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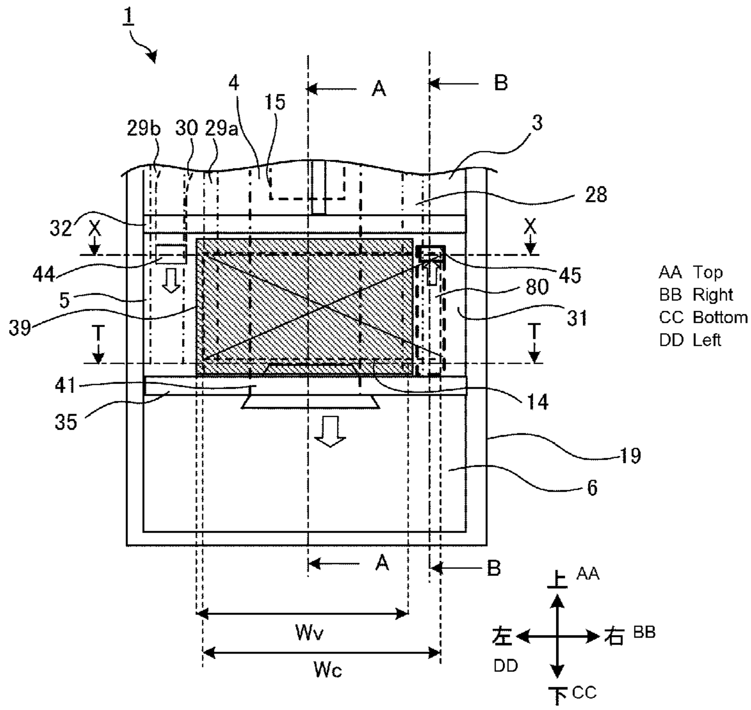

(57) **Abstract:** This refrigerator has an insulated box that has an opening covered with a door on the front and that has an interior in which a plurality of storage compartments are formed. Provided inside the insulated box are: a first storage compartment that is set at a higher temperature than other adjacent storage compartments and stores items to be stored; a cooler compartment that is provided behind the first storage compartment and in which a cooler is disposed; a first vacuum insulation material that is disposed between the first storage compartment and the cooler compartment; and a return air

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path that allows communication between the first storage compartment and the cooler compartment and circulates cold air returning to the cooler compartment. In a front view of the insulated box, the first vacuum insulation material is disposed so as to overlap part of the cooler, the return air path is provided adjacent to the first vacuum insulation material so as not to overlap the first vacuum insulation material and so as to overlap the cooler, and the cold air outlet in the return air path is disposed at a position overlapping the cooler or below the cooler.

(57) 要約：冷蔵庫は、前面に扉で覆われる開口を有し、内部に複数の貯蔵室が形成された断熱箱体を備え、断熱箱体の内部には、隣接する他の貯蔵室よりも高温に設定されて貯蔵物を貯蔵する第１の貯蔵室と、第１の貯蔵室の後方に設けられ、冷却器が配置された冷却器室と、第１の貯蔵室と冷却器室との間に配置された第１の真空断熱材と、第１の貯蔵室と冷却器室とを連通させ、冷却器室へ戻る冷気が流通する戻り風路と、が設けられる。断熱箱体を正面視した場合において、第１の真空断熱材は、冷却器の一部と重複するように配置され、戻り風路は、第１の真空断熱材と重複せず、且つ冷却器と重複するように、第１の真空断熱材と隣接して設けられ、戻り風路における冷気の出口は、冷却器と重複する位置又は冷却器の下方の位置に配置されている。

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Technical Field

[0001]

The present disclosure relates to a refrigerator that includes a vacuum thermal insulator.

Background

[0002]

There is a type of refrigerator that includes a storage compartment that is set to a temperature higher than the temperatures of other compartments disposed around the storage compartment (see Patent Literature 1, for example). Patent Literature 1 discloses a refrigerator where a refrigerator compartment, an ice-making compartment, a vegetable compartment, and a freezer compartment are provided in this order from the top. When the frequency of opening and closing the door or the opening duration of the door is compared between the vegetable compartment and the freezer compartment, although there are differences according to the individual, the vegetable compartment generally has a higher frequency of opening and closing the door and a longer opening duration of the door. For this reason, in Patent Literature 1, the vegetable compartment is disposed at a position higher than the freezer compartment to improve convenience of the refrigerator. However, in the refrigerator having such a configuration, the ice-making compartment and the freezer compartment, which are spaces in a minus temperature zone, are provided above and below the vegetable compartment, which is a space in a plus temperature zone, and hence, a cooler is disposed behind the vegetable compartment, and cools the spaces disposed above and below the vegetable compartment into the minus temperature zone. In the refrigerator disclosed in Patent Literature 1, to prevent a situation where the vegetable compartment is excessively cooled, a vacuum thermal insulator is provided in the rear wall portion of the vegetable compartment, the vacuum thermal insulator having higher thermal insulation performance (that is, having a smaller heat transfer coefficient) than a foamed thermal insulator. Further, the refrigerator disclosed in Patent Literature 1 has a plurality of air passages that allow a cooler chamber, in which the cooler is disposed, to communicate with the storage compartments, such as the vegetable compartment. Cold air cycles through the inside of the refrigerator via these air passages, so that stored objects accommodated in the respective storage compartments are cooled by cold air. In the refrigerator disclosed in Patent Literature 1, the vacuum thermal insulator is provided to the rear wall portion of the vegetable compartment except for the left and right end portions of the rear wall portion, and the entire cooler is covered by the vacuum thermal insulator when viewed in the front view.

Patent Literature

[0003]

Patent Literature 1: International Publication No. WO 2018/13115

[0004]

The refrigerator disclosed in Patent Literature 1 is provided with a return air passage for cold air, the return air passage allowing the vegetable compartment and the cooler chamber to communicate with each other. Cold air warmed in the vegetable compartment is returned to the cooler chamber through the return air passage, and is cooled by the cooler again. Therefore, the outlet in the cooler chamber for the return air passage is disposed to cause cold air returned to the cooler chamber to pass through the cooler. In the refrigerator disclosed in Patent Literature 1, the vacuum thermal insulator is provided to cover the entire cooler when viewed in a front view, and the inlet of the return air passage is provided next to the vacuum thermal insulator. Accordingly, in the case where the outlet of the return air passage is disposed to cause cold air to pass through the cooler in the refrigerator disclosed in Patent Literature 1, the return air passage is provided to extend in the lateral direction from the inlet to the cooler when viewed in a front view. Further, in this case, a portion of the return air passage that overlaps with the vacuum thermal insulator when viewed in a front view is disposed behind the vacuum thermal insulator to bypass the vacuum thermal insulator. Therefore, the shape of the return air passage is complicated, and it is necessary to ensure a space to provide the return air passage in the rear wall portion of the vegetable compartment at a position behind the vacuum thermal insulator. Accordingly, in the case where the return air passage is provided in the refrigerator disclosed in Patent Literature 1 such that cold air returned to the cooler chamber from the vegetable compartment is caused to pass through the cooler, the thickness of the rear wall portion of the vegetable compartment increases, thus reducing a storage space.

[0005]

It is desired to address or alleviate one or more disadvantages or limitations of the prior art, or to at least provide a useful alternative. In some embodiments, the present disclosure provides a refrigerator in which a return air passage is provided without reducing a storage space, the return air passage returning cold air to cause the cold air to pass through the cooler.

Summary

[0006]

A refrigerator according to an embodiment of the present disclosure includes a thermal insulation box body in which a plurality of storage compartments are formed, the thermal insulation box body having an opening that is formed at a front side of the thermal insulation box body and that is covered by a door, wherein a first storage compartment configured to store a stored object, a temperature of the first storage compartment being set to a temperature higher than a temperature of another storage compartment of the plurality of storage compartments, another storage compartment being adjacent to the first storage compartment, a cooler chamber provided behind the first storage compartment, a cooler being disposed in the cooler chamber, a first vacuum thermal insulator disposed between the first storage compartment and the cooler chamber, and a return air passage configured to allow the first storage compartment and the cooler chamber to communicate with each other, cold air returning to the cooler chamber flowing through the return air passage, are provided in the thermal insulation box body, and when the thermal insulation box body is viewed in a front view, the first vacuum thermal insulator is disposed to overlap with a portion of the cooler, the return air passage is provided to be adjacent to the first vacuum thermal insulator in a state of overlapping with the cooler without overlapping with the first vacuum thermal insulator, and an outlet of the return air passage for the cold air is disposed at a position that overlaps with the cooler or at a position below the cooler.

[0007]

In the refrigerator according to this embodiment of the present disclosure, the return air passage does not overlap with the first vacuum thermal insulator when the thermal insulation box body is viewed in a front view and hence, it is unnecessary to provide a space for a return air passage at a position behind the vacuum thermal insulator. Accordingly, it is possible to avoid a reduction in the storage space of the first storage compartment. Further, in the refrigerator according to the embodiment of the present disclosure, when the thermal insulation box body is viewed in a front view, the return air passage is provided to be adjacent to the first vacuum thermal insulator in a state of overlapping with the cooler, and the outlet of the return air passage for cold air is disposed at a position that overlaps with the cooler or at a position below the cooler. Accordingly, unlike a conventional technique, it is possible to provide the return air passage that returns cold air to cause the cold air to pass through the cooler without requiring the return air passage to extend in the lateral direction. Therefore, according to the present disclosure, it is possible to provide the return air passage without reducing the storage space, the return air passage returning cold air to cause the cold air to pass through the cooler.

Brief Description of Drawings

[0008]

One or more embodiments of the present invention are hereinafter described, by way of example only, with reference to the accompanying drawings in which:

[Fig. 1] Fig. 1 is a perspective view showing the external appearance of a refrigerator according to Embodiment 1 of the present disclosure.

[Fig. 2] Fig. 2 is a schematic front view showing the inside of the refrigerator shown in Fig. 1.

[Fig. 3] Fig. 3 is an explanatory view showing a longitudinal cross section of the refrigerator shown in Fig. 1 taken along a front-back direction.

[Fig. 4] Fig. 4 is a diagram showing a refrigerant circuit of the refrigerator shown in Fig. 1.

[Fig. 5] Fig. 5 is an explanatory view showing a cross section of a portion of a wall portion of a thermal insulation box body of the refrigerator shown in Fig. 1.

[Fig. 6] Fig. 6 is an explanatory view showing a cross section of a portion of a wall portion of a left side surface portion of the thermal insulation box body of the refrigerator shown in Fig. 1.

[Fig. 7] Fig. 7 is an explanatory view showing another example of the cross section of the portion of the wall portion of the thermal insulation box body shown in Fig. 5.

[Fig. 8] Fig. 8 is an explanatory view showing another example of the cross section of the portion of the wall portion of the thermal insulation box body shown in Fig. 5.

[Fig. 9] Fig. 9 is a diagram showing a longitudinal cross section of an area around a vegetable compartment of the refrigerator shown in Fig. 1 taken along the front-back direction.

[Fig. 10] Fig. 10 is an explanatory view showing a longitudinal cross section of another example of a ceiling wall portion of the vegetable compartment shown in Fig. 9.

[Fig. 11] Fig. 11 is an explanatory view showing a longitudinal cross section of another example of the ceiling wall portion of the vegetable compartment shown in Fig. 9.

[Fig. 12] Fig. 12 is a diagram showing another example of a vegetable compartment rear wall portion shown in Fig. 9.

[Fig. 13] Fig. 13 is a diagram showing another example of the vegetable compartment rear wall portion shown in Fig. 9.

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[Fig. 14] Fig. 14 is a schematic view showing an X-X cross section of the refrigerator shown in Fig. 2.

[Fig. 15] Fig. 15 is a schematic front view showing a lower portion of the refrigerator shown in Fig. 2.

[Fig. 16] Fig. 16 is a schematic view showing an A-A cross section of the refrigerator shown in Fig. 2.

[Fig. 17] Fig. 17 is a schematic view showing a blowout air passage for cold air to a freezer compartment shown in Fig. 16 and a return air passage for cold air from the freezer compartment.

[Fig. 18] Fig. 18 is a schematic view showing a B-B cross section of the refrigerator shown in Fig. 2.

[Fig. 19] Fig. 19 is a schematic view showing a return air passage for cold air from the vegetable compartment shown in Fig. 18.

[Fig. 20] Fig. 20 is a schematic front view showing a cooler of the refrigerator shown in Fig. 3.

[Fig. 21] Fig. 21 is a front perspective view showing the cooler shown in Fig. 20.

[Fig. 22] Fig. 22 is a schematic view showing a T-T cross section of the refrigerator shown in Fig. 2.

[Fig. 23] Fig. 23 is a schematic view showing another example of the return air passage for cold air from the vegetable compartment of the refrigerator shown in Fig. 22.

[Fig. 24] Fig. 24 is a schematic front view showing another example of the refrigerator shown in Fig. 2.

[Fig. 25] Fig. 25 is a schematic front view of the refrigerator shown in Fig. 24.

[Fig. 26] Fig. 26 is a schematic view showing vacuum thermal insulators in wall portions forming the vegetable compartment of the refrigerator shown in Fig. 1.

[Fig. 27] Fig. 27 is a schematic view showing the vacuum thermal insulators in the wall portions forming the vegetable compartment of the refrigerator shown in Fig. 26 as viewed from the rear side.

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[Fig. 28] Fig. 28 is a partial schematic view of the vegetable compartment of the refrigerator shown in Fig. 15.

[Fig. 29] Fig. 29 is a schematic front view of a refrigerator according to Embodiment 2 of the present disclosure.

[Fig. 30] Fig. 30 is a schematic view showing a C-C cross section of the refrigerator shown in Fig. 29.

Detailed Description

[0009]

Hereinafter, Embodiments of the present disclosure will be described with reference to drawings. In the respective drawings, components given the same reference symbols are identical or corresponding components, and the same goes for the entire specification. Modes of constitutional elements shown in the entire specification are merely given for the sake of example, and are not limited to the description in the specification.

[0010]

Embodiment 1

Fig. 1 is a perspective view showing the external appearance of a refrigerator 1 according to Embodiment 1 of the present disclosure. Fig. 2 is a schematic front view showing the inside of the refrigerator 1 shown in Fig. 1. Fig. 3 is an explanatory view showing a longitudinal cross section of the refrigerator 1 shown in Fig. 1 taken along a front-back direction. Fig. 4 is a diagram showing a refrigerant circuit of the refrigerator shown in Fig. 1. The schematic configuration of the refrigerator 1 will be described with reference to Fig. 1 to Fig. 4.

[0011]

As shown in Fig. 1, the refrigerator 1 includes a thermal insulation box body 19. As shown in Fig. 2, a plurality of storage compartments are provided in the thermal insulation box body 19. In an example shown in Fig. 2, the thermal insulation box body 19 has a vertically elongated cuboid shape. In the example shown in Fig. 2, a refrigerator compartment 2, an ice-making compartment 3, a temperature versatile compartment 4, a freezer compartment 6, and a vegetable compartment 5 are formed in the thermal insulation box body 19. The refrigerator compartment 2, the ice-making compartment 3 and the temperature versatile compartment 4, the vegetable compartment 5, and the freezer compartment 6 are disposed in this order from the top. The ice-making compartment 3 and the temperature versatile compartment 4 are provided to be adjacent to each other in a lateral direction. The temperature versatile compartment 4 is disposed on the left, and the ice-making compartment 3 is disposed on the right of the temperature versatile compartment 4. Partitions that separates the storage compartments are provided in the thermal insulation box body 19. The number of storage compartments of the refrigerator 1, the type, that is, the set temperature, of each storage compartment, and the arrangement of the storage compartments are not limited to the above. For example, the refrigerator 1 may be configured to include a chiller compartment (being a storage compartment having a set temperature of 0 to 3 degrees C, for example). The temperature versatile compartment 4 may be disposed on the right, and the ice-making compartment 3 may be disposed on the left of the temperature versatile compartment 4.

[0012]

As shown in Fig. 2, the thermal insulation box body 19 includes an upper surface portion 19a, a bottom surface portion 19b, a right side surface portion 19c, a left side surface portion 19d, and a rear surface portion 19f (see Fig. 3), and has an opening formed at the front side thereof. As shown in Fig. 1, the refrigerator 1 includes doors 2a, 3a, 4a, 5a, and 6a that open and close the respective storage compartments. In the example shown in Fig. 2 and Fig. 3, the upper surface portion 19a of the thermal insulation box body 19 forms the ceiling wall portion of the refrigerator compartment 2, which is disposed at the uppermost portion, and the bottom surface portion 19b of the thermal insulation box body 19 forms the bottom wall portion of the freezer compartment 6, which is disposed at the lowermost portion. In the example shown in Fig. 2 and Fig. 3, the left side surface portion 19d of the thermal insulation box body 19 forms left side wall portions of the refrigerator compartment 2, the temperature versatile compartment 4, the vegetable compartment 5, and the freezer compartment 6. The right side surface portion 19c of the thermal insulation box body 19 forms right side wall portions of the refrigerator compartment 2, the ice-making compartment 3, the vegetable compartment 5, and the freezer compartment 6.

[0013]

As shown in Fig. 3, the refrigerator 1 includes a cooler 14 that cools the plurality of storage compartments. As shown in Fig. 4, the refrigerator 1 includes a refrigerant circuit 7 that includes the cooler 14. In an example shown in Fig. 4, the refrigerant circuit 7 is formed by connecting, by pipes, a compressor 8, an air cooled condenser 9, a condenser 10, a frost prevention pipe 11, a dryer 12, a pressure reducing device 13, and the cooler 14, the compressor 8 compressing refrigerant, the air cooled condenser 9 causing the refrigerant to exchange heat with surrounding air, the condenser 10 being provided in the wall portion of the thermal insulation box body 19, the dryer 12 removing moisture and foreign substances from the refrigerant, the pressure reducing device 13 reducing the pressure of the refrigerant. The frost prevention pipe 11 is routed around the respective storage compartments on the front side of the refrigerator 1. The configuration of the refrigerant circuit 7 is not limited to the above-mentioned configuration.

[0014]

As shown in Fig. 3, an air passage through which cold air passes is provided in the thermal insulation box body 19. As shown in Fig. 2, the refrigerator 1 includes a fan 15 that is disposed in the air passage at a position above the cooler, and causes cold air to cycle through the inside of the refrigerator 1. As shown in Fig. 3, the refrigerator 1 also includes air volume adjustment devices 18a, 18b, and 18c that adjust the volume of cold air being supplied to the respective storage compartments.

[0015]

The air passage is branched into a plurality of blowout air passages at positions higher than the cooler 14. Cold air that is cooled by the cooler 14 and is discharged from the fan 15 flows into the respective branched air passages. A blowout air passage 27 that communicates with the refrigerator compartment 2 is provided in a foamed thermal insulator installed at a position close to the rear surface of the refrigerator compartment 2. A portion of cold air from the cooler 14 is supplied to the refrigerator compartment 2 via the blowout air passage 27. The air volume adjustment device 18a is disposed in the blowout air passage 27, the air volume adjustment device 18a adjusting the volume of cold air supplied to the refrigerator compartment 2. Electric components that form the respective air volume adjustment devices 18a, 18b, and 18c are stored in the rear wall portions of the storage compartments disposed at positions above the vegetable compartment 5. With such a configuration, it is unnecessary to provide an extra space at a position behind the vegetable compartment 5 and hence, it is possible to achieve the vegetable compartment 5 having a large capacity.

[0016]

The lower portion of the rear surface portion 19f of the thermal insulation box body 19 is indented frontward, so that a machine chamber 51 is formed at a lower portion of the refrigerator 1 at a position close to the rear surface. The thermal insulation box body 19 also includes a vegetable compartment rear wall portion 31 provided between the cooler 14 and the vegetable compartment 5, and a cooler chamber 52, which is a space where the cooler 14 is disposed, is formed on the rear surface side of the vegetable compartment rear wall portion 31. The cooler chamber 52 communicates with the air passage. A frost prevention heater 47 (described later, see Fig. 16) and a drip tray 66 are provided in the cooler chamber 52 at a position below the cooler 14, the drip tray 66 receiving melted water from the cooler 14.

[0017]

As shown by solid line arrows in Fig. 4, in the refrigerant circuit 7, refrigerant discharged from the compressor 8 is supplied to the air cooled condenser 9, which is installed in the machine chamber 51. The refrigerant that flows through the air cooled condenser 9 flows through the condenser 10 installed in urethane of the thermal insulation box body 19 (see Fig. 3). The refrigerant that flows through the condenser 10 is condensed by a condensation step during the period in which the refrigerant flows through the frost prevention pipe 11 that is routed around the respective storage compartments on the front side of the refrigerator 1. The refrigerant that flows through the frost prevention pipe 11 passes through the dryer 12 and, thereafter, is supplied to the pressure reducing device 13, thus being reduced in pressure. The refrigerant that is reduced in pressure by the pressure reducing device 13 is supplied to the cooler 14. The refrigerant that is supplied to the cooler 14 evaporates in the cooler 14, thus exchanging heat with cold air that is forcibly caused to cycle through the inside of the refrigerator 1 by the fan 15. The cold air generated by the heat exchange in the cooler 14 cools the respective storage compartments in the refrigerator 1. After the refrigerant exchanges heat in the cooler 14, the refrigerant receives heat, thus being gasified, and then returns to the compressor 8.

[0018]

As shown by broken line arrows in Fig. 4, cold air generated by the cooler 14 is supplied to the respective storage compartments through the air passage by the fan 15. After the cold air cools the inside of the respective storage compartments and stored objects, such as food, the cold air returns to the cooler chamber 52 (see Fig. 3) again, and is cooled by the cooler 14.

[0019]

Each of the air volume adjustment devices 18a, 18b, and 18c shown in Fig. 3 is an electric component that adjusts opening and closing of an air passage, such as a damper. In the example shown in Fig. 3, three air volume adjustment devices, that is, the air volume adjustment devices 18a, 18b, 18c, are provided in the air passage at positions higher than the cooler 14 and downstream of the fan 15. The volume of air being supplied to the refrigerator compartment 2 is adjusted by the air volume adjustment device 18a, the volume of air being supplied to the temperature versatile compartment 4 is adjusted by the air volume adjustment device 18b, and the volume of air being supplied to the vegetable compartment 5 is adjusted by the air volume adjustment device 18c. The detailed configuration of the air passage will be described later.

[0020]

As shown in Fig. 3, the refrigerator 1 includes a plurality of temperature sensors 16a, 16b, 16c, and 16d installed in the storage compartments. Each temperature sensor detects the temperature of air in the storage compartment in which the temperature sensor is installed or the temperature of stored objects. In the example shown in Fig. 3, the temperature sensor 16a is installed in the refrigerator compartment 2, the temperature sensor 16b is installed in the temperature versatile compartment 4, the temperature sensor 16c is installed in the vegetable compartment 5, and the temperature sensor 16d is installed in the freezer compartment 6. Although not shown in the drawing, a temperature sensor is also installed in the ice-making compartment 3.

[0021]

The refrigerator 1 also includes a control unit 17 that performs various controls for the refrigerator 1. The control unit 17 is provided at the upper portion of the rear surface portion of the thermal insulation box body 19, for example. The control unit 17 includes a control board and a microcomputer, electronic components, and other components disposed on the control board. Temperature information detected by each of the above-mentioned plurality of temperature sensors is inputted into the control unit 17. The control unit 17 causes the respective air volume adjustment devices 18a, 18b, 18c to be operated according to the inputted temperature information. With such an operation, the volumes of air being supplied to the respective storage compartments are adjusted by the air volume adjustment devices 18a, 18b, 18c according to the temperatures detected by the temperature sensors 16a, 16b, 16c, 16d, so that the respective storage compartments are maintained at appropriate temperatures. The control unit 17 controls a frequency of the compressor 8 and the opening degree of the pressure reducing device 13, the compressor 8 and the pressure reducing device 13 being shown in Fig. 4.

[0022]

As shown in Fig. 2, the refrigerator 1 includes the storage compartments that are set to a freezing temperature zone, being a minus temperature zone, (the freezer compartment 6 and the ice-making compartment 3, for example), and the storage compartments that are set to a refrigeration temperature zone, being a plus temperature zone, (the refrigerator compartment 2 and the vegetable compartment 5, for example). In the example shown in Fig. 2 and Fig. 3, the freezer compartment 6 is disposed at the lowermost portion of the refrigerator 1 and the vegetable compartment 5 having a higher frequency of access than the freezer compartment 6 is disposed above the freezer compartment 6 to improve convenience. In the example shown in Fig. 2 and Fig. 3, the vegetable compartment 5 in the refrigeration temperature zone is disposed to be adjacent to the freezer compartment 6 and the ice-making compartment 3 in the up-down direction of the refrigerator 1, the freezer compartment 6 and the ice-making compartment 3 being in the freezing temperature zone. To ensure thermal insulation properties between the respective storage compartments, vacuum thermal insulators (not shown in the drawing) are provided to the partitions that are provided between the respective storage compartments. In the example shown in Fig. 2 and Fig. 3, to cool both the freezer compartment 6 and the ice-making compartment 3, which are in the freezing temperature zone, the cooler chamber 52 is provided behind the vegetable compartment 5, which is disposed between the freezer compartment 6 and the ice-making compartment 3. Therefore, to insulate the cooler 14 against heat from the vegetable compartment 5, a vacuum thermal insulator 39 (see Fig. 9, which will be described later) is also provided to the vegetable compartment rear wall portion 31, which is disposed between the cooler chamber 52 and the vegetable compartment 5 in the refrigeration temperature zone. Hereinafter, the vacuum thermal insulator 39 disposed between the cooler 14 and the vegetable compartment 5 may be referred to as "first vacuum thermal insulator". The arrangement of the first vacuum thermal insulator will be described later in more detail.

[0023]

In the refrigerator 1 shown in Fig. 3, by taking into account accessibility to the respective storage compartments and a balance between the inner volumes of the storage compartments, it is preferable to set a distance L from the floor surface of the room to a floor surface 2b of the refrigerator compartment 2 to 954 mm or more and 994 mm or less, the refrigerator compartment 2 being the storage compartment disposed at the uppermost portion.

[0024]

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In the example shown in Fig. 3, the cooler chamber 52, in which the cooler 14 is disposed, is mainly provided behind the vegetable compartment 5, and also extends to positions behind the lower portions of the ice-making compartment 3 and the temperature versatile compartment 4 and to a position behind the upper portion of the freezer compartment 6. A lower end 14b of the cooler 14 is located in the cooler chamber 52 at a position lower than a height F of the floor surface of the vegetable compartment 5 in the up-down direction. In the case where the lower end 14b of the cooler 14 is located at the position lower than the height F of the floor surface of the vegetable compartment 5 as shown in Fig. 3, a large space is ensured above the cooler 14, thus increasing the degree of freedom in selection of the size of the fan 15 that is disposed in this space.

[0025]

Fig. 5 is an explanatory view showing a cross section of a portion of a wall portion 20 of the thermal insulation box body 19 of the refrigerator 1 shown in Fig. 1. As shown in Fig. 5, the wall portion 20 of the thermal insulation box body 19 includes a metal sheet 21, an inner box 22, and a thermal insulator 23, the metal sheet 21 forming the outer shell, the inner box 22 forming inner walls of the respective storage compartments, the thermal insulator 23 being disposed between the metal sheet 21 and the inner box 22. The wall portion 20 suppresses the amount of heat intrusion from the outside. In Embodiment 1, the thermal insulator 23 is configured to include a vacuum thermal insulator 24. By sticking the vacuum thermal insulator 24 to the metal sheet 21 forming the outer shell, it is possible to significantly reduce the amount of heat intrusion. The vacuum thermal insulator 24 that is disposed in the wall portion 20 may be one rectangular plate-like vacuum thermal insulator, for example.

[0026]

Aside from the vacuum thermal insulator 24, the thermal insulator 23 is mainly made of a urethane foam material. The thermal insulator 23 is configured to include various internal parts disposed in a space in which a urethane foam material is sealed, the internal parts being fixed by the urethane foam material. Examples of the internal parts include a reinforcing part that corrects distortion of the refrigerator 1, parts of the above-mentioned refrigerant circuit 7, and parts of electric wiring.

[0027]

Fig. 6 is an explanatory view showing a cross section of a portion of the wall portion 20 of the left side surface portion 19d of the thermal insulation box body 19 of the refrigerator 1 shown in Fig. 1. As shown in Fig. 6, the thermal insulator 23 of the wall portion 20 of the left side surface portion 19d of the thermal insulation box body 19 of the refrigerator 1 is configured to fix, by a urethane foam material, various internal parts disposed in the space in which a urethane foam material is sealed. In Embodiment 1, a support 25 is also disposed on the wall portion 20 of the left side surface portion 19d of the thermal insulation box body 19 as the internal part in addition to the above-mentioned reinforcing part, the parts of the refrigerant circuit 7, and the parts of the electric wiring, for example, the support 25 supporting the door (for example, the door 5a shown in Fig. 1) of the drawer-type storage compartment. The support 25 has a rail structure that receives a frame structure forming the door of the drawer-type storage compartment, and the thermal insulator 23 that fixes the support 25 is formed into a shape that conforms to the shape of the rail structure to fix the rail structure of the support 25.

[0028]

The configuration of the wall portion 20 of the thermal insulation box body 19 is not limited to the above-mentioned configuration. Fig. 7 is an explanatory view showing another example of the cross section of the portion of the wall portion 20 of the thermal insulation box body 19 shown in Fig. 5. Fig. 8 is an explanatory view showing another example of the cross section of the portion of the wall portion 20 of the thermal insulation box body 19 shown in Fig. 5.

[0029]

As shown in Fig. 7, at some installation positions, the vacuum thermal insulator 24 of the thermal insulator 23 may be disposed at an intermediate position between the metal sheet 21 forming the outer shell and the wall surface of the inner box 22 by using spacers 26. Alternatively, as shown in Fig. 8, at some installation positions, the vacuum thermal insulator 24 of the thermal insulator 23 may be adhered to the wall surface of the inner box 22. As described above, the vacuum thermal insulator 24 of the thermal insulator 23 may be installed in the wall portion 20 by any one of the methods shown in Fig. 5, Fig. 6, and Fig. 7. To avoid the breakage of the vacuum thermal insulator 24, the vacuum thermal insulator 24 is installed in a state of preventing interference with the above-mentioned internal parts.

[0030]

It is preferable that an area covered by the vacuum thermal insulators 24 disposed in these wall portions 20 be 40% or more of the entire surface area of the outer shell including the thermal insulation box body 19 of the refrigerator 1 and the doors 2a, 3a, 4a, 5a and 6a (see Fig. 1) of the respective storage compartments. It is also preferable that the foam density of a urethane foam material sealed in an area around these vacuum thermal insulators 24 be 60 kg/cm^3 or more. It is also preferable that the flexural modulus of the urethane foam material be 15.0 MPa or more. By forming the urethane foam material as described above, it is possible to ensure the strength of the thermal insulation box body 19 of the refrigerator 1.

[0031]

As described above, the vacuum thermal insulator 24 having higher thermal insulation performance than the foamed thermal insulator is included in the thermal insulator 23 of the thermal insulation box body 19. Accordingly, even when a distance between the outer shell of the refrigerator 1 and the inner wall of the inner box 22 is reduced, that is, even when a thermal insulation thickness is reduced, it is possible to ensure equivalent thermal insulation performance. Therefore, in the case where the vacuum thermal insulator 24 is provided in the wall portion 20 of the thermal insulation box body 19, it is possible to increase the inner volume of the refrigerator 1 by reducing the thickness of the wall portion 20 compared with the case where the vacuum thermal insulator 24 is not provided.

[0032]

Fig. 9 is a diagram showing a longitudinal cross section of an area around the vegetable compartment 5 of the refrigerator 1 shown in Fig. 1 taken along the front-back direction. Fig. 10 is an explanatory view showing a longitudinal cross section of another example of a ceiling wall portion 32 of the vegetable compartment 5 shown in Fig. 9. Fig. 11 is an explanatory view showing a longitudinal cross section of another example of the ceiling wall portion 32 of the vegetable compartment 5 shown in Fig. 9. Fig. 12 is a diagram showing another example of the vegetable compartment rear wall portion 31 shown in Fig. 9. Fig. 13 is a diagram showing another example of the vegetable compartment rear wall portion 31 shown in Fig. 9. The plurality of wall portions forming the vegetable compartment 5 will be described with reference to Fig. 9 to Fig. 13.

[0033]

As shown in Fig. 9, the ceiling wall portion 32 of the vegetable compartment 5 forms the partition between the vegetable compartment 5, and the ice-making compartment 3 and the temperature versatile compartment 4 shown in Fig. 3. The ceiling wall portion 32 is a thermal insulation wall, and suppresses heat transfer between the vegetable compartment 5 and the storage compartments that are set to temperatures lower than the temperature of the vegetable compartment 5 and that are disposed above the vegetable compartment 5. The outer shell of the ceiling wall portion 32 is made of an injection molding material, and the inner portion of the ceiling wall portion 32 is made of a vacuum thermal insulator 33 and a urethane foam material 34. In the ceiling wall portion 32, the vacuum thermal insulator 33 is installed at a position close to the storage compartments having temperatures lower than the temperature of the vegetable compartment 5, that is, at a position close to the upper side.

[0034]

As shown in Fig. 9, a bottom wall portion 35 of the vegetable compartment 5 forms the partition between the vegetable compartment 5 and the freezer compartment 6 shown in Fig. 3. The bottom wall portion 35 is a thermal insulation wall, and suppresses heat transfer between the vegetable compartment 5 and the storage compartment that is set to a temperature lower than the temperature of the vegetable compartment 5 and that is disposed below the vegetable compartment 5.

In the same manner as the ceiling wall portion 32, the outer shell of the bottom wall portion 35 is made of an injection molding material, and the inner portion of the bottom wall portion 35 is made of a vacuum thermal insulator 36 and a urethane foam material 37. In the bottom wall portion 35, the vacuum thermal insulator 36 is installed at a position close to the storage compartment having a temperature lower than the temperature of the vegetable compartment 5, that is, at a position close to the lower side.

[0035]

By taking into account fluidity during manufacture and manufacturing variations, it is preferable that the thickness of each of the urethane foam material 34 in the ceiling wall portion 32 of the vegetable compartment 5 and of the urethane foam material 37 in the bottom wall portion 35 of the vegetable compartment 5 be 7 mm or more. Each of the vacuum thermal insulator 33 in the ceiling wall portion 32 of the vegetable compartment 5 and the vacuum thermal insulator 36 in the bottom wall portion 35 of the vegetable compartment 5 is one rectangular plate-like vacuum thermal insulator.

[0036]

The arrangement of the vacuum thermal insulator 33 in the ceiling wall portion 32 of the vegetable compartment 5 is not limited to the above. A configuration may be adopted where the vacuum thermal insulator 33 disposed in the ceiling wall portion 32 of the vegetable compartment 5 and the vacuum thermal insulator 36 disposed in the bottom wall portion 35 of the vegetable compartment 5 are respectively wrapped by the urethane foam materials 34, 37 in the urethane injection step in the manufacturing process of the refrigerator 1.

[0037]

As shown in Fig. 10, for example, in the ceiling wall portion 32, the vacuum thermal insulator 33 may be disposed between the upper and lower wall surfaces of the outer shell by ensuring viscosity of the urethane foam material 34 or the width of a flow passage. In this case, the entire vacuum thermal insulator 33 is wrapped by the urethane foam material 34 and hence, it is possible to further suppress the deterioration of the vacuum thermal insulator 33. Alternatively, as shown in Fig. 11, for example, in the ceiling wall portion 32, the vacuum thermal insulator 33 may be installed on the wall surface close to the vegetable compartment 5, that is, on the lower wall surface, from out of the upper and lower wall surfaces of the outer shell. In this case, a coverage of the vacuum thermal insulator 33 can be increased on the inner wall surface of the vegetable compartment 5 and hence, it is possible to suppress the amount of heat intrusion.

[0038]

As described above, the ceiling wall portion 32 and the bottom wall portion 35 respectively include the vacuum thermal insulator 33 and the vacuum thermal insulator 36, each of the ceiling wall portion 32 and the bottom wall portion 35 providing, in the refrigerator 1, the partition between the vegetable compartment 5 and the storage compartment that is adjacent to the vegetable compartment and that has a temperature lower than the temperature of the vegetable compartment (the freezer compartment 6 and the ice-making compartment 3, for example, in Embodiment 1). With such a configuration, an area of the vegetable compartment 5 that is covered by the vacuum thermal insulators 33, 36 increases as much as possible. Accordingly, it is possible to prevent inflow of cooling energy into the vegetable compartment 5 from the periphery of the vegetable compartment 5 and hence, it is possible to avoid a situation where the inside of the vegetable compartment 5 is excessively cooled.

[0039]

As shown in Fig. 9, of the plurality of wall portions forming the vegetable compartment 5, the vegetable compartment rear wall portion 31 is a thermal insulation wall that provides the partition between the vegetable compartment 5 and the cooler chamber 52 disposed behind the vegetable compartment 5. The vegetable compartment rear wall portion 31 includes thermal insulation wall outer shells 38 and 42, the vacuum thermal insulator 39, and a foamed thermal insulator 40 provided to wrap the vacuum thermal insulator 39. That is, the vegetable compartment rear wall portion 31 is configured to include the vacuum thermal insulator 39 between the inner wall of the vegetable compartment 5 and the cooler 14. The vacuum thermal insulator 39 may be one rectangular plate-like vacuum thermal insulator, for example.

[0040]

The thickness of the foamed thermal insulator 40 of the vegetable compartment rear wall portion 31 is set to a thickness obtained by using the limit thickness for molding as a reference and by providing a required thermal insulation thickness if there is an additional function desired to be provided to the foamed thermal insulator 40. In the case where PS-FO is used as a material for forming the foamed thermal insulator 40 and an expansion ratio is 40 times, for example, it is preferable to form the foamed thermal insulator 40 such that a thickness is at least 5 mm or more.

[0041]

A blowout air passage 41 for cold air to the freezer compartment 6 is provided in the foamed thermal insulator 40 of the vegetable compartment rear wall portion 31, the blowout air passage 41 allowing the cooler chamber 52 and the freezer compartment 6 (see Fig. 3) to communicate with each other. In an example shown in Fig. 9, components are arranged in front of and behind the blowout air passage 41 such that the cooler 14, the thermal insulation wall outer shell 42, the foamed thermal insulator 40 in which the blowout air passage 41 is formed, the vacuum thermal insulator 39, and the thermal insulation wall outer shell 38 that forms the inner wall of the vegetable compartment 5 are arranged in this order from the back.

[0042]

The configuration of the vegetable compartment rear wall portion 31 is not limited to the above-mentioned configuration. For example, as shown in Fig. 12, to make the thermal insulation effect of the vacuum thermal insulator 39 of the vegetable compartment rear wall portion 31 more effective, the vacuum thermal insulator 39 may be adhered to the inner wall of the thermal insulation wall outer shell 42 disposed close to the cooler 14. That is, the vacuum thermal insulator 39 is disposed in the vegetable compartment rear wall portion 31 at a position close to the cooler 14. However, in this case, restrictions are imposed on the vacuum thermal insulator 39 due to the position or the size of an outlet for cold air discharged from the fan 15 (see

Fig. 2), so that the dimension of the vacuum thermal insulator 39 in the height direction slightly reduces. In this case, the rear surface of the vacuum thermal insulator 39 is not covered by the foamed thermal insulator 40 and hence, there is a concern about the deterioration of the vacuum thermal insulator 39. By providing the foamed thermal insulator 40 between the vacuum thermal insulator 39 and the inner wall of the thermal insulation wall outer shell 42 disposed close to the cooler 14 as shown in Fig. 13, the rear surface of the vacuum thermal insulator 39 can be covered by the foamed thermal insulator 40. Accordingly, compared with the case shown in Fig. 13, it is possible to suppress the deterioration of the vacuum thermal insulator 39.

[0043]

The description has been made with reference to Fig. 9 for the case where, of the plurality of wall portions forming the vegetable compartment 5, the ceiling wall portion 32, the bottom wall portion 35, and the vegetable compartment rear wall portion 31 respectively include the vacuum thermal insulators 33, 36, 39. However, a configuration may be adopted where each of the left and right side wall portions of the vegetable compartment 5 and the door 5a of the vegetable compartment 5 also includes the vacuum thermal insulator. Each vacuum thermal insulator may be one rectangular plate-like vacuum thermal insulator. As in the case of the vegetable compartment 5 of the present disclosure, when the configuration is adopted where the vegetable compartment 5 is adjacent to the storage compartment having a temperature lower than the temperature of the vegetable compartment 5 and the cooler 14 is disposed behind the vegetable compartment 5, there is a possibility that cooling energy flows into the vegetable compartment 5, thus excessively cools the inside of the vegetable compartment 5. However, by adopting the configuration where the plurality of wall portions forming the vegetable compartment 5 respectively include vacuum thermal insulators 24, 33, 36, 39, each being one rectangular vacuum thermal insulator, as described above, it is possible to prevent inflow of cooling energy into the vegetable compartment 5 from the periphery of the vegetable compartment 5 and hence, it is possible to avoid a situation where the inside of the vegetable compartment 5 is excessively cooled. Further, it is also possible to prevent heat radiation from the inside of the vegetable compartment 5 to the periphery of the refrigerator 1 being the outside of the vegetable compartment 5 and hence, the inside of the vegetable compartment 5 can be maintained at a set temperature with high heat efficiency.

[0044]

Fig. 14 is a schematic view showing an X-X cross section of the refrigerator 1 shown in Fig. 2. Fig. 15 is a schematic front view showing the lower portion of the refrigerator shown in Fig. 2. Fig. 16 is a schematic view showing an A-A cross section of the refrigerator 1 shown in Fig. 2. Fig. 17 is a schematic view showing the blowout air passage 41 for cold air to the freezer compartment 6 shown in Fig. 16 and a return air passage 70 for cold air from the freezer compartment 6. Fig. 18 is a schematic view showing a B-B cross section of the refrigerator 1 shown in Fig. 2. Fig. 19 is a schematic view showing a return air passage 80 for cold air from the vegetable compartment 5 shown in Fig. 18. Outline arrows in the drawings show directions in which cold air flows. The configuration of the air passages and the positional relationship between the air passages and the vacuum thermal insulator 39 will be described with reference to Fig. 14 to Fig. 19.

[0045]

As shown in Fig. 14 and Fig. 15, a blowout air passage 30 for cold air to the vegetable compartment 5, blowout air passages (not shown in the drawing) for cold air to the temperature versatile compartment 4 and the ice-making compartment 3, and the blowout air passage 41 for cold air to the freezer compartment 6 are provided in the thermal insulation box body 19 in addition to the blowout air passage 27 for cold air to the refrigerator compartment 2 shown in Fig. 3, the blowout air passage 30, the blowout air passages (not shown in the drawing), and the blowout air passage 41 being branched from the blowout air passage 27 at positions above the cooler 14. A return air passage 29a for cold air from the temperature versatile compartment 4, a return air passage 28 for cold air from the ice-making compartment 3, a return air passage 29b for cold air from the refrigerator compartment 2, and the return air passage 80 for cold air from the vegetable compartment 5 are also provided in the thermal insulation box body 19. As shown in Fig. 16, the return air passage 70 for cold air from the freezer compartment 6 is provided in the thermal insulation box body 19.

[0046]

As shown in Fig. 15, the blowout air passage 30 for cold air to the vegetable compartment 5 is provided to extend from a branch point on the downstream of the fan 15 to the upper side of the rear portion of the vegetable compartment 5. A blowout port 44 is an outlet of the blowout air passage 30 for cold air, and is provided in the inner wall of the vegetable compartment 5. In an example shown in Fig. 15, the blowout port 44 is provided in the inner wall of the vegetable compartment rear wall portion 31. The air volume adjustment device 18c is disposed in the blowout air passage 30, and a portion of cold air cooled by the cooler 14 is blown into the vegetable compartment 5 by the fan 15 from the blowout port 44 via the air volume adjustment device 18c. Of the wall portions forming the vegetable compartment 5, the blowout port 44 may be formed in the inner wall of the wall portion other than the vegetable compartment rear wall portion 31. In the example shown in Fig. 15, the configuration is adopted where the blowout air passage 30 allows the cooler 14 and the vegetable compartment to directly communicate with each other, and the blowout port 44 causes cold air cooled by the cooler 14 to directly flow into the vegetable compartment 5. However, the configuration is not particularly limited to such a configuration. For example, a configuration may be adopted where the blowout air passage 30 communicates with the vegetable compartment 5 via another storage compartment (for example, the refrigerator compartment 2) from the cooler 14. In this case, cold air that is cooled by the cooler 14 and is then warmed by cooling stored objects in another storage compartment (the refrigerator compartment 2) is supplied to the vegetable compartment 5.

[0047]

As shown in Fig. 15 and Fig. 16, the blowout air passage 41 for cold air to the freezer compartment 6 is provided to extend from a branch point on the downstream of the fan 15 to an area behind the vegetable compartment 5 and an area behind the bottom wall portion 35 of the vegetable compartment that provides the partition between the freezer compartment 6 and the vegetable compartment 5. As shown in Fig. 16 and Fig. 17, the return air passage 70 for cold air from the freezer compartment 6 is provided behind the lower portion of the blowout air passage 41 for cold air to the freezer compartment 6, the return air passage 70 allowing the freezer compartment 6 and the cooler chamber 52 to communicate with each other.

[0048]

As shown in Fig. 15, the return air passage 29a for cold air from the temperature versatile compartment 4 is provided behind the temperature versatile compartment 4 and behind the vegetable compartment 5, and allows the temperature versatile compartment 4 and the cooler chamber 52 (see Fig. 14) to communicate with each other. The return air passage 28 for cold air from the ice-making compartment 3 is provided behind the ice-making compartment 3 and behind the vegetable compartment 5, and allows the ice-making compartment 3 and the cooler chamber 52 (see Fig. 14) to communicate with each other in the up-down direction.

[0049]

As shown in Fig. 15 and Fig. 18, the return air passage 80 for cold air from the vegetable compartment 5 is provided behind the vegetable compartment 5, and allows the vegetable compartment 5 and the cooler chamber 52 (see Fig. 14) to communicate with each other. As shown in Fig. 15, the return air passage 80 has a vertically elongated shape that extends in the up-down direction when viewed in a front view. As shown in Fig. 18, a return port 45 being an inlet for cold air is provided in the front side of the upper end portion of the return air passage 80, and an outlet 81 for cold air is provided in the rear side of the lower end portion of the return air passage 80. The return air passage 80 is provided in the vegetable compartment rear wall portion 31, and the return port 45 is provided in the inner wall of the vegetable compartment rear wall portion 31.

[0050]

In the example shown in Fig. 15, the blowout air passage 41 for cold air to the freezer compartment 6 and the return air passage 70 for cold air from the freezer compartment 6 (see Fig. 16) are disposed behind the vegetable compartment 5 at the center in the left-right direction when viewed in a front view. The blowout air passage 30 for cold air to the vegetable compartment 5, the return air passage 29a for cold air from the temperature versatile compartment 4, the return air passage 28 for cold air from the ice-making compartment 3, and the return air passage 80 for cold air from the vegetable compartment 5 are disposed on the right or left of the blowout air passage 41 in a state of being substantially parallel to the blowout air passage 41. The blowout air passage 30 for cold air to the vegetable compartment 5, the return air passage 29a for cold air from the temperature versatile compartment 4, and the return air passage 29b for cold air from the refrigerator compartment 2 are disposed on the left of the blowout air passage 41 for cold air to the freezer compartment 6. Of these air passages, the return air passage 29b for cold air from the refrigerator compartment 2 is disposed at the leftmost position. The return air passage 28 for cold air from the ice-making compartment 3 and the return air passage 80 for cold air from the vegetable compartment 5 are disposed on the right of the blowout air passage 41 for cold air to the freezer compartment 6 when viewed in a front view. The return air passage 80 for cold air from the vegetable compartment 5 is disposed at the rightmost position. The return air passage 29b for cold air from the refrigerator compartment 2 is connected to the drip tray 66 in the cooler chamber 52 (see Fig. 16) from the left at a position below the cooler 14.

[0051]

As shown in Fig. 14, the above-mentioned air passages, that is, the blowout air passages 30, 41 and the return air passages 29a, 28, 80, are formed in the vegetable compartment rear wall portion 31, which is provided between the vegetable compartment 5 and the cooler chamber 52. In the vegetable compartment rear wall portion 31 shown in Fig. 14, a space formed between the blowout air passage 41 and the return air passage 28 is a thickness reducing portion that is provided for stabilizing the shape of the vegetable compartment rear wall portion 31.

[0052]

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As shown in Fig. 15, the vacuum thermal insulator 39 of the vegetable compartment rear wall portion 31 is disposed to overlap with a portion of the cooler 14 when viewed in a front view. The return air passage 80 for cold air from the vegetable compartment 5 is provided to be adjacent to the vacuum thermal insulator 39 in a state of, without overlapping with the vacuum thermal insulator 39, overlapping with a portion of the cooler 14 that does not overlap with the vacuum thermal insulator 39 when viewed in a front view. In the example shown in Fig. 15, a configuration is adopted where most of the left portion of the front surface of the cooler 14 from the upper end to the lower end is covered by the rectangular vacuum thermal insulator 39, and the right portion of the front surface of the cooler 14 is covered by the return air passage 80 for cold air from the vegetable compartment 5, the return air passage 80 extending in the up-down direction.

[0053]

It is preferable that substantially the entire cooler 14 be covered by one rectangular vacuum thermal insulator 39 and the space of the return air passage 80 when viewed in a front view, cold air warmed in the vegetable compartment 5 flowing through the return air passage 80. With such a configuration, an effect of suppressing inflow of cooling energy into the vegetable compartment 5 from the cooler 14 can be maintained and, compared with the conventional configuration where the entire front surface of the cooler 14 is covered only by the vacuum thermal insulator 39, the lateral width of the vacuum thermal insulator 39 can be reduced compared with the conventional configuration and hence, it is possible to reduce costs. Further, by suppressing inflow of cooling energy into the vegetable compartment 5 from the cooler 14, it is possible to prevent a rise in temperature of the cooler 14 and it is also possible to prevent lowering of the temperature of the vegetable compartment rear wall portion 31. As a result, it is possible to prevent frosting in the vegetable compartment 5.

[0054]

It is not always necessary to adopt the configuration where the entire front surface of the cooler 14 is completely covered by the vacuum thermal insulator 39 and the return air passage 80. In the case where the return air passage 80 is disposed next to the vacuum thermal insulator 39, a wall portion that forms the return air passage 80 is disposed between the vacuum thermal insulator 39 and the return air passage 80. Therefore, by taking into account the strength and the like necessary for the return air passage 80, a wall portion having a certain thickness or less may be interposed between the return air passage 80 and the vacuum thermal insulator 39. Further, the wall portion that forms the return air passage 80 may include a thermal insulator.

[0055]

The return air passage 80 for cold air from the vegetable compartment 5 is disposed in the vegetable compartment rear wall portion 31 in a space next to the vacuum thermal insulator 39, the space being formed by reducing the lateral width of the vacuum thermal insulator 39. The return air passage 80 is disposed to overlap with the portion of the cooler 14 that does not overlap with the vacuum thermal insulator 39 when viewed in a front view. Accordingly, as shown in Fig. 19, it is sufficient that the outlet 81 of the return air passage 80 extends in the backward direction only by an amount corresponding to the thickness of the wall portion of the vegetable compartment rear wall portion 31 at a position close to the cooler chamber 52. Therefore, unlike the conventional configuration where the entire front surface of the cooler 14 is covered only by the vacuum thermal insulator 39, it is unnecessary to adopt a complicated configuration where the return air passage 80 is provided in a state of bypassing the vacuum thermal insulator 39 or is caused to extend not only in the backward direction but also in the lateral direction.

[0056]

In the example shown in Fig. 15, the vacuum thermal insulator 39 has a lateral width Wv smaller than a lateral width Wc of the cooler 14, and is provided such that the left end portion of the vacuum thermal insulator 39 covers the left end of the cooler 14 when viewed in a front view. The right portion of the cooler 14 is not covered by the vacuum thermal insulator 39, but is covered by the return air passage 80 when viewed in a front view.

[0057]

The arrangement of the vacuum thermal insulator 39 relative to the cooler 14 is not limited to the above. For example, the vacuum thermal insulator 39 may be disposed such that the right end portion of the vacuum thermal insulator 39 covers the right end of the cooler 14 when viewed in a front view. Alternatively, for example, one end portion of the vacuum thermal insulator 39 may be aligned with the end portion of the cooler 14 such that the right end of the vacuum thermal insulator 39 matches the right end of the cooler 14 or the left end of the vacuum thermal insulator 39 matches the left end of the cooler 14 when viewed in a front view.

[0058]

In the example shown in Fig. 14 and Fig. 15, in the same manner as the above-mentioned case of the return air passage 80, the blowout air passage 30 is also configured not to overlap with the vacuum thermal insulator 39 when viewed in a front view, the inner wall of the vegetable compartment rear wall portion 31 having the blowout port 44 of the blowout air passage 30. However, unlike the case of the return air passage 80, it is not always necessary for the blowout air passage 30 for cold air to the vegetable compartment 5 to overlap with the cooler 14 when viewed in a front view.

[0059]

As shown in Fig. 15, neither the blowout port 44 for cold air to the vegetable compartment 5 nor the return port 45 for cold air from the vegetable compartment 5 is provided in the inner wall of the vegetable compartment rear wall portion 31 at positions that overlap with the vacuum thermal insulator 39 when viewed in a front view. Such a configuration does not require special working, such as forming holes or notches in the vacuum thermal insulator 39, or does not require the use of a plurality of vacuum thermal insulators in forming the blowout port 44 and the return port 45. Further, it is unnecessary to cause the blowout air passage 30 and the return air passage 80 to have a complicated shape that bypasses the vacuum thermal insulator 39, the blowout air passage 30 and the return air passage 80 communicating with the vegetable compartment 5.

[0060]

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In the conventional refrigerator, a blowout port for cold air to a vegetable compartment and a return port for cold air from the vegetable compartment are provided in a vegetable compartment rear wall portion at diagonal corner portions disposed outside a vacuum thermal insulator when viewed in a front view. In the conventional refrigerator, the vacuum thermal insulator is provided over a large area to cover the entire front surface of a cooler and hence, restrictions are imposed on a choice for the arrangement of the return port for cold air from the vegetable compartment compared with the present disclosure. In the conventional refrigerator, the blowout port is provided in the vegetable compartment rear wall portion at an upper corner portion, and the return port is provided in the vegetable compartment rear wall portion at a lower corner portion disposed at the opposite diagonal corner from the blowout port for cold air. In such a configuration, cold air cannot easily enter the return air passage from the return port, the cold air being blown into the vegetable compartment from the blowout port and descending while spreading. The reason is as follows. The cold air blown out from the blowout port and having a temperature lower than the temperature in the vegetable compartment flows downward immediately after being blown out. However, the cold air is gradually warmed as the cold air cools casings and food in the vegetable compartment, so that the warmed cold air gradually rises.

[0061]

In contrast, in the present disclosure, as shown in Fig. 14, the blowout port 44 and the return port 45 are provided in the inner wall of the vegetable compartment rear wall portion 31 at the same height. More specifically, the blowout port 44 is provided at the upper portion located on the left of the vacuum thermal insulator 39 when viewed in a front view. The return port 45 is provided at the upper portion located on the right of the vacuum thermal insulator 39, the upper portion being located at a position that overlaps with the cooler 14 when viewed in a front view.

[0062]

With such a configuration, it is possible to separate the blowout port 44 and the return port 45 from each other by a certain distance or more in the left-right direction

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due to the vacuum thermal insulator 39. Further, it is possible to provide the return port 45 at an intermediate portion or an upper portion located at a position higher than the return port of the conventional configuration. Accordingly, cold air circulates through the entire vegetable compartment 5, so that a thermal efficiency is improved. In the above-mentioned configuration, the blowout air passage 30 and the return air passage 80 can be provided without being interrupted by the vacuum thermal insulator 39 in the front-back direction. Further, the return air passage 80 can be provided at a position that overlaps with the cooler 14 when viewed in a front view. Accordingly, cold air can be returned to the cooler 14 while the blowout air passage 30 and the return air passage 80 are allowed to have simple shapes.

[0063]

Positions where the blowout port 44 and the return port 45 are provided are not limited to the above-mentioned case. For example, of the wall portions forming the vegetable compartment 5, the blowout port 44 for cold air to the vegetable compartment 5 may be provided in a wall portion other than the vegetable compartment rear wall portion 31, such as the ceiling wall portion 32 of the vegetable compartment 5. For example, the return port 45 for cold air from the vegetable compartment 5 may be provided at a position higher than the blowout port 44.

[0064]

Even when the return port 45 is provided at the height of the intermediate stage or the upper stage of the cooler 14 when viewed in a front view, it is possible to guide cold air from the vegetable compartment 5 to the lowermost stage of the cooler 14 from the return port 45 by causing the cold air to pass through the return air passage 80 extending in the up-down direction. Cold air in the cooler chamber 52 is moved upward by the fan 15. Accordingly, it is possible to efficiently perform heat exchange between the cooler 14 and cold air that is returned from the vegetable compartment 5.

[0065]

In such a configuration, cold air that is blown into the vegetable compartment 5 from the blowout port 44 takes a path where the cold air once reaches the lower portion of the vegetable compartment 5 and, thereafter, returns toward the return port

45 disposed at the upper portion. In the case where a plurality of casings are provided in the storage compartment, such as the vegetable compartment, in the conventional refrigerator, cold air that is blown out from the blowout port, which is located in the storage compartment at a right upper back portion takes a cyclic path where the cold air first enters an upper casing, and then flows into a lower casing and, thereafter, flows into the return port, which is located in the storage compartment at a left lower back portion. However, when cold air flows as described above, immediately after cold air is blown out, the cold air impinges on the casings and food, so that there is a possibility that food is frozen or dried out. In contrast, in the configuration of the present disclosure, the return port 45 is provided to the vegetable compartment 5 at a position higher than the return port of the conventional configuration and hence, it is possible to cause cold air that is blown out to uniformly cycle around the casings without directly guiding the cold air into the casings (not shown in the drawing) provided in the vegetable compartment 5. As a result, it is possible to avoid a situation where food is frozen. Further, water vapor in the casing is prevented from easily flowing to the outside of the casing and hence, it is possible to enhance food moisture retention performance.

[0066]

As described with reference to Fig. 15, the blowout air passage 41 for cold air to the freezer compartment 6 includes, in the up-down direction, a portion provided in the vegetable compartment rear wall portion 31, which separates the vegetable compartment 5 and the cooler 14 from each other, and a portion provided in the bottom wall portion 35 of the vegetable compartment 5, which provides the partition between the vegetable compartment 5 and the freezer compartment 6. The portion of the blowout air passage 41 for cold air to the freezer compartment 6, the portion being provided in the vegetable compartment rear wall portion 31, that is, the portion of the blowout air passage 41 that is located at a position behind the vegetable compartment 5, is disposed to overlap with the vacuum thermal insulator 39 when viewed in a front view. Further, the return air passage 29a for cold air from the temperature versatile compartment 4 and the return air passage 28 for cold air from

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the ice-making compartment 3 are also provided in the vegetable compartment rear wall portion 31 to overlap with the vacuum thermal insulator 39 when viewed in a front view. In the example shown in Fig. 14, the blowout air passage 41 for cold air to the freezer compartment 6, the return air passage 29a for cold air from the temperature versatile compartment 4, and the return air passage 28 for cold air from the ice-making compartment 3 are arranged in the lateral direction of the refrigerator 1 at positions behind the vacuum thermal insulator 39. In the example shown in Fig. 14, the return air passage 29b for cold air from the refrigerator compartment 2 is provided in the thermal insulator that is disposed behind the vegetable compartment rear wall portion 31 and on the left of the cooler 14.

[0067]

As shown in Fig. 15, in the lateral direction of the refrigerator 1, the vacuum thermal insulator 39 of the vegetable compartment rear wall portion 31 is provided over an area larger than the area where the cooler 14 and the blowout air passage 41 are provided. In the height direction of the refrigerator 1, the vacuum thermal insulator 39 of the vegetable compartment rear wall portion 31 is provided over an area larger than the area where the cooler 14 is provided. It is preferable that the vacuum thermal insulator 39 of the vegetable compartment rear wall portion 31 be provided from the upper end to the lower end of the vegetable compartment rear wall portion 31 to overlap with substantially the entire portion of the blowout air passage 41 for cold air to the freezer compartment 6, the portion of the blowout air passage 41 being provided in the vegetable compartment rear wall portion 31, when viewed in a front view.

[0068]

As shown in Fig. 17, the return air passage 70 for cold air from the freezer compartment 6 is provided to overlap with the lower portion of the blowout air passage 41 shown in Fig. 15 at a position behind the bottom wall portion 35 of the vegetable compartment 5, which is provided between the vegetable compartment 5 and the freezer compartment 6. As shown in Fig. 15, in the lateral direction of the refrigerator 1, the blowout air passage 41 and the return air passage 70 (see Fig. 17) are disposed within the area where the cooler 14 is disposed, and the blowout air passage 41 and the return air passage 70 have a width equal to or smaller than the width Wc of the cooler 14. As shown in Fig. 16, the outlet of the return air passage 70 for cold air is connected to the drip tray 66 in the cooler chamber 52 at a position below the cooler 14 in the same manner as the outlet of the return air passage 29b for cold air from the refrigerator compartment 2 (see Fig. 14).

[0069]

As shown in Fig. 17, the blowout air passage 41 for cold air to the freezer compartment 6 is branched into an upper blowout air passage and a lower blowout air passage at the outlet. Accommodation casings 6b in the plurality of stages in the up-down direction are provided in the freezer compartment 6. A guide portion 6c is provided to the ceiling of the freezer compartment 6 at a position close to the back side, and the guide portion 6c guides cold air from upper and lower outlets of the blowout air passage 41. The guide portion 6c includes a first guide portion 6c1 and a second guide portion 6c2 provided behind the first guide portion 6c1. The first guide portion 6c1 is configured to branch the outlet of the blowout air passage 41 into the upper outlet and the lower outlet, and the second guide portion 6c2 is configured to provide the partition between the lower outlet of the blowout air passage 41 and the inlet of the return air passage 70. That is, the guide portion 6c plays a role of both a guide for cold air blown into the freezer compartment 6 and a guide for cold air returned from the inside of the freezer compartment 6.

[0070]

As shown in Fig. 17, cold air is cooled by the cooler 14 and is then caused to pass through the blowout air passage 41 for cold air to the freezer compartment 6 by the fan 15. The cold air is introduced into the accommodation casings 6b in the plurality of stages in the freezer compartment 6 by the guide portion 6c of the freezer compartment 6, and cools stored objects in the respective accommodation casings 6b. The cold air that is warmed by cooling the stored objects in the respective accommodation casings 6b is introduced to the inlet of the return air passage 70 by the guide portion 6c, and then enters the return air passage 70. The cold air that enters the return air passage 70 passes through the return air passage 70 and then returns to an area below the cooler 14 in the cooler chamber 52.

[0071]

As shown in Fig. 14, the vacuum thermal insulator 39 of the vegetable compartment rear wall portion 31 can be provided to overlap with the front surface of a cooler center portion 14a of the cooler 14 when viewed in a front view, fins 91 being provided to the cooler center portion 14a. In this case, the return air passage 80 for cold air from the vegetable compartment 5 is provided to overlap with a portion of the cooler 14 that does not overlap with the vacuum thermal insulator 39, such as hairpin portions 95 of a refrigerant pipe 92, when viewed in a front view. The area of the cooler 14 that overlaps with the vacuum thermal insulator 39 or the return air passage 80 when viewed in a front view is not limited to the above. For example, in the case where importance is placed on a reduction in cost of the vacuum thermal insulator 39, the return air passage 80 may be disposed on one end side of the cooler 14 in the left-right direction to overlap with a portion of the cooler 14 that is disposed outside the cooler center portion 14a and a portion of the cooler center portion 14a on one end side. Alternatively, in the case where importance is placed on thermal insulation properties between the vegetable compartment 5 and the cooler chamber 52, for example, the vacuum thermal insulator 39 may be provided to overlap with at least the entire front surface of the cooler center portion 14a.

[0072]

Fig. 20 is a schematic front view showing the cooler 14 of the refrigerator 1 shown in Fig. 3. Fig. 21 is a front perspective view showing the cooler 14 shown in Fig. 20. Fig. 22 is a schematic view showing a T-T cross section of the refrigerator 1 shown in Fig. 2. The configuration of the cooler 14 will be described in detail with reference to Fig. 20 to Fig. 22.

[0073]

The cooler 14 includes the refrigerant pipe 92 and the plurality of fins 91, refrigerant flowing through the inside of the refrigerant pipe 92, the plurality of fins 91 being mounted on the refrigerant pipe 92. The cooler 14 performs heat exchange

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between refrigerant and air that flows around the fins 91 with the plurality of fins 91. On the right and the left of the cooler center portion 14a to which the fins 91 are provided, the refrigerant pipe 92 is bent, thus forming the hairpin portions 95. Refrigerant pipe center portions of the refrigerant pipe 92 form the cooler center portion 14a, and the plurality of hairpin portions 95 are provided to the left side and the right side of the refrigerant pipe center portions. Each hairpin portion 95 connects right ends or left ends of two refrigerant pipe center portions to which the plurality of fins 91 are provided. The connected refrigerant pipe center portions are horizontally provided to be parallel to each other.

[0074]

The cooler 14 also includes partition portions 97 at the left and right end portions respectively, the partition portions 97 being provided to surround the hairpin portions 95. Each partition portion 97 includes a plate-like separation plate 97a, an outer plate 97b, and a roof portion 97c, the separation plate 97a extending in the up-down direction and having holes in which the refrigerant pipe 92 is disposed, the outer plate 97b covering the end portions of the hairpin portions 95 of the refrigerant pipe 92 in the lateral direction, the roof portion 97c being disposed above the hairpin portions 95. The partition portion 97 has a substantially U shape. The separation plate 97a is provided to separate the refrigerant pipe center portions of the refrigerant pipe 92 from the hairpin portions 95 of the refrigerant pipe 92. A portion of the cooler 14 between the separation plate 97a of the left partition portion 97 and the separation plate 97a of the right partition portion 97 is the cooler center portion 14a. Each partition portion 97 can be formed by bending one plate part.

[0075]

As described above, the fins 91 are not provided to the hairpin portions 95 of the cooler 14 and hence, compared with the cooler center portion 14a, the left end portion and the right end portion of the cooler 14 have lower heat exchange capacity. Therefore, a temperature difference between the cooler chamber 52 and the vegetable compartment 5 shown in Fig. 14 is smaller in the periphery of the hairpin portions 95 than in the periphery of the cooler center portion 14a. For this reason, as shown in

Fig. 14, the vacuum thermal insulator 39 is provided in the vegetable compartment rear wall portion 31, which is disposed between the vegetable compartment 5 and the cooler chamber 52, to overlap with the cooler center portion 14a when viewed in a front view, and the return air passage 80 is provided next to the vacuum thermal insulator 39 to overlap with at least a portion of the hairpin portions 95. With such a configuration, an influence on heat transfer between the vegetable compartment 5 and the cooler chamber 52 is suppressed, and the lateral width Wv of the vacuum thermal insulator 39 of the vegetable compartment rear wall portion 31 (see Fig. 15) can be reduced compared with the conventional technique.

[0076]

As shown in Fig. 21, a heater pipe 93 of the frost prevention heater 47 is disposed at the front surface portion of the cooler 14. As shown in Fig. 22, the frost prevention heater 47 includes a holding portion 94 that holds the heater pipe 93. The frost prevention heater 47 of the cooler 14 melts frost, thus generating melted water, and the melted water is discharged to the outside of the thermal insulation box body 19 via the drip tray 66.

[0077]

As shown in Fig. 22 showing a transverse cross section of the lower portion of the cooler chamber 52, a configuration is adopted where the outlet 81 of the return air passage 80 for cold air from the vegetable compartment 5 is provided in the vegetable compartment rear wall portion 31 at a position in the vicinity of the holding portion 94 for the heater pipe 93, and cold air returns to the cooler 14 disposed above the outlet 81. Specifically, in an example shown in Fig. 22, the outlet 81 of the return air passage 80 for cold air from the vegetable compartment 5 is provided at a position that overlaps with the holding portion 94 for the heater pipe 93 when viewed in a front view. Alternatively, the outlet 81 of the return air passage 80 may be provided outside the holding portion 94 when viewed in a front view.

[0078]

The position and the configuration of the outlet 81 of the return air passage 80 for cold air from the vegetable compartment 5 are not limited to the above. It is

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sufficient that the outlet 81 of the return air passage 80 for cold air be disposed at a position that overlaps with the cooler 14 or a position below the cooler 14 when viewed in a front view. If the outlet 81 for cold air is disposed at a position higher than the cooler 14, cold air cannot be returned to pass through the cooler 14. Accordingly, such a case is excluded.

[0079]

Fig. 23 is a schematic view showing another example of the return air passage 80 for cold air from the vegetable compartment 5 of the refrigerator 1 shown in Fig. 22. In an example shown in Fig. 23, the return air passage 80 includes an air passage guide portion 82 at a position close to the outlet 81, the air passage guide portion 82 extending toward the heater pipe 93 disposed at a position closer to the center than the holding portion 94. The air passage guide portion 82 includes, for example, a guide front portion 82b and a guide rear portion 82a, the guide front portion 82b being formed at the rear portion of the vegetable compartment rear wall portion 31, the guide rear portion 82a being formed from a thermal insulation wall different from the vegetable compartment rear wall portion 31 provided in the cooler chamber 52.

[0080]

The air passage guide portion 82 is provided to incline toward the rear side and the center as the air passage guide portion 82 extends toward the outlet 81. With such a configuration, the outlet 81 of the return air passage 80 is disposed at a position close to the heater pipe 93 and hence, return cold air that flows out from the outlet 81 is warmed by the heater pipe 93. Accordingly, it is possible to suppress frost formed around the outlet 81.

[0081]

In the example shown in Fig. 23, the air passage guide portion 82 is provided at a position close to the outlet of the return air passage 80 for cold air from the vegetable compartment 5, and is configured such that the width of the air passage is reduced toward the outlet 81. With such a configuration, a thermal insulator having a large thickness can be disposed in the vicinity of the outlet 81 and hence, compared with the case shown in Fig. 22, it is possible to increase thermal insulation properties

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in an area around the return air passage 80. Further, the width of the return air passage 80 at the air passage guide portion 82 is reduced compared with the width of other portions of the return air passage 80 and hence, even in the case where the same amount of thermal insulator (for example, polystyrene foam) as the case shown in Fig. 22 is used for the vegetable compartment rear wall portion 31, it is possible to increase the capacity of the vegetable compartment 5 by reducing the thickness of the vegetable compartment rear wall portion 31.

[0082]

In the example shown in Fig. 23, the guide rear portion 82a of the air passage guide portion 82 is a part that has at least a portion thereof overlapping with the holding portion 94 for the heater pipe 93 when viewed in a front view and that guides the outlet 81 of the return air passage 80 toward the heater pipe 93. The guide rear portion 82a and the guide front portion 82b may be integrally formed with polystyrene foam used for the vegetable compartment rear wall portion 31, the return air passage 80 being formed in the polystyrene foam, or may be attached as separated parts as described above.

[0083]

In the example shown in Fig. 2 and Fig. 15, the return air passage 80 for cold air from the vegetable compartment 5 and the return port 45, which is the inlet of the return air passage 80, are provided on the right of the center line passing through the center of the thermal insulation box body 19 in the left-right direction, and the vacuum thermal insulator 39 is disposed on the left of the return air passage 80 and the return port 45. However, Embodiment 1 is not limited to the above-mentioned configuration.

[0084]

Fig. 24 is a schematic front view showing another example of the refrigerator 1 shown in Fig. 2. Fig. 25 is a schematic front view of the refrigerator 1 shown in Fig. 24. In an example shown in Fig. 24 and Fig. 25, a configuration is adopted where the configuration of the refrigerator 1 shown in Fig. 2 is inverted in the left-right direction about the center line of the thermal insulation box body 19 in the left-right direction. That is, in the example shown in Fig. 24 and Fig. 25, the return air passage 80 for cold air from the vegetable compartment 5 and the return port 45 are provided on the left of the center line of the thermal insulation box body 19 in the left-right direction, and the vacuum thermal insulator 39 is disposed on the right of the return air passage 80. Such a configuration of the refrigerator 1 can also obtain advantageous effects substantially equal to the advantageous effects obtained in the case shown in Fig. 2.

[0085]

Fig. 26 is a schematic view showing the vacuum thermal insulators in the wall portions forming the vegetable compartment 5 of the refrigerator 1 shown in Fig. 1. Fig. 27 is a schematic view showing the vacuum thermal insulators in the wall portions forming the vegetable compartment 5 of the refrigerator 1 shown in Fig. 26 as viewed from the rear side. The description will be made with reference to Fig. 1, Fig. 2, Fig. 26, and Fig. 27 for the arrangement of the vacuum thermal insulators of the refrigerator 1, particularly, for the arrangement of the vacuum thermal insulators in the wall portions forming the vegetable compartment 5.

[0086]

The vegetable compartment 5 includes a plurality of wall portions including the ceiling wall portion 32, the bottom wall portion 35, the vegetable compartment rear wall portion 31, and a right side wall portion 19c1, a left side wall portion 19d1 and the door 5a, the ceiling wall portion 32 providing the partition between the vegetable compartment 5, and the ice-making compartment 3 and the temperature versatile compartment 4 disposed above the vegetable compartment 5, the bottom wall portion 35 providing the partition between the vegetable compartment 5 and the freezer compartment 6 disposed below the vegetable compartment 5, the vegetable compartment rear wall portion 31 providing the partition between the vegetable compartment 5 and the cooler chamber 52 disposed behind the vegetable compartment 5, the right side wall portion 19c1, the left side wall portion 19d1 and the door 5a providing partitions between the vegetable compartment 5 and the outside of the refrigerator 1 on the left side, the right side, and the front side of the refrigerator 1.

[0087]

The vacuum thermal insulators 24, 24, 24, 33, 36, 39, each being one rectangular vacuum thermal insulator, are respectively provided in the plurality of wall portions forming the vegetable compartment 5. The right side wall portion 19c1 of the vegetable compartment 5 is a portion of the right side surface portion 19c of the thermal insulation box body 19, and the left side wall portion 19d1 of the vegetable compartment 5 is a portion of the left side surface portion 19d of the thermal insulation box body 19. Therefore, a configuration may be adopted where one rectangular plate-like vacuum thermal insulator 24 is disposed over the right side surface portion 19c of the thermal insulation box body 19 for the entire refrigerator 1 including other storage compartments disposed above and below the vegetable compartment 5. Further, a configuration may be adopted where one rectangular plate-like vacuum thermal insulator 24 is disposed over the left side surface portion 19d of the thermal insulation box body 19 for the entire refrigerator 1 including other storage compartments disposed above and below the vegetable compartment 5.

[0088]

In contrast, one rectangular plate-like vacuum thermal insulator 33 is provided in the ceiling wall portion 32 of the vegetable compartment 5, one rectangular plate-like vacuum thermal insulator 36 is provided in the bottom wall portion 35 of the vegetable compartment 5, and one rectangular plate-like vacuum thermal insulator 39 is provided in the vegetable compartment rear wall portion 31. Further, one rectangular plate-like vacuum thermal insulator 24 is provided in the door 5a of the vegetable compartment 5.

[0089]

It is preferable that coverage of the vacuum thermal insulators 24, 24, 24, 33, 36, 39 relative to the total area of the wall surfaces of the vegetable compartment 5 be 80% or more. By disposing the vacuum thermal insulators 24, 24, 24, 33, 36, 39 on all of six surfaces of the vegetable compartment 5 having a substantially cuboid shape or a substantially cubic shape as described above, it is possible to suppress heat transfer from the vegetable compartment 5 to other storage compartments adjacent to the vegetable compartment 5. Alternatively, it is possible to suppress transfer of cooling energy to the vegetable compartment 5 from other storage compartments adjacent to the vegetable compartment 5 and from the cooler chamber 52. It is also possible to suppress the amount of heat intrusion into the vegetable compartment 5 from the outside by the right side wall portion 19c1, the left side wall portion 19d1, and the door 5a.

[0090]

Fig. 28 is a partial schematic view of the vegetable compartment 5 of the refrigerator shown in Fig. 15. At least one of the plurality of wall portions forming the vegetable compartment 5 includes a heat retaining heater 46. In an example shown in Fig. 28, the bottom wall portion 35 of the vegetable compartment 5 is configured to include the heat retaining heater 46. By adopting a configuration where at least one of the plurality of wall portions forming the vegetable compartment 5 includes the heat retaining heater 46, it is possible to warm the inside of the vegetable compartment 5 with the heat retaining heater 46 when the inside of the vegetable compartment 5 is excessively cooled.

[0091]

In Embodiment 1, it is defined that the cooler 14 is disposed behind the vegetable compartment 5. However, the present disclosure is applicable to any configuration where the cooler 14 is disposed behind a storage compartment (first storage compartment) set to a temperature higher than the temperatures of other storage compartments adjacent to the storage compartment (first storage compartment). The description has been made assuming that the vacuum thermal insulator 39 is included in the vegetable compartment rear wall portion 31, that is, in the rear wall portion of the storage compartment. However, the storage compartment and the cooler 14 may be separated from each other by the vacuum thermal insulator 39 and the return air passage for cold air from the storage compartment. In this case, the return air passage disposed next to the vacuum thermal insulator 39 may be a duct.

[0092]

As described above, the refrigerator 1 of Embodiment 1 includes the thermal insulation box body 19 in which the plurality of storage compartments are formed, the thermal insulation box body 19 having the opening that is formed at the front side of the thermal insulation box body 19 and that is covered by the door 5a. The first storage compartment (for example, the vegetable compartment 5) and the cooler chamber 52 are provided in the thermal insulation box body 19, the first storage compartment being configured to store stored objects, a temperature of the first storage compartment being set to a temperature higher than temperatures of other storage compartments (for example, the ice-making compartment 3 and the temperature versatile compartment 4) adjacent to the first storage compartment, the cooler chamber 52 being provided behind the first storage compartment, the cooler 14 being disposed in the cooler chamber 52. The first vacuum thermal insulator (the vacuum thermal insulator 39) and the return air passage 80 are also provided in the thermal insulation box body 19, the first vacuum thermal insulator being disposed between the first storage compartment and the cooler chamber 52, the return air passage 80 being configured to allow the first storage compartment and the cooler chamber 52 to communicate with each other, cold air returning to the cooler chamber 52 flowing through the return air passage 80. When the thermal insulation box body 19 is viewed in a front view, the first vacuum thermal insulator (the vacuum thermal insulator 39) is disposed to overlap with a portion of the cooler 14. The return air passage 80 is provided to be adjacent to the first vacuum thermal insulator in a state of overlapping with the cooler 14 without overlapping with the first vacuum thermal insulator. The outlet 81 of the return air passage 80 for cold air is disposed at a position that overlaps with the cooler 14 or at a position below the cooler 14.

[0093]

With such a configuration, when the thermal insulation box body 19 is viewed in a front view, the return air passage 80 does not overlap with the first vacuum thermal insulator and hence, it is unnecessary to provide a space for the return air passage 80 at a position behind the first vacuum thermal insulator. Accordingly, it is possible to avoid a reduction in the storage space of the first storage compartment (the vegetable compartment 5). Further, in the refrigerator 1 according to the present disclosure, when the thermal insulation box body 19 is viewed in a front view, the return air passage 80 is provided to be adjacent to the first vacuum thermal insulator in a state of overlapping with a portion of the cooler 14 that does not overlap with the first vacuum thermal insulator. The outlet 81 of the return air passage 80 for cold air is disposed at a position that overlaps with the cooler 14 or at a position lower than the cooler 14. Accordingly, in the present disclosure, unlike the conventional technique, it is possible to provide the return air passage 80 that returns cold air to cause the cold air to pass through the cooler 14 without requiring the return air passage 80 to extend in the lateral direction to bypass the first vacuum thermal insulator. As described above, according to the present disclosure, it is possible to provide the refrigerator 1 in which the return air passage 80 can be provided without reducing a storage space, the return air passage 80 returning cold air to cause the cold air to pass through the cooler 14.

[0094]

The first vacuum thermal insulator (the vacuum thermal insulator 39) has the lateral width Wv smaller than the lateral width Wc of the cooler 14. When the thermal insulation box body 19 is viewed in a front view, the first vacuum thermal insulator is provided such that the right end portion of the first vacuum thermal insulator covers the right end of the cooler 14, or the left end portion of the first vacuum thermal insulator covers the left end of the cooler 14.

[0095]

With such a configuration, by moving one vacuum thermal insulator in the left-right direction relative to the cooler 14 and by disposing the return air passage 80 on the side in the direction opposite to the direction in which the one vacuum thermal insulator is moved, it is possible to easily cover the front surface of the cooler 14 by the first vacuum thermal insulator and the return air passage 80 with a simple shape and arrangement.

[0096]

The first vacuum thermal insulator (the vacuum thermal insulator 39) has the lateral width Wv smaller than the lateral width Wc of the cooler 14. When the thermal insulation box body 19 is viewed in a front view, the first vacuum thermal insulator is provided such that the right end of the first vacuum thermal insulator matches the right end of the cooler 14 or the left end of the first vacuum thermal insulator matches the left end of the cooler 14.

[0097]

With such a configuration, heat transfer between the cooler 14 and the vegetable compartment 5 can be suppressed by covering the front surface of the cooler 14 by the first vacuum thermal insulator (the vacuum thermal insulator 39) and the return air passage 80, and it is possible to reduce costs by setting the size of the first vacuum thermal insulator to the minimum size.

[0098]

The thermal insulation box body 19 includes the storage compartment rear wall portion (the vegetable compartment rear wall portion 31) configured to provide the partition between the first storage compartment (the vegetable compartment 5) and the cooler chamber 52, the first vacuum thermal insulator (the vacuum thermal insulator 39) being included in the storage compartment rear wall portion, and the return air passage 80 is provided in the storage compartment rear wall portion. With such a configuration, compared with the conventional case, it is possible to reduce manufacturing costs for the storage compartment rear wall portion that includes the first vacuum thermal insulator.

[0099]

A storage compartment blowout air passage (the blowout air passage 30) is provided in the storage compartment rear wall portion (the vegetable compartment rear wall portion 31), the storage compartment blowout air passage allowing the cooler chamber 52 and the first storage compartment (the vegetable compartment 5) to communicate with each other, cold air to be blown into the first storage compartment flowing through the storage compartment blowout air passage. The blowout port 44 and the return port 45 are formed in the inner wall of the storage compartment rear wall portion on the first storage compartment side, the blowout port 44 being the outlet of the storage compartment blowout air passage for cold air, the return port 45 being the inlet of the return air passage 80 for cold air. When the thermal insulation box body 19 is viewed in a front view, the first vacuum thermal insulator (the vacuum thermal insulator 39) is provided at a position that overlaps with neither the blowout port 44 nor the return port 45.

[0100]

With such a configuration, it is not necessary to cause not only the return air passage 80 but also the blowout air passage 30 to bypass the first vacuum thermal insulator and hence, it is possible to allow the blowout air passage 30 to have a simple shape.

[0101]

The return port 45 is provided in the inner wall at a position at the same height as the blowout port 44 or at a position higher than the blowout port 44. With such a configuration, compared with the conventional case where the return port 45 is provided at a position lower than the blowout port 44, warmed cold air that rises in the first storage compartment (the vegetable compartment 5) can easily flow into the return air passage 80. As a result, cold air can easily cycle through the inside of the refrigerator 1 and hence, it is possible to efficiently cool stored objects in the respective storage compartments.

[0102]

The blowout port 44 causes cold air cooled by the cooler 14 to be directly blown into the first storage compartment (the vegetable compartment 5) or causes cold air cooled by the cooler 14 and caused to pass through another storage compartment (for example, the refrigerator compartment 2) to be blown into the first storage compartment (the vegetable compartment 5).

[0103]

With such a configuration, in the case where cold air cooled by the cooler 14 is directly blown into the first storage compartment (the vegetable compartment 5), it is possible to effectively cool stored objects, such as food, stored in the first storage compartment. In the case where cold air is blown into the first storage compartment (the vegetable compartment 5) via another storage compartment, it is possible to suppress a situation where stored objects in the vegetable compartment 5 is excessively cooled.

[0104]

The refrigerator 1 includes the air volume adjustment device 18c configured to adjust a volume of cold air to be blown out from the blowout port 44. With such a configuration, it is possible to adjust the volume of cold air being supplied to the first storage compartment according to the temperature of the first storage compartment (the vegetable compartment 5), the set temperatures of another storage compartment of the refrigerator 1, or the relationship of capacity, for example, and hence, it is possible to suppress a situation where stored objects stored in the first storage compartment are excessively cooled.

[0105]

The refrigerator 1 includes the heat retaining heater 46 configured to retain heat in the first storage compartment (the vegetable compartment 5), the thermal insulation box body 19 includes the plurality of wall portions forming the first storage compartment, and the heat retaining heater 46 is provided to any one of the plurality of wall portions. With such a configuration, it is possible to avoid unintended freezing of stored objects in the first storage compartment by warming the inside of the first storage compartment with the heat retaining heater 46 when the inside of the first storage compartment is excessively cooled.

[0106]

The first storage compartment is the vegetable compartment 5, and another storage compartment is the storage compartment (for example, the refrigerator compartment 2) that has a temperature lower than the temperature zone of the vegetable compartment 5, the temperature versatile compartment 4 that is switched to a temperature zone lower than the temperature zone of the vegetable compartment 5, the freezer compartment 6, the ice-making compartment 3, or a chiller compartment. With such a configuration, by applying the present disclosure to various refrigerators 1 in which the vegetable compartment 5 and other storage compartments are provided, it is possible to obtain substantially the same advantageous effects.

[0107]

The refrigerator compartment 2, the ice-making compartment 3, the temperature versatile compartment 4, the freezer compartment 6, and the vegetable compartment 5 being the first storage compartment are formed in the thermal insulation box body 19. The refrigerator compartment 2, the ice-making compartment 3 and the temperature versatile compartment 4, the vegetable compartment 5, and the freezer compartment 6 are disposed in this order from the top. With such a configuration, the return air passage 80 that communicates with the vegetable compartment 5 is allowed to have a simple shape, and it is possible to efficiently supply cold air from the cooler 14 to both the ice-making compartment 3 and the freezer compartment 6 that are provided above and below the vegetable compartment 5 and that are set to the minus temperature zone, the vegetable compartment 5 being set to the plus temperature zone.

[0108]

The first storage compartment and another storage compartment are arranged in the up-down direction of the thermal insulation box body 19. Each of two side wall portions (the right side surface portion 19c and the left side surface portion 19d) of the thermal insulation box body 19 includes the second vacuum thermal insulator (the vacuum thermal insulator 24, 24) provided over another storage compartment and the first storage compartment in the up-down direction. With such a configuration, the vacuum thermal insulator 24 that is used in the refrigerator 1 is efficiently disposed. As a result, it is possible to reduce the number of vacuum thermal insulators to be used, leading to a reduction in manufacturing costs, a simplification of assembly, and an improvement in a manufacturing efficiency.

[0109]

Embodiment 2.

Fig. 29 is a schematic front view of a refrigerator 1 according to Embodiment 2 of the present disclosure. Fig. 30 is a schematic view showing a C-C cross section of the refrigerator 1 shown in Fig. 29. The configuration of the refrigerator 1 of Embodiment 2 that is different from the configuration of the refrigerator 1 of Embodiment 1 will be described.

[0110]

As shown in Fig. 29, in the refrigerator 1 of Embodiment 2, one rectangular plate-like vacuum thermal insulator 39 is disposed to overlap with the entire blowout air passage 41 for cold air to the freezer compartment 6 when viewed in a front view. The return air passage 80 is disposed to cover the right portion of the cooler 14 that does not overlap with the vacuum thermal insulator 39 when viewed in a front view. The return air passage 80 and the vacuum thermal insulator 39 are disposed without overlapping with each other when viewed in a front view. A foamed thermal insulator 40a is disposed to cover the left portion of the cooler 14 that does not overlap with the vacuum thermal insulator 39 when viewed in a front view. The foamed thermal insulator 40a overlaps with neither the vacuum thermal insulator 39 nor the blowout air passage 41 when viewed in a front view.

[0111]

Fig. 30 shows a longitudinal cross section taken along a line not passing through the vacuum thermal insulator 39 but passing through the cooler 14. As shown in Fig. 30, between the vegetable compartment 5 and the cooler 14, the foamed thermal insulator 40a suppresses the intrusion of cooling energy into the vegetable compartment 5 from the cooler 14 at a portion where neither the vacuum thermal insulator 39 nor the blowout air passage 41 is disposed. The thermal insulator disposed between the vegetable compartment 5 and the cooler 14 at a portion where neither the vacuum thermal insulator 39 nor the blowout air passage 41 is disposed is not limited to the foamed thermal insulator 40a.

[0112]

As described above, in Embodiment 2, the freezer compartment 6 and the freezer compartment blowout air passage (the blowout air passage 41) are provided in the thermal insulation box body 19, the freezer compartment 6 being adjacent to the first storage compartment (the vegetable compartment 5), the freezer compartment

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blowout air passage allowing the cooler chamber 52 and the freezer compartment 6 to communicate with each other, cold air to be blown into the freezer compartment 6 flowing through the freezer compartment blowout air passage. The foamed thermal insulator 40a is provided in the thermal insulation box body 19. When the thermal insulation box body 19 is viewed in a front view, the first vacuum thermal insulator (the vacuum thermal insulator 39) is provided to overlap with the entire portion of the freezer compartment blowout air passage that is located behind the first storage compartment. When the thermal insulation box body 19 is viewed in a front view, the foamed thermal insulator 40a is provided for the region of the cooler 14 that overlaps with neither the first vacuum thermal insulator nor the return air passage 80.

[0113]

With such a configuration, in the refrigerator 1 of Embodiment 2, it is possible to further reduce the amount of the vacuum thermal insulator 39 compared with the case of Embodiment 1 while inflow of cooling energy into the vegetable compartment 5 from the blowout air passage 41 for cold air to the freezer compartment 6 is suppressed by the vacuum thermal insulator 39 and the foamed thermal insulator that are disposed in front of the blowout air passage 41, and hence, manufacturing costs can be reduced.

[0114]

Embodiments 1, 2 of the present disclosure may be combined, or may be applied to other portions. For example, also in Embodiment 2, in the same manner as Embodiment 1, a configuration may be adopted where the vegetable compartment rear wall portion 31 that provides the partition between the cooler chamber 52 and the vegetable compartment 5 is provided, and the vegetable compartment rear wall portion 31 includes the vacuum thermal insulator 39. In this case, the foamed thermal insulator 40a is a portion of the foamed thermal insulator 40 disposed around the vacuum thermal insulator 39 in the vegetable compartment rear wall portion 31. The present disclosure is applicable to any configuration where two or more storage compartments having different set temperatures are provided and the cooler 14 overlaps with at least a portion of the storage compartment having a higher temperature when viewed in a front view.

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[0114a]

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

[0114b]

The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as an acknowledgment or admission or any form of suggestion that that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

Reference Signs List

[0115]

1: refrigerator, 2: refrigerator compartment, 2a, 3a, 4a, 5a, 6a: door, 2b: floor surface, 3: ice-making compartment, 4: temperature versatile compartment, 5: vegetable compartment, 6: freezer compartment, 6b: accommodation casing, 6c: guide portion, 6c1: first guide portion, 6c2: second guide portion, 7: refrigerant circuit, 8: compressor, 9: air cooled condenser, 10: condenser, 11: frost prevention pipe, 12: dryer, 13: pressure reducing device, 14: cooler, 14a: cooler center portion, 14b: lower end, 15: fan, 16a, 16b, 16c, 16d: temperature sensor, 17: control unit, 18a, 18b, 18c: air volume adjustment device, 19: thermal insulation box body, 19a: upper surface portion, 19b: bottom surface portion, 19c: right side surface portion, 19c1: right side wall portion, 19d: left side surface portion, 19d1: left side wall portion, 19f: rear surface portion, 20: wall portion, 21: metal sheet, 22: inner box, 23: thermal insulator, 24, 33, 36, 39: vacuum thermal insulator, 25: support, 26: spacer, 27: blowout air passage (for cold air to refrigerator compartment), 28: return air passage (for cold air from ice-making compartment), 29a: return air passage (for cold air from temperature versatile compartment), 29b: return air passage (for cold air from refrigerator compartment), 30:

blowout air passage (for cold air to vegetable compartment), 31: vegetable compartment rear wall portion, 32: ceiling wall portion, 34, 37: urethane foam material, 35: bottom wall portion, 38, 42: thermal insulation wall outer shell, 40, 40a: foamed thermal insulator, 41: blowout air passage (for cold air to freezer compartment), 44: blowout port, 45: return port, 46: heat retaining heater, 47: frost prevention heater, 51: machine chamber, 52: cooler chamber, 66: drip tray, 70: return air passage (for cold air from freezer compartment), 80: return air passage (for cold air from vegetable compartment), 81: outlet, 82: air passage guide portion, 82a: guide rear portion, 82b: guide front portion, 91: fin, 92: refrigerant pipe, 93: heater pipe, 94: holding portion, 95: hairpin portion, 97: partition portion, 97a: separation plate, 97b: outer plate, 97c: roof portion.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

[Claim 1]

A refrigerator comprising a thermal insulation box body in which a plurality of storage compartments are formed, the thermal insulation box body having an opening that is formed at a front side of the thermal insulation box body and that is covered by a door, wherein

a first storage compartment configured to store a stored object, a temperature of the first storage compartment being set to a temperature higher than a temperature of an other storage compartment of the plurality of storage compartments, the other storage compartment being adjacent to the first storage compartment,

a cooler chamber provided behind the first storage compartment, a cooler being disposed in the cooler chamber,

a first vacuum thermal insulator disposed between the first storage compartment and the cooler chamber, and

a return air passage configured to allow the first storage compartment and the cooler chamber to communicate with each other, cold air returning to the cooler chamber flowing through the return air passage,

are provided in the thermal insulation box body, and

when the thermal insulation box body is viewed in a front view,

the first vacuum thermal insulator is disposed to overlap with a portion of the cooler, and

the return air passage is provided to be adjacent to the first vacuum thermal insulator in a state of overlapping with the cooler without overlapping with the first vacuum thermal insulator.

[Claim 2]

The refrigerator of claim 1, wherein

when the thermal insulation box body is viewed in the front view,

an outlet of the return air passage for the cold air is disposed at a position that overlaps with the cooler or at a position below the cooler.

[Claim 3]

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The refrigerator of claim 1 or 2, wherein

the first vacuum thermal insulator has a lateral width smaller than a lateral width of the cooler, and

when the thermal insulation box body is viewed in the front view, the first vacuum thermal insulator is provided such that a right end portion of the first vacuum thermal insulator covers a right end of the cooler, or a left end portion of the first vacuum thermal insulator covers a left end of the cooler.

[Claim 4]

The refrigerator of claim 1 or 2, wherein

the first vacuum thermal insulator has a lateral width smaller than a lateral width of the cooler, and

when the thermal insulation box body is viewed in the front view, the first vacuum thermal insulator is provided such that a right end of the first vacuum thermal insulator matches a right end of the cooler, or a left end of the first vacuum thermal insulator matches a left end of the cooler.

[Claim 5]

The refrigerator of claim 1 or 2, wherein

a freezer compartment adjacent to the first storage compartment,

a freezer compartment blowout air passage configured to allow the cooler chamber and the freezer compartment to communicate with each other, the cold air to be blown into the freezer compartment flowing through the freezer compartment blowout air passage, and

a foamed thermal insulator

are provided in the thermal insulation box body, and

when the thermal insulation box body is viewed in the front view, the first vacuum thermal insulator is provided to overlap with an entire portion of the freezer compartment blowout air passage that is located behind the first storage compartment, and the foamed thermal insulator is provided for a region of the cooler that overlaps with neither the first vacuum thermal insulator nor the return air passage.

[Claim 6]

The refrigerator of any one of claims 1 to 5, wherein

the first vacuum thermal insulator is one rectangular plate-like vacuum thermal insulator.

[Claim 7]

The refrigerator of any one of claims 1 to 6, wherein

the thermal insulation box body includes a storage compartment rear wall portion configured to provide a partition between the first storage compartment and the cooler chamber, the first vacuum thermal insulator being included in the storage compartment rear wall portion, and

the return air passage is provided in the storage compartment rear wall portion.

[Claim 8]

The refrigerator of claim 7, wherein

a storage compartment blowout air passage is provided in the storage compartment rear wall portion, the storage compartment blowout air passage allowing the cooler chamber and the first storage compartment to communicate with each other, the cold air to be blown into the first storage compartment flowing through the storage compartment blowout air passage,

a blowout port and a return port are formed in an inner wall of the storage compartment rear wall portion on a first storage compartment side, the blowout port being an outlet of the storage compartment blowout air passage for the cold air, the return port being an inlet of the return air passage for the cold air, and

when the thermal insulation box body is viewed in the front view, the first vacuum thermal insulator is provided at a position that overlaps with neither the blowout port nor the return port.

[Claim 9]

The refrigerator of claim 8, wherein

the return port is provided in the inner wall at a position at a same height as the blowout port or at a position higher than the blowout port.

[Claim 10]

The refrigerator of claim 8 or 9, wherein the blowout port causes the cold air cooled by the cooler to be directly blown into the first storage compartment or causes the cold air cooled by the cooler and caused to pass through the other storage compartment to be blown into the first storage compartment.

[Claim 11]

The refrigerator of any one of claims 8 to 10, comprising an air volume adjustment device configured to adjust a volume of the cold air blown out from the blowout port.

[Claim 12]

The refrigerator of any one of claims 1 to 11, comprising

a heat retaining heater configured to retain heat in the first storage compartment, wherein

the thermal insulation box body includes a plurality of wall portions forming the first storage compartment, and

the heat retaining heater is provided to any one of the plurality of wall portions.

[Claim 13]

The refrigerator of any one of claims 1 to 12, wherein

the first storage compartment is a vegetable compartment, and

the other storage compartment is a storage compartment of the plurality of storage compartments that has a temperature lower than a temperature zone of the vegetable compartment, a temperature versatile compartment that is switched to a temperature zone lower than the temperature zone of the vegetable compartment, a freezer compartment, an ice-making compartment, or a chiller compartment.

[Claim 14]

The refrigerator of any one of claims 1 to 12, wherein

a refrigerator compartment, an ice-making compartment, a temperature versatile compartment, the freezer compartment, and a vegetable compartment being the first storage compartment are formed in the thermal insulation box body, and the refrigerator compartment, the ice-making compartment and the temperature versatile compartment, the vegetable compartment, and the freezer compartment are disposed in this order from a top.

[Claim 15]

The refrigerator of any one of claims 1 to 14, wherein

the first storage compartment and the other storage compartment are arranged in an up-down direction of the thermal insulation box body, and

each of two side wall portions of the thermal insulation box body includes a second vacuum thermal insulator provided over the other storage compartment and the first storage compartment in the up-down direction.

FIG. 1

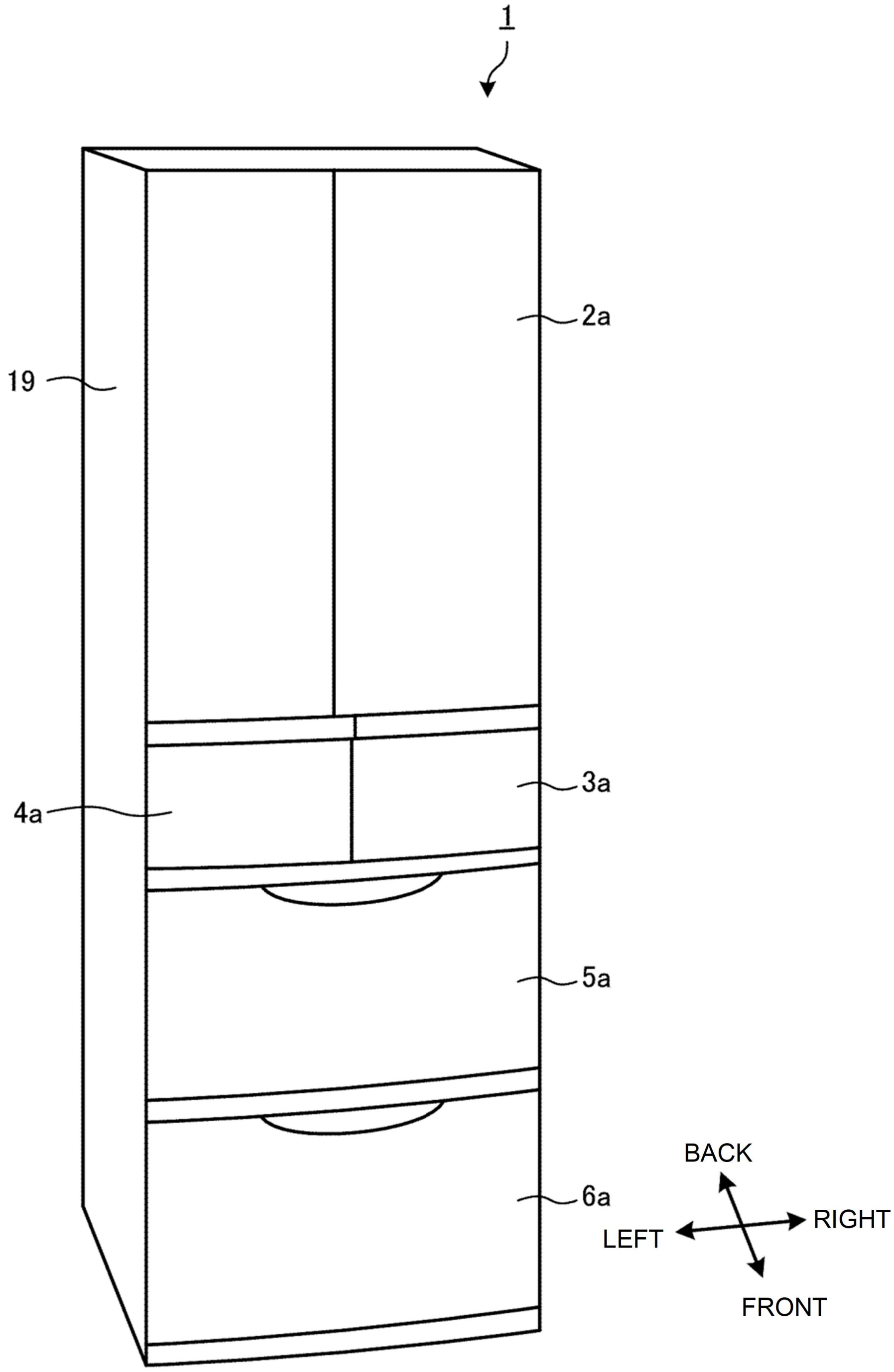

FIG. 2

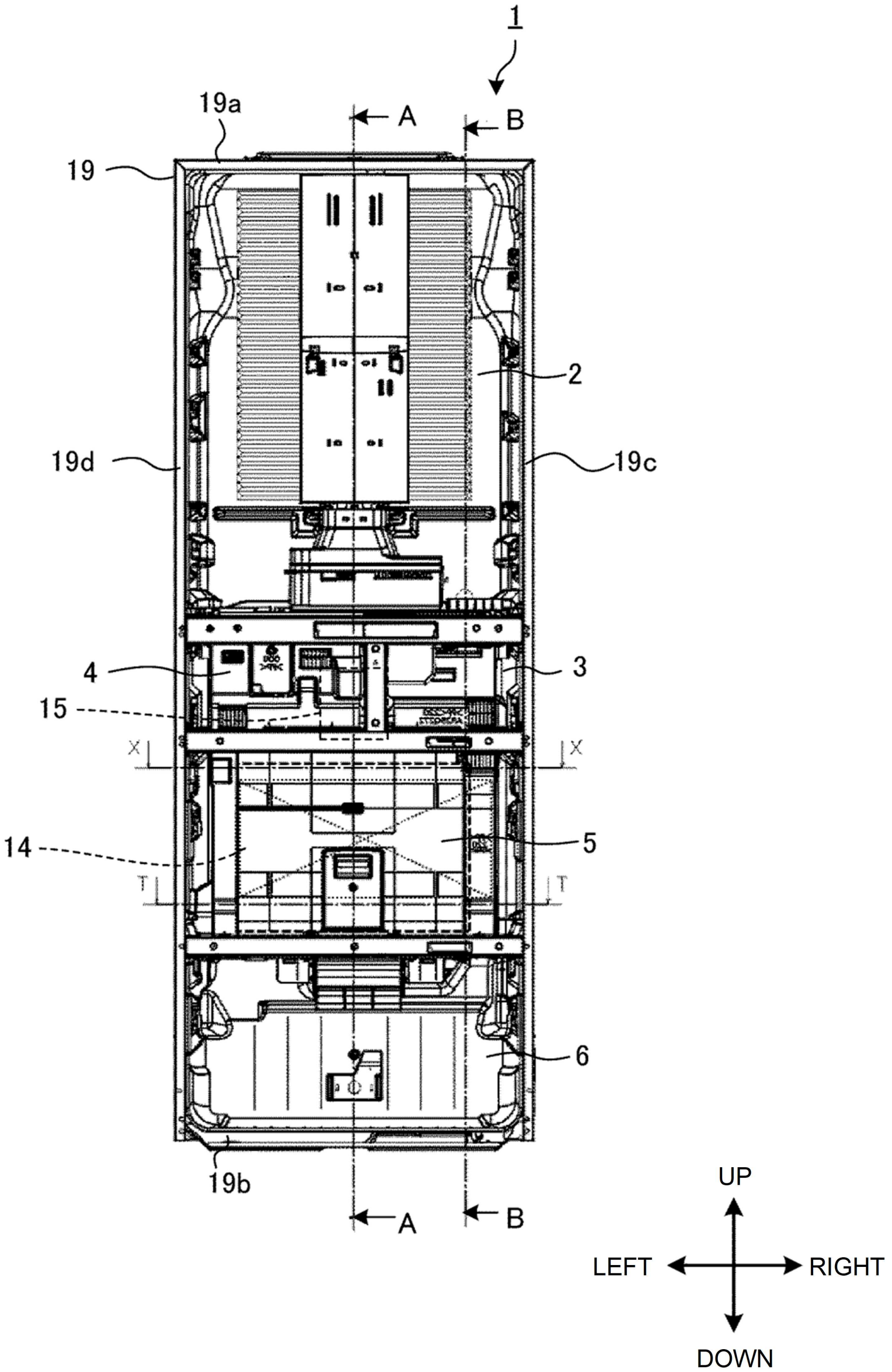

FIG. 3

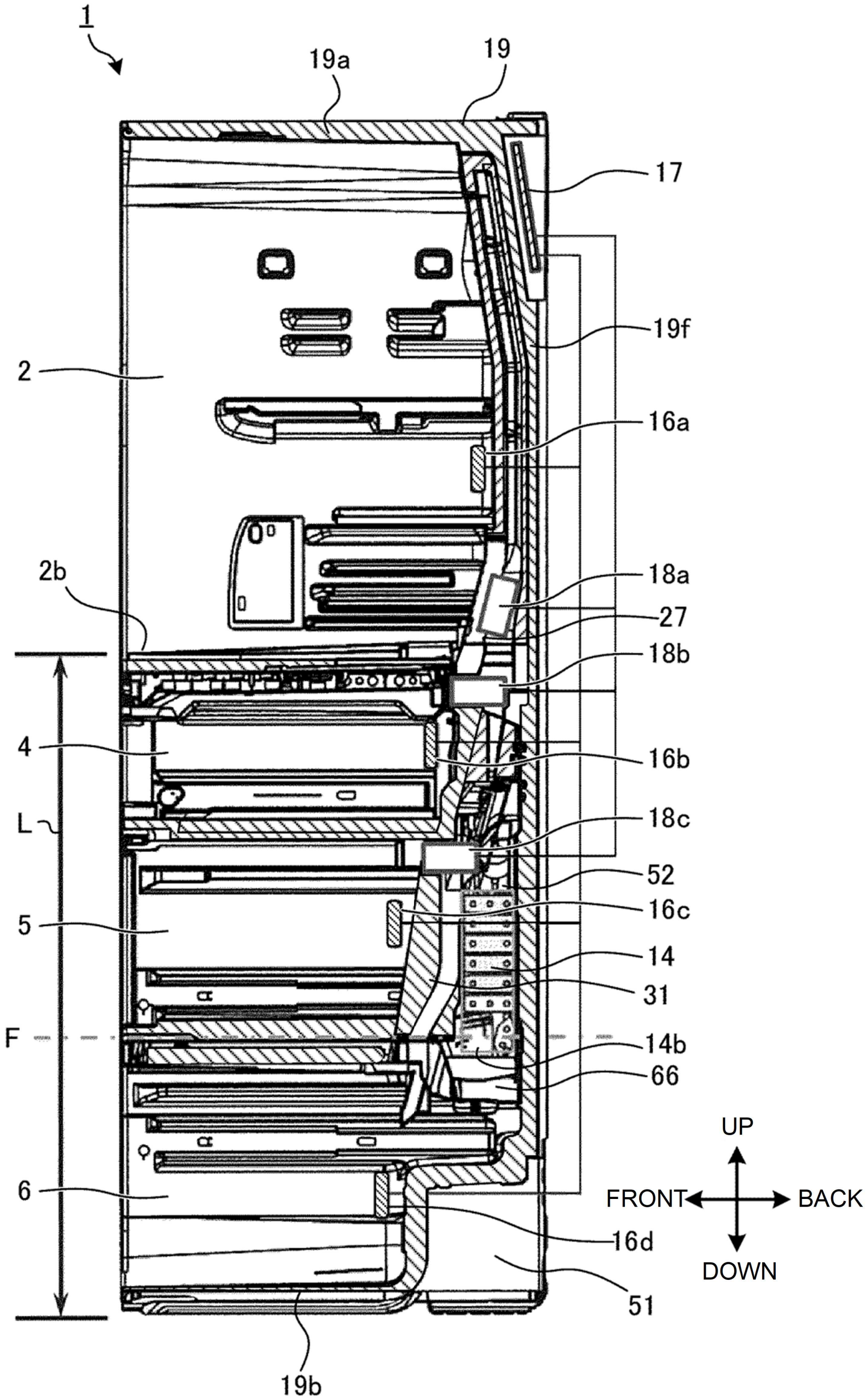
1
19a
19
17
19f
2
16a
2b
18a
27
18b
4
16b
L
18c
52
5
16c
14
31
F
14b
66
UP
FRONT
BACK
DOWN
6
16d
51
19b

FIG. 4

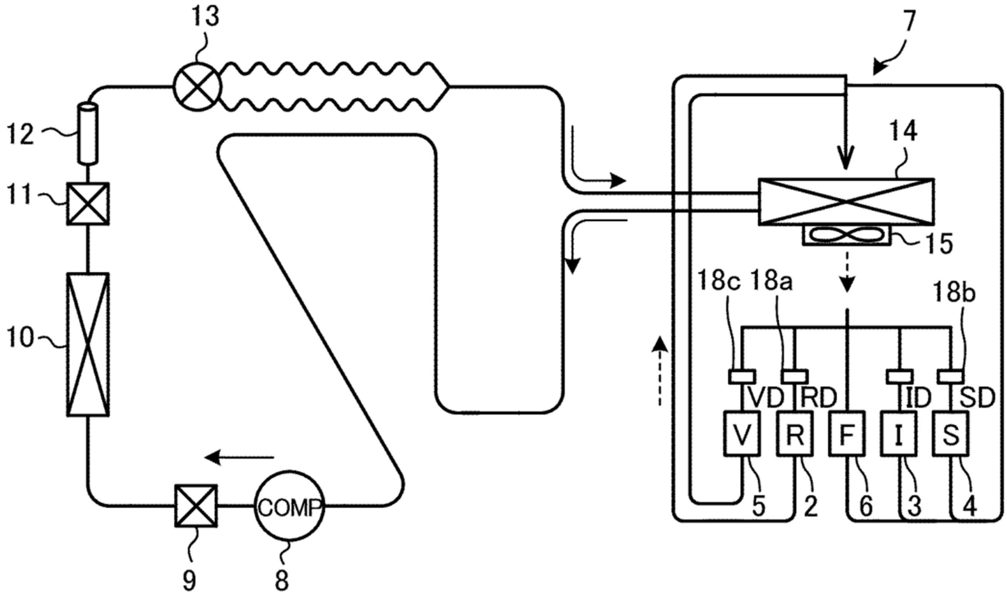
13
7
12
14
11
15
18c 18a
18b
10
VD RD
ID SD
V R F I S
COMP
5 2 6 3 4
9 8

FIG. 5

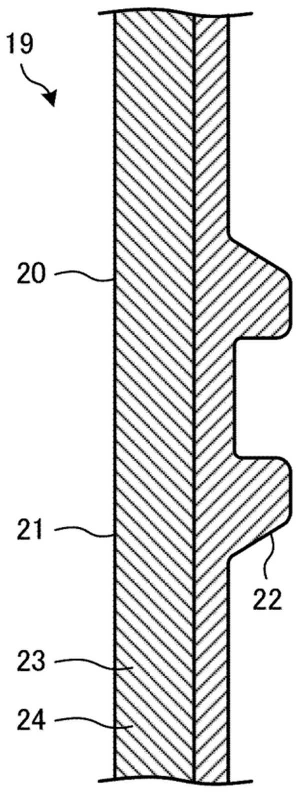
19
20
21
22
23
24

FIG. 6

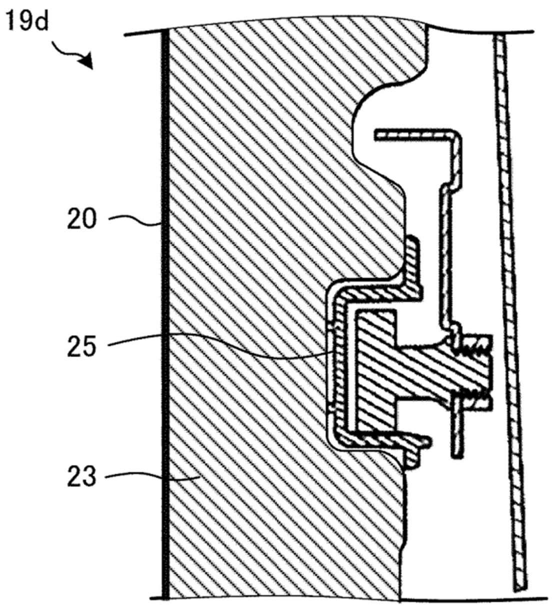

FIG. 7

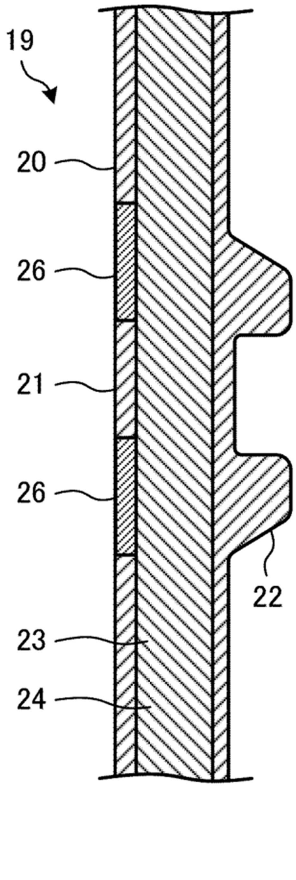

FIG. 8

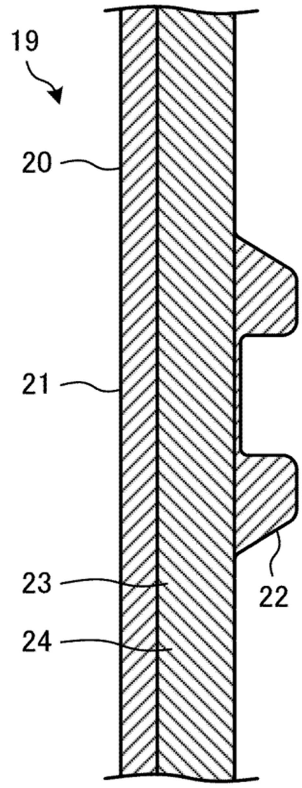

FIG. 9

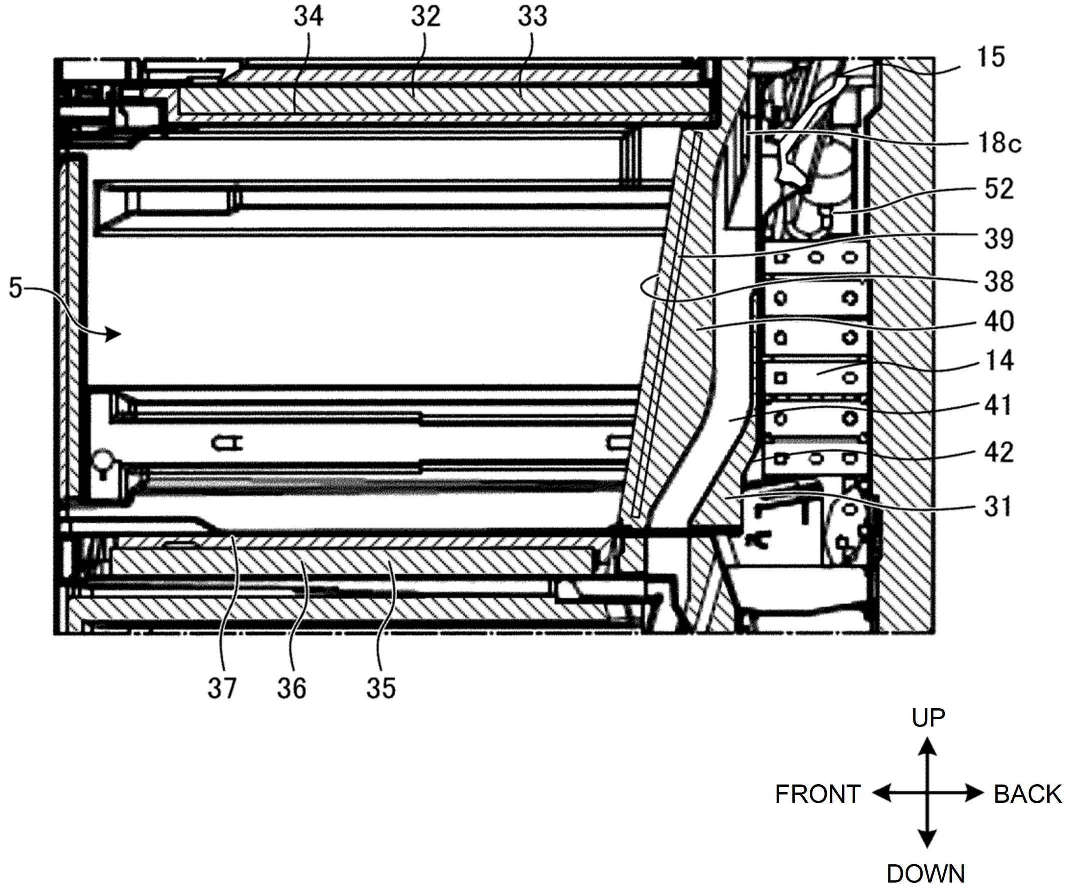

FIG. 10

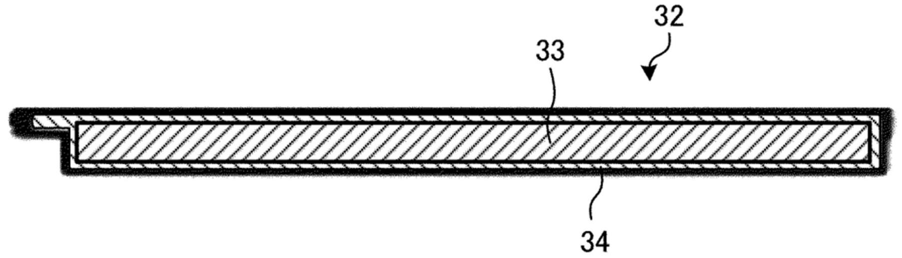

FIG. 11

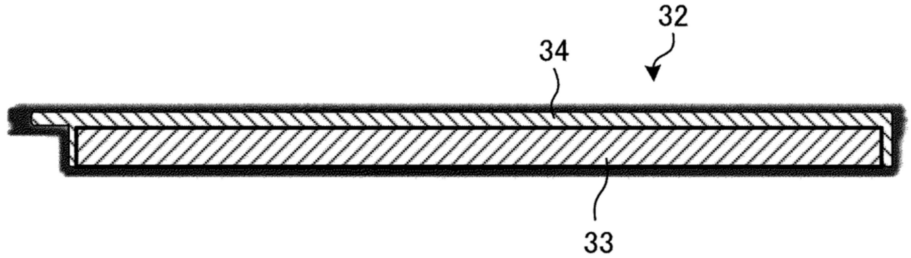

FIG. 12

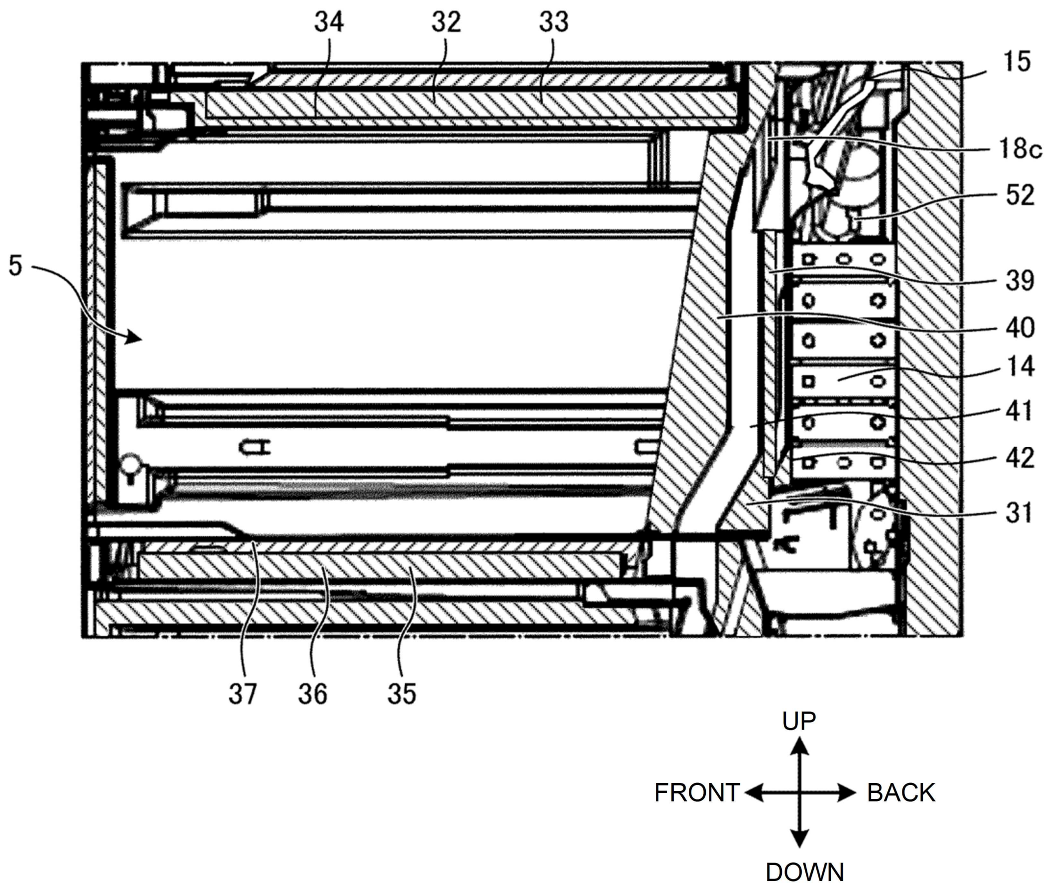

FIG. 13

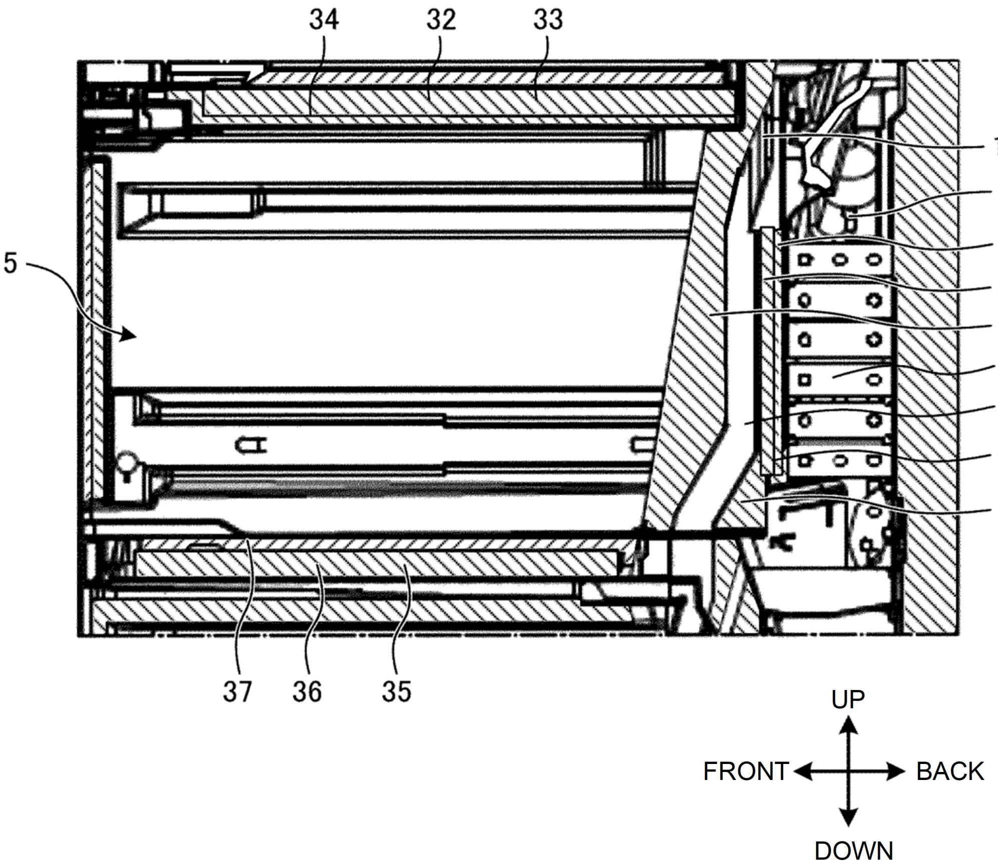

FIG. 14

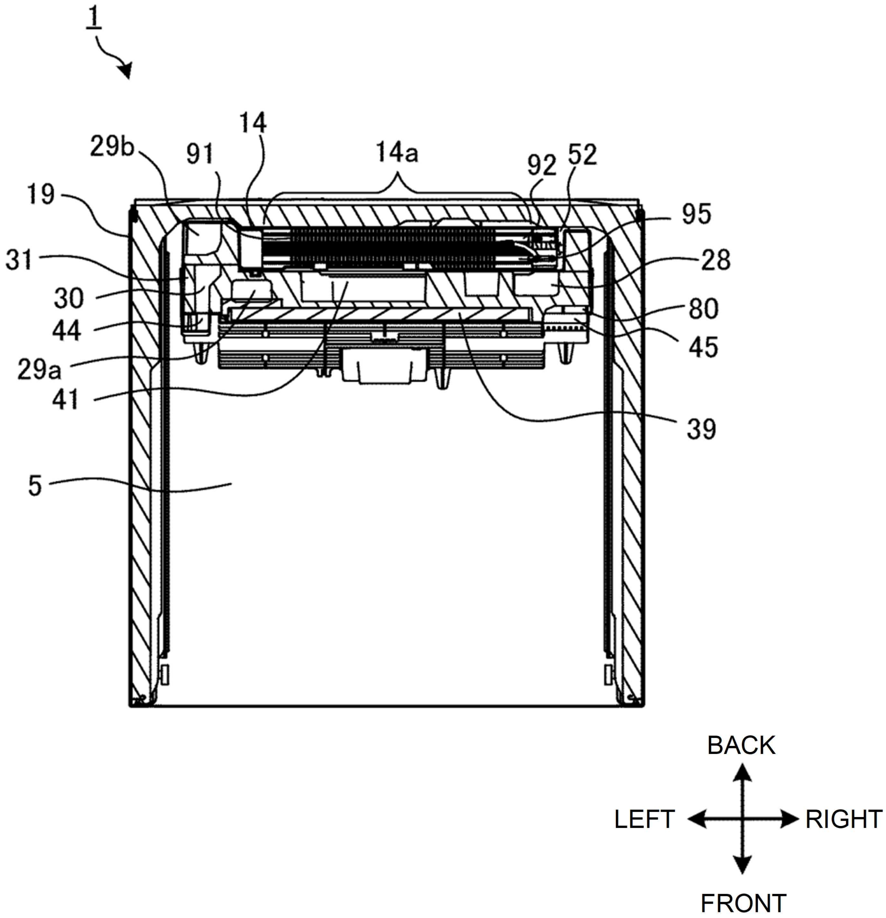
1
14
29b
91
14a
92
52
19
95
31
28
30
80
44
45
29a
41
39
5
BACK
LEFT
RIGHT
FRONT

FIG. 15

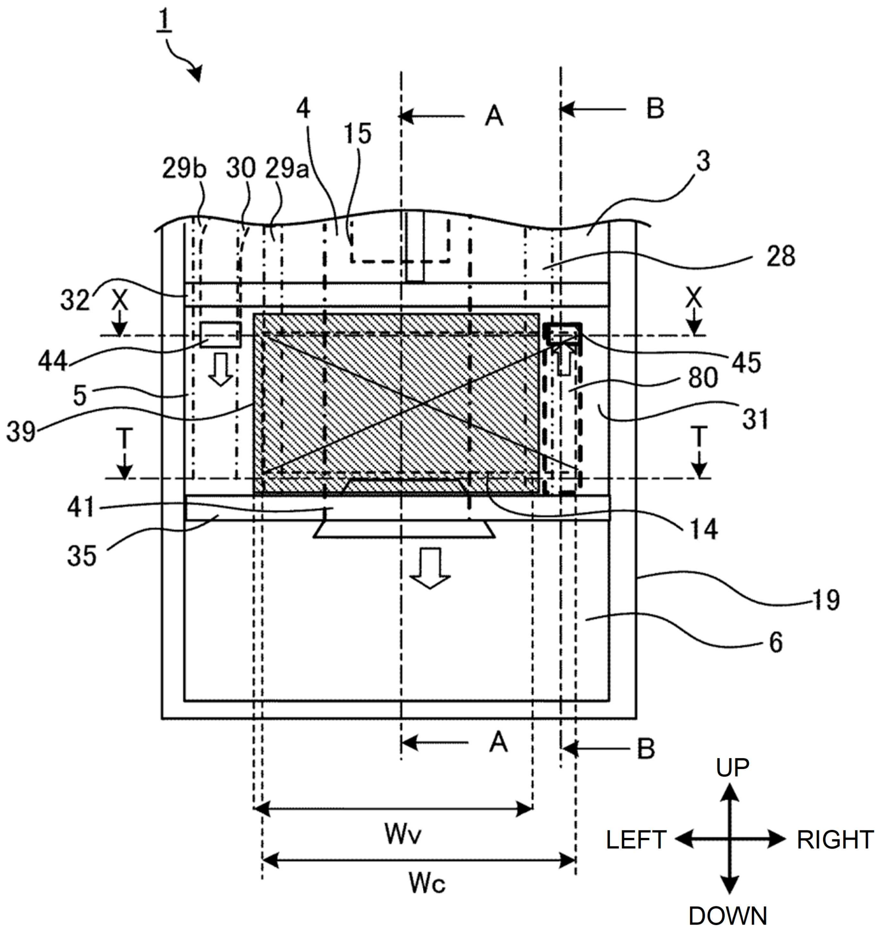
1
4
15
A
B
29b
30
29a
3
28
32
X
X
44
45
80
5
31
39
T
T
41
14
35
19
6
A
B
UP
LEFT
RIGHT
DOWN
Wv
Wc

FIG. 16

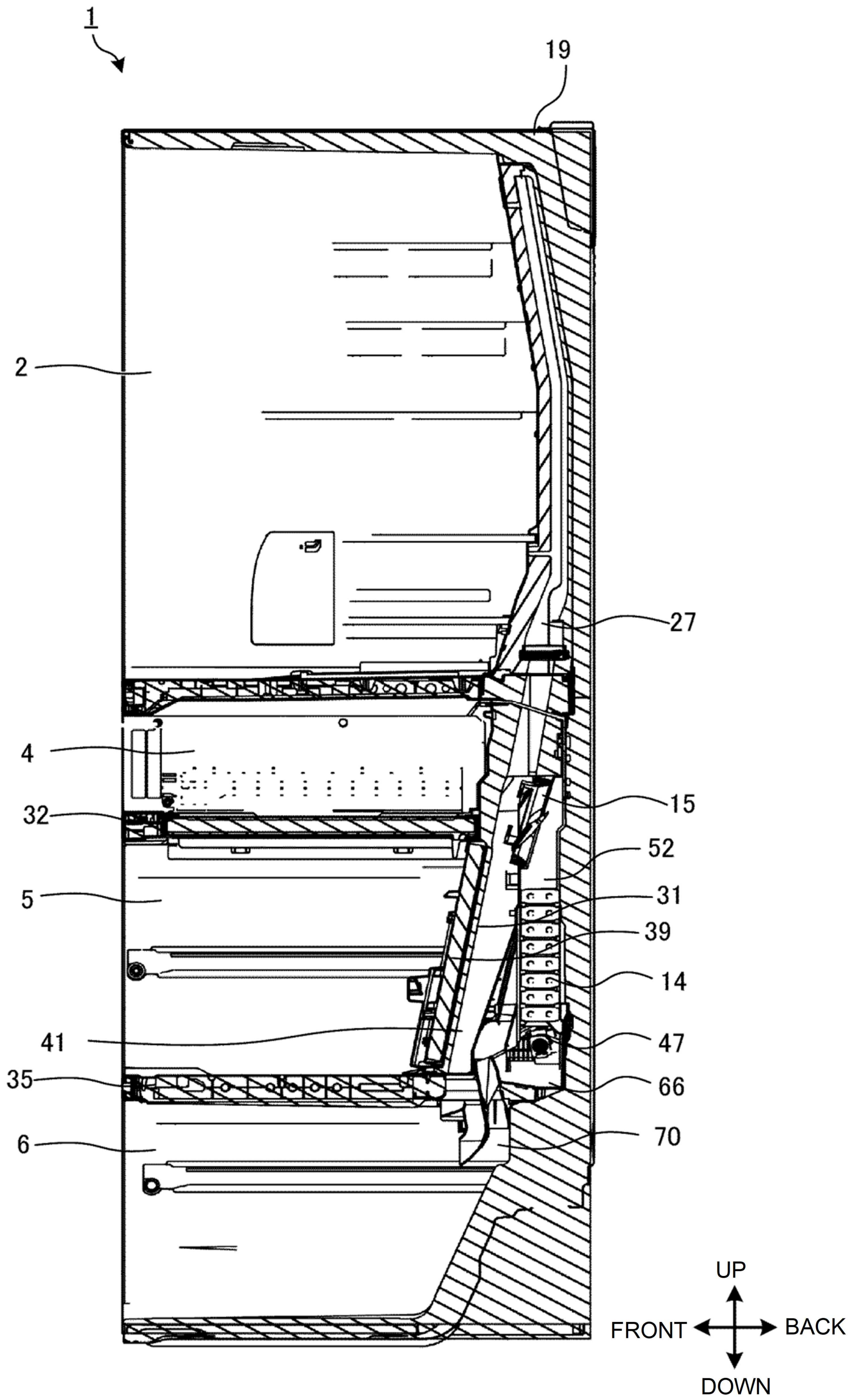

FIG. 17

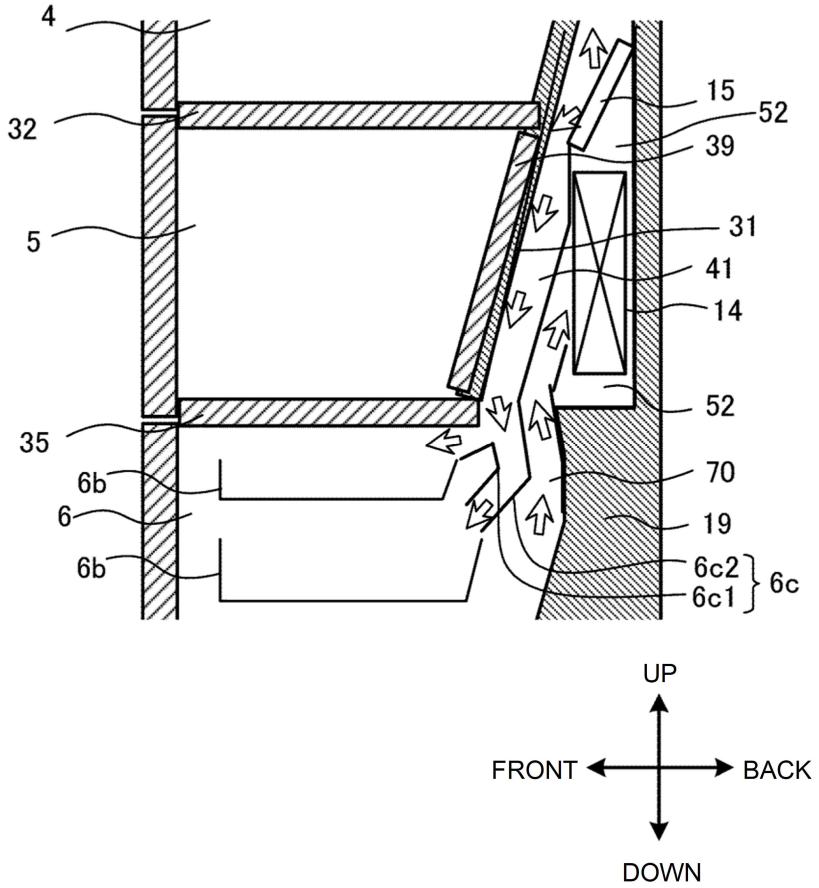
4
32
5
35
6b
6
6b
15
52
39
31
41
14
52
70
19
6c2
6c1
6c
UP
FRONT
BACK
DOWN

FIG. 18

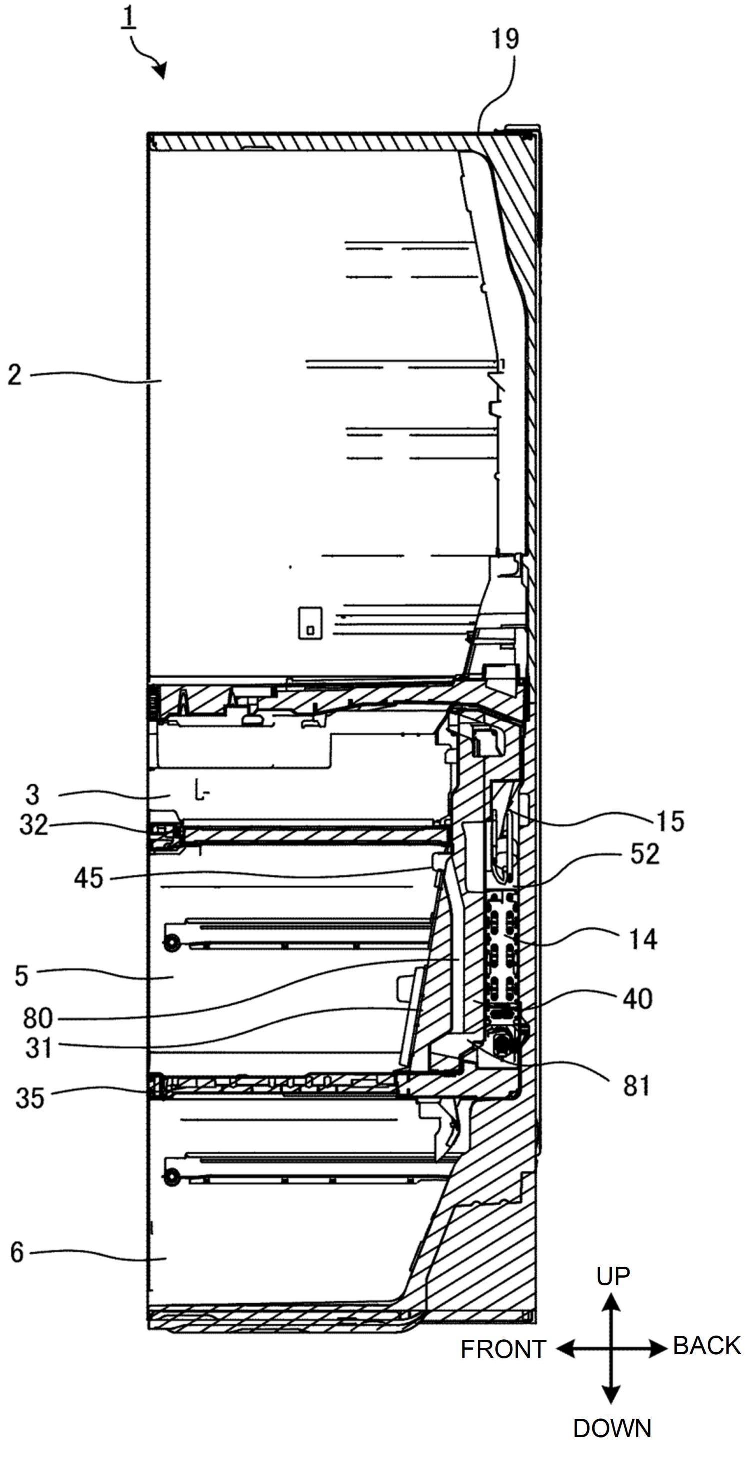

FIG. 19

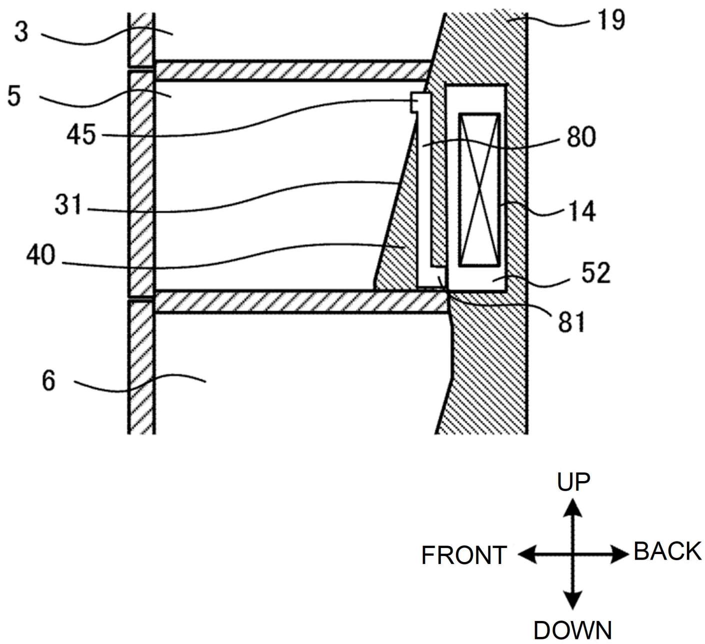
3
19
5
45
80
31
14
40
52
81
6
UP
FRONT
BACK
DOWN

FIG. 20

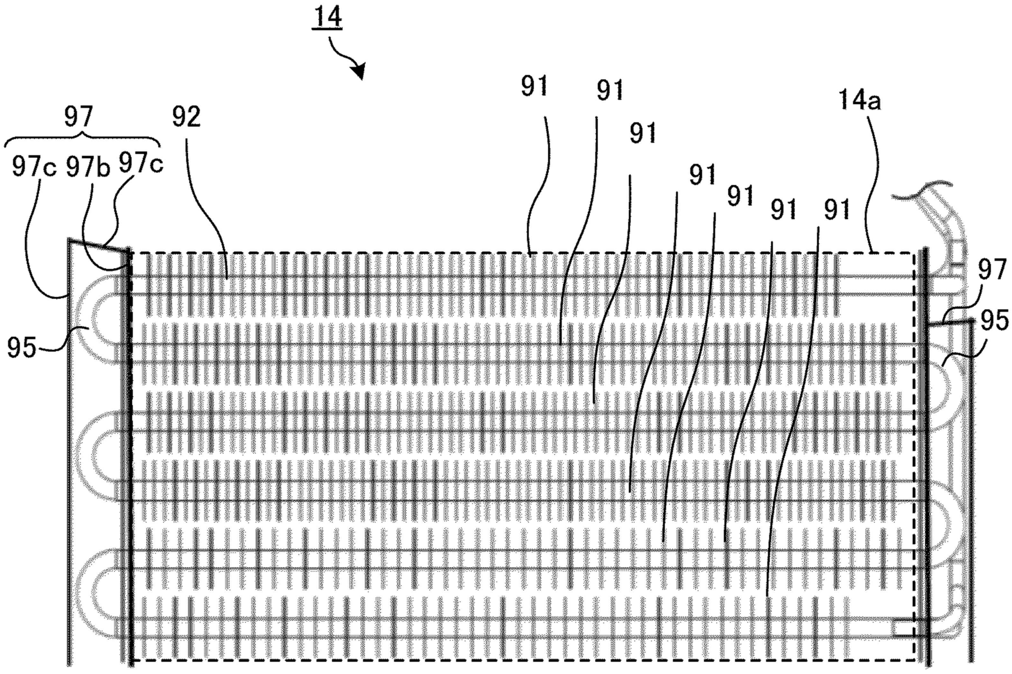
14
97
92
91
91
91
91
91
91
91
14a
97c 97b 97c
97
95
95

FIG. 21

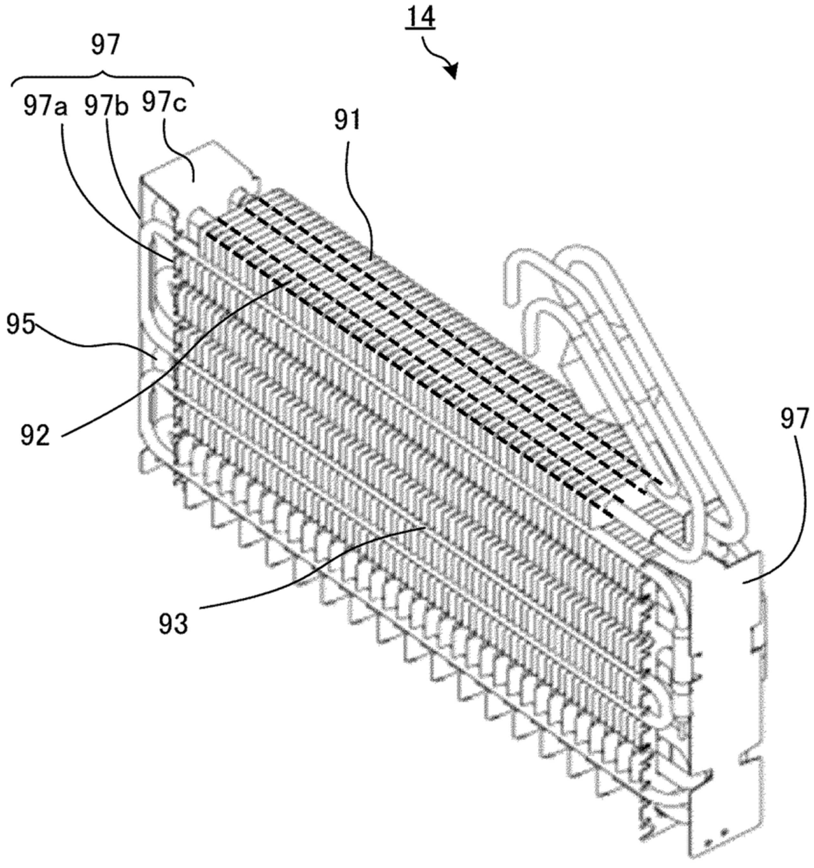

FIG. 22

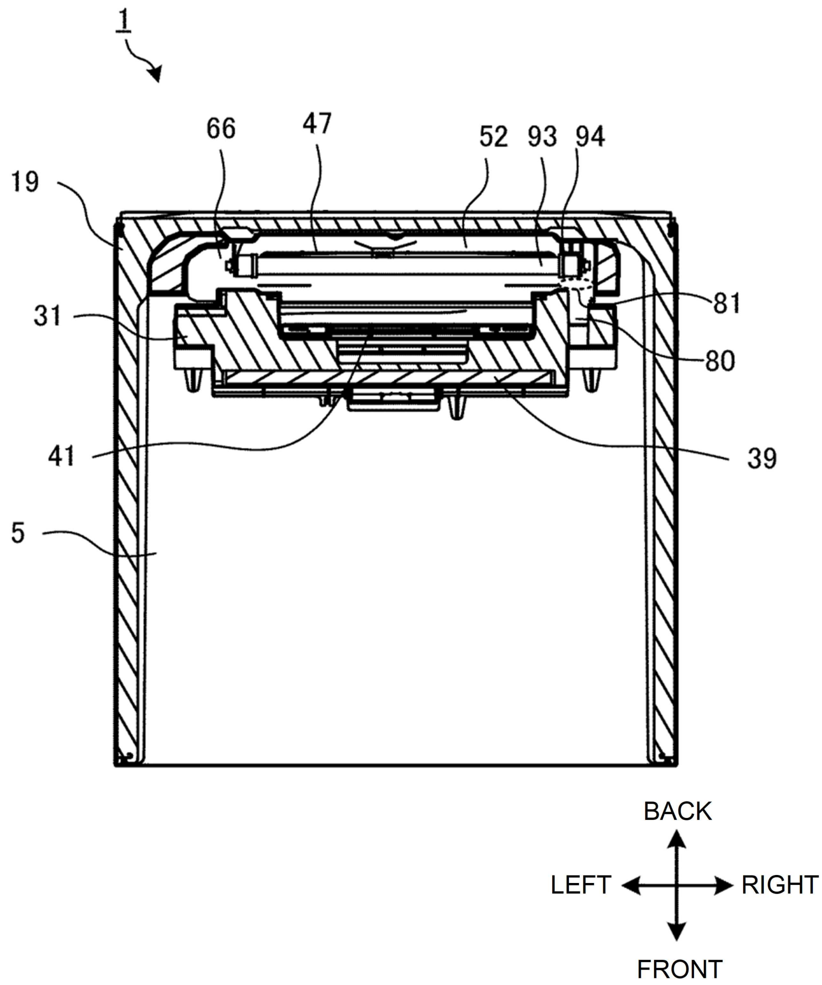

FIG. 23

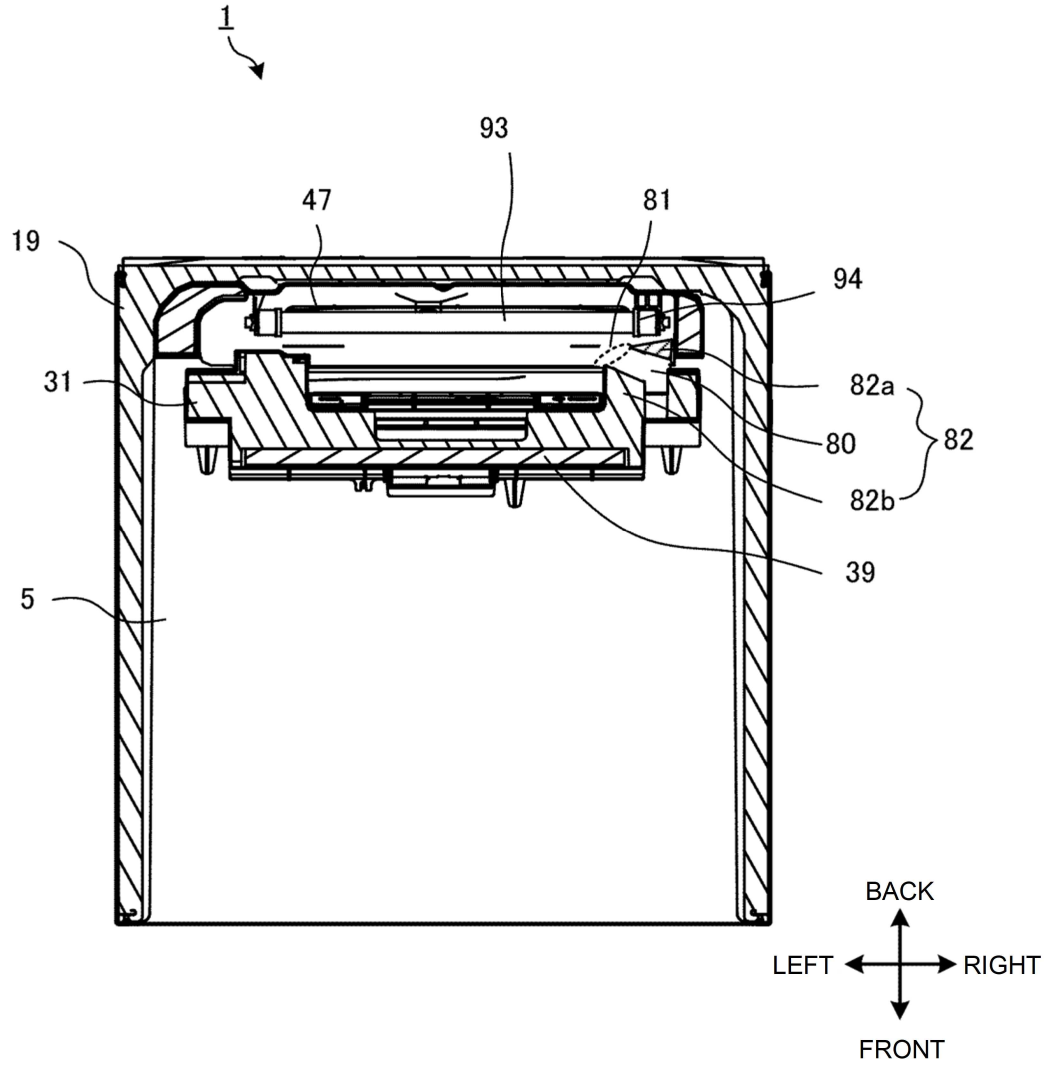

FIG. 24

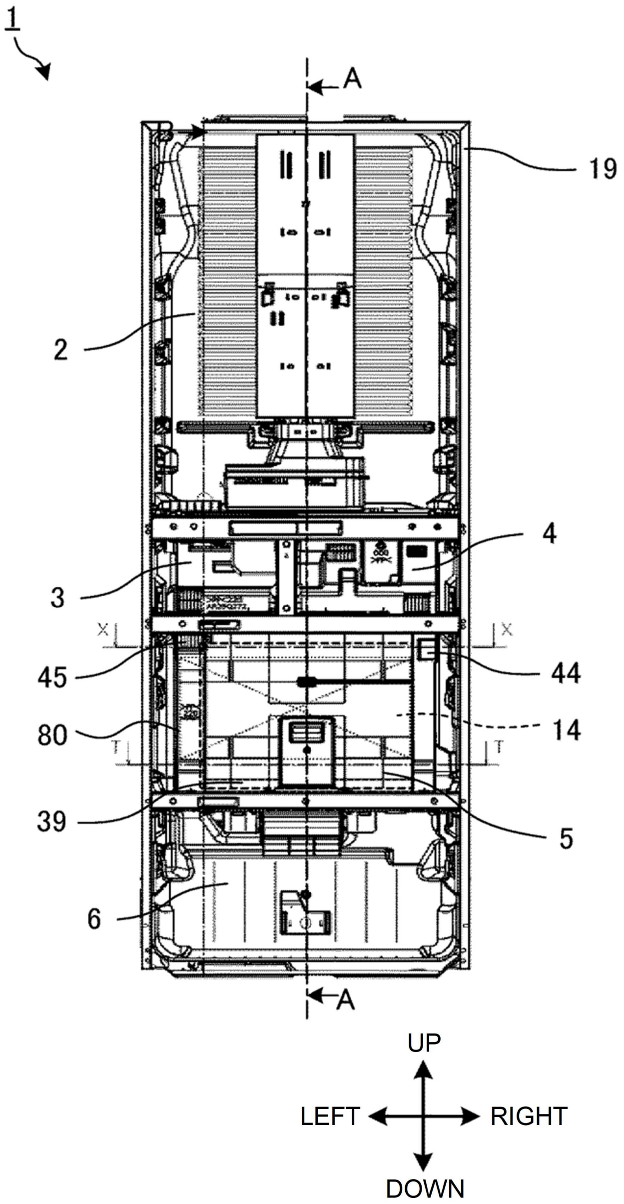

FIG. 25

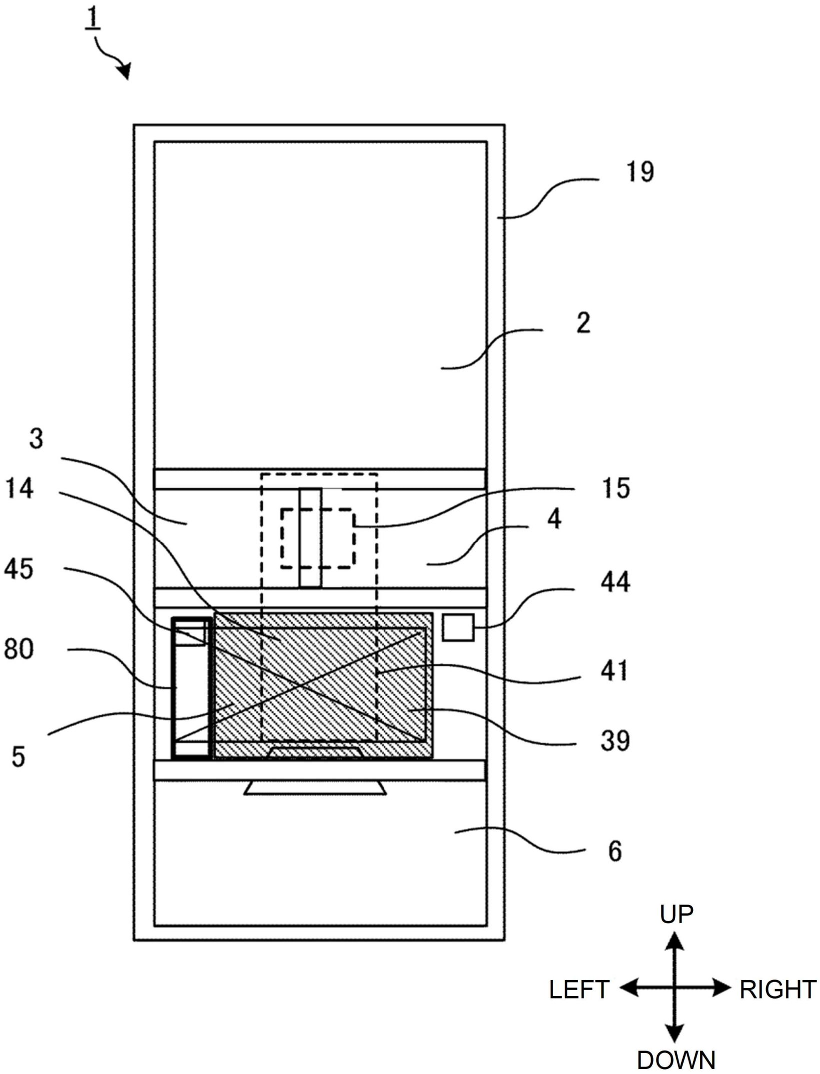

FIG. 26

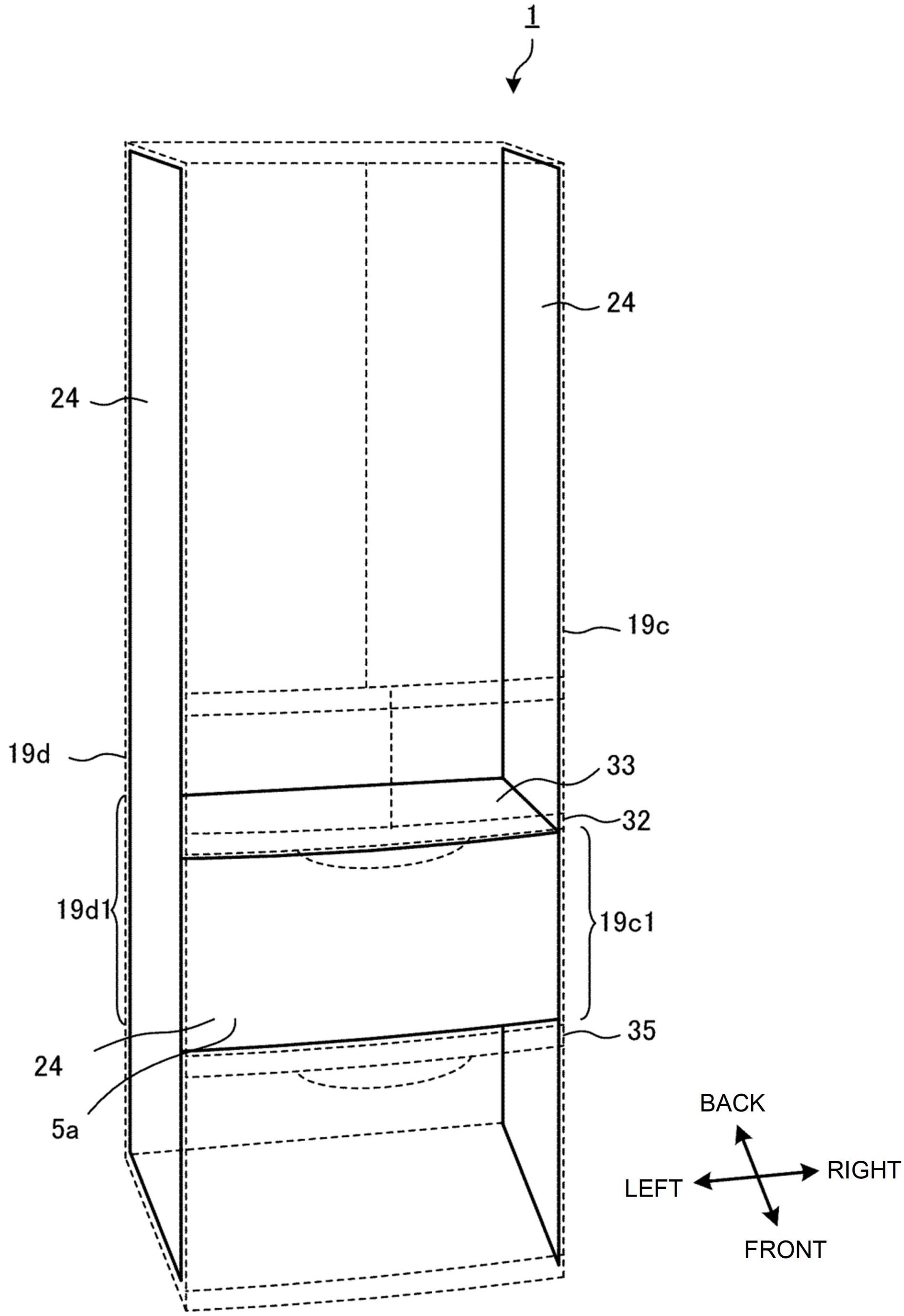

FIG. 27

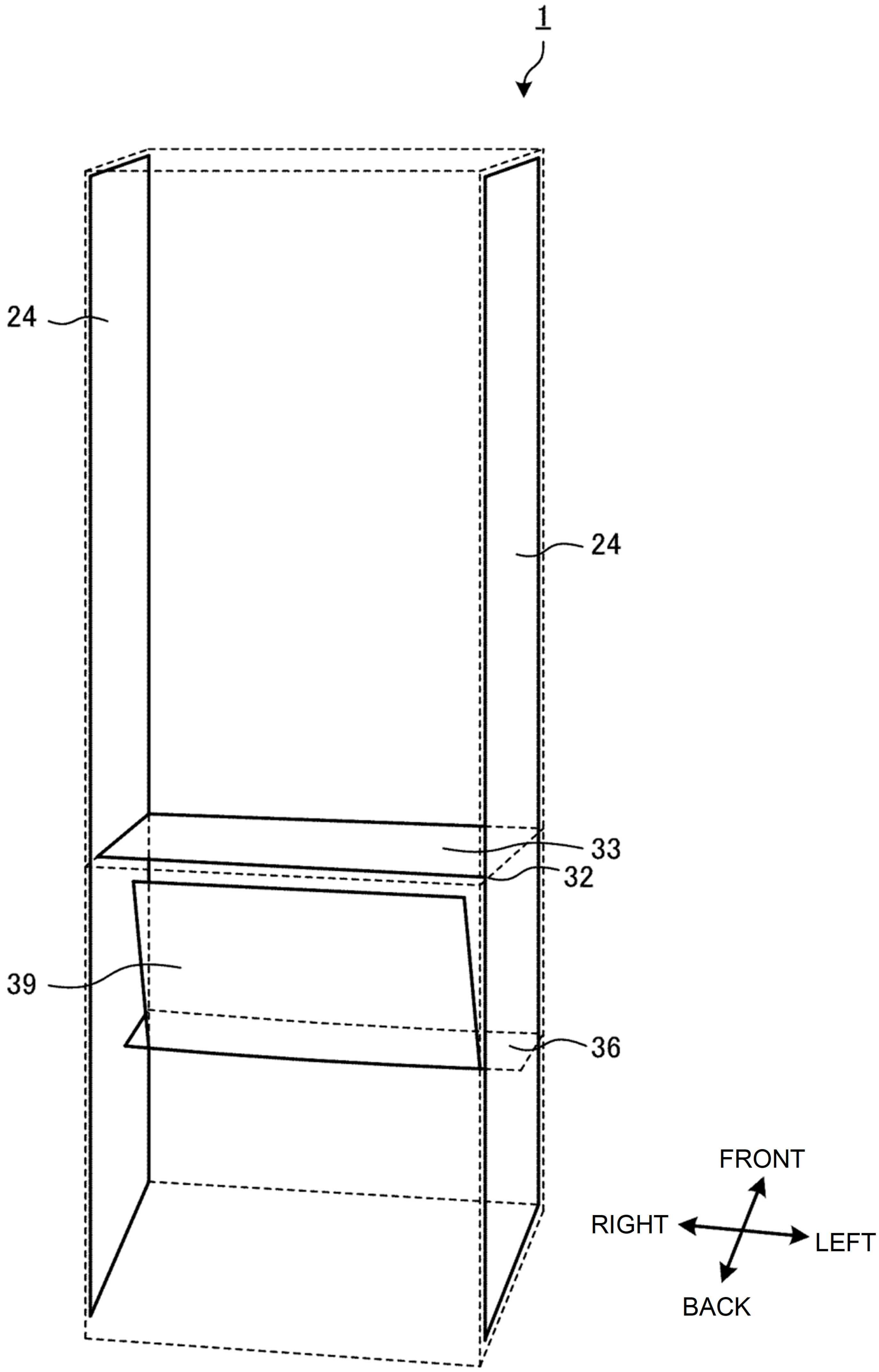

FIG. 28

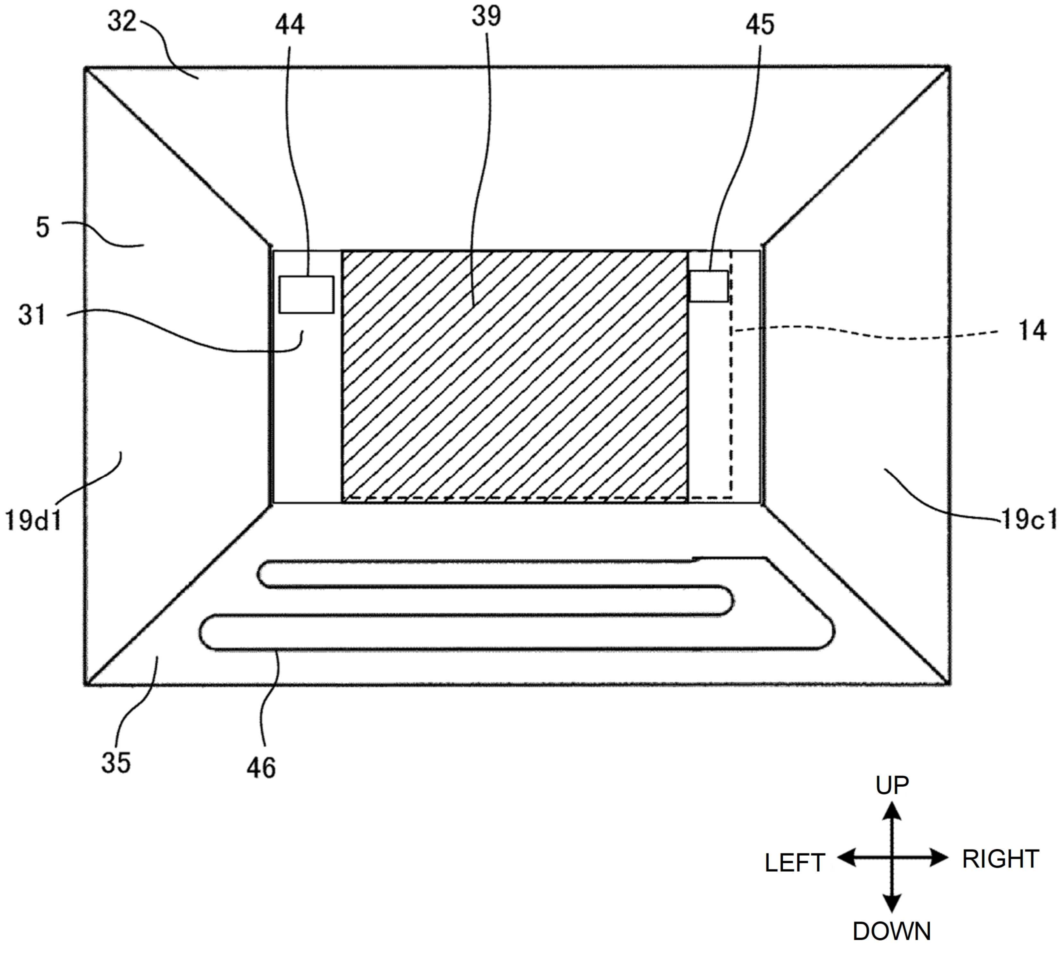

FIG. 29

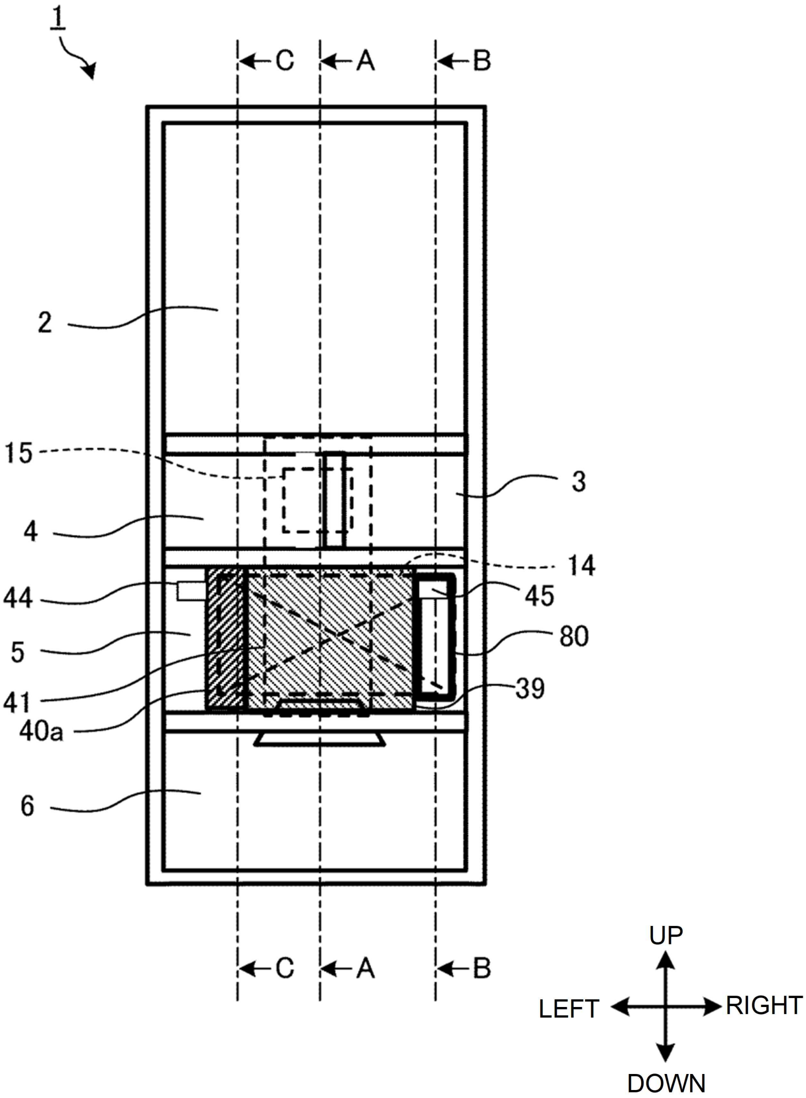

FIG. 30