigerator 100 including the heat-insulating cabinet 8 according to Embodiment 2, the thickness of the bottom portion 15 of the heat-insulating cabinet 8 can be made smaller than in Embodiment 1. Hence, it is possible to increase the inner volume of the storage compartments 20 without changing the outer dimensions and to enhance storability for food and so on.

[0036]

In Embodiment 2, the tape-shaped heat insulator 19 is wound around the vicinity of the distal end of the portion of the vacuum heat insulator 1 disposed in the bottom portion 15. However, the present invention is not limited to this, and a tape-shaped heat insulator 19 may be attached on an area opposed to the outer box 9 near the distal end of the portion of the vacuum heat insulator 1 disposed in the bottom portion 15. This structure can also prevent contact of the edge of the vacuum heat insulator 1 with the area of the outer box 9 that forms the bottom portion 15.

Reference Signs List

[0037]

1: vacuum heat insulator, 2: core material, 3: desiccant, 4: exterior packaging material, 5: seal layer, 6: gas barrier layer, 7: protective layer, 8: heat-insulating cabinet, 9: outer box, 10: inner box, 11: foam heat insulator, 13: machine chamber, 14: upright wall, 15: bottom portion, 16a: projection (first projection), 16b: projection (second projection), 18: injection port, 19: heat insulator, 20: storage compartment, 21: partition plate, 22:refrigerating compartment, 23: freezing compartment, 24: vegetable compartment, 25: door, 30: cooling device, 31: compressor, 32: cooler, 35: cooling chamber, 36: fan grille, 38: cooler fan, 100: refrigerator

CLAIMS

[Claim 1]

A heat-insulating cabinet comprising: an inner box; an outer box; and a vacuum heat insulator and a foam heat insulator that fill a space between the inner box and the outer box,

the heat-insulating cabinet having a part of a lower portion thereof, which is recessed inwards and forms a machine chamber where a compressor is to be disposed,

wherein one bent vacuum heat insulator is disposed within a bottom portion of the heat-insulating cabinet and an upright wall of the machine chamber, standing upright from the bottom portion, and extends from the bottom portion to the upright wall,

wherein the outer box includes, in at least an area that forms the upright wall, at least one first projection projecting toward the inner box,

wherein the vacuum heat insulator extending from the bottom portion to the upright wall is provided between the inner box and the outer box while being in contact with the first projection, and is disposed at a predetermined distance from the outer box, except for the first projection, within the upright wall, and

wherein the vacuum heat insulator extending from the bottom portion to the upright wall is provided with one of

a tape-shaped heat insulator which is wound around a distal end of a portion thereof disposed in the bottom portion, and

a tape-shaped heat insulator which is attached on an area of the distal end of the portion thereof disposed in the bottom portion and the area is opposed to the outer box.

[Claim 2]

The heat-insulating cabinet of claim 1, wherein the outer box includes an area which forms the bottom portion, in which the vacuum heat insulator extending from the bottom portion to the upright wall is provided, and in which projection projecting toward the inner box is absent.

[Claim 3]

The heat-insulating cabinet of claim 1 or 2, wherein the first projection is opposed to a vicinity of a distal end of a portion of the vacuum heat insulator disposed in the upright wall.

[Claim 4]

A refrigerator comprising:

the heat-insulating cabinet of any one of claims 1 to 3; and

a cooling device including a compressor and configured to cool air to be supplied to a storage compartment provided in the heat-insulating cabinet,

wherein the compressor of the cooling device is disposed in the machine chamber.