(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 293 304 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
20.12.2023 Bulletin 2023/51

(21) Application number: **21925742.5**

(22) Date of filing: **26.08.2021**

(51) International Patent Classification (IPC):
F25D 23/06 *(2006.01)* ***F25D 23/08*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F25D 23/06; F25D 23/08

(86) International application number:
PCT/JP2021/031317

(87) International publication number:
WO 2022/172494 (18.08.2022 Gazette 2022/33)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **15.02.2021 JP 2021021704**
19.02.2021 JP 2021024799

(71) Applicant: **Hitachi Global Life Solutions, Inc.**
Minato-ku, Tokyo 105-8410 (JP)

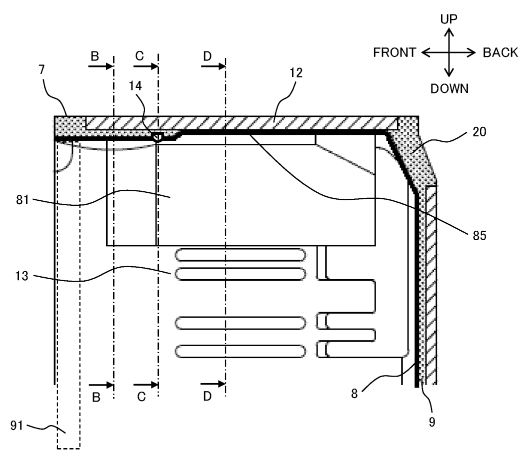
(72) Inventors:
- **KANO Masakazu**
Tokyo 105-8410 (JP)
- **TSUBUKU Masayasu**
Tokyo 105-8410 (JP)
- **WATANABE Hirotoshi**
Tokyo 105-8410 (JP)
- **UCHIYAMA Takashi**
Tokyo 105-8410 (JP)
- **ANDO Hiroaki**
Tokyo 105-8410 (JP)

(74) Representative: **MERH-IP Matias Erny Reichl Hoffmann**
Patentanwälte PartG mbB
Paul-Heyse-Strasse 29
80336 München (DE)

(54) REFRIGERATOR

(57) To provide a refrigerator having a reduced filling amount of a foam heat-insulating material while the strength of the box is maintained. The refrigerator according to the present invention includes a box that forms a storage compartment having an opening front, includes an area between an inner box and an outer box which area is foam-filled with a foam heat-insulating material, and has an up-down dimension which is greater than a left-right dimension, in which a left surface and/or a right surface of the box have or has a front end(s) including a front-end heat-insulating material foam-filled with the foam heat-insulating material continuously in an up-down direction; have or has an area(s) where an area(s) having a flow-permitting thickness for a foam heat-insulating material which is smaller than those of surrounding areas; and include(s) another heat-insulating material that provides heat insulation performance higher than that of the foam heat-insulating material.

FIG. 6



EP 4 293 304 A1

Description

Technical Field

[0001] The present invention relates to a refrigerator.

Background Art

[0002] To meet a need for space saving and larger volumes, there are known technologies related to refrigerators with reduced wall thicknesses and expanded inner volumes. The energy saving performance of a refrigerator is realized by using mainly two heat-insulating materials which are a vacuum heat-insulating material and a foam heat-insulating material in combination. In view of this, recently, there is a refrigerator proposed to enhance the coverage or thickness of a vacuum heat-insulating material with excellent heat insulation performance, and reduce the thickness of a foam heat-insulating material. For example, PTL 1 discloses a refrigerator in which the area size of portions where there is not a foam heat-insulating material on a rear heat insulating wall is made greater than the area size of portions where there is not a foam heat-insulating material on a side heat insulating wall (claim 1, etc.) .

Citation List

Patent Literature

[0003] PTL 1: Japanese Patent No. 6023941

Summary of Invention

Technical Problem

[0004] However, conventional technologies like the one disclosed in PTL 1 or the like related to a refrigerator with a reduced filling amount of a foam heat-insulating material are targeted only at the rear surface of a heat insulation box, and are not targeted at the side surfaces, top surface, and bottom surface of the heat insulation box. In view of this, the present inventors paid attention to the fact that if portions where a foam heat-insulating material influences the strength of a refrigerator less can be identified, the filling amount of the foam heat-insulating material can be reduced also at those portions of the box.

Solution to Problem

[0005] In view of the problem, a refrigerator according to the present invention includes a box that forms a storage compartment having an opening front, includes an area between an inner box and an outer box which area is foam-filled with a foam heat-insulating material, and has an up-down dimension which is greater than a left-right dimension, in which a left surface and/or a right surface of the box have or has a front end(s) including a front-end heat-insulating material foam-filled with the foam heat-insulating material continuously in an up-down direction; have or has an area(s) where an area(s) having a flow-permitting thickness for a foam heat-insulating material which is smaller than those of surrounding areas; and include(s) another heat-insulating material that provides heat insulation performance higher than that of the foam heat-insulating material.

Brief Description of Drawings

[0006]

Figure 1 is a front view depicting the external appearance of a refrigerator.
Figure 2 is a perspective view depicting configuration of a heat insulation box in the refrigerator.
Figure 3 is a figure depicting, about each filling amount of a foam heat-insulating material, results of analysis of filled portions that are necessary in terms of strength.
Figure 4 is a rear perspective view of an inner box of the refrigerator.
Figure 5 is a plan view of the refrigerator as seen from above.
Figure 6 is an arrow view of a cross section taken along A-A in Figure 5.
Figure 7 is an arrow view of a cross section taken along B-B in Figure 5.
Figure 8 is an arrow view of a cross section taken along C-C in Figure 5.
Figure 9 is an arrow view of a cross section taken along D-D in Figure 5.
Figure 10 is a figure depicting a ceiling portion of a cold compartment as seen from the front side.
Figure 11 is a partial cross-sectional perspective view depicting portions near an inside light at the ceiling portion of the cold compartment.
Figure 12 is a perspective view of the ceiling portion of the cold compartment as seen from above without an outer box, an inner box, and a vacuum heat-insulating material.
Figure 13 is a partial cross-sectional view of the ceiling portion of the cold compartment as seen from front.
Figure 14 is a plan view of the ceiling portion of the cold compartment as seen from above, in which the vacuum heat-insulating material, the inside light, and a wire for the inside light can be seen through.
Figure 15 is a perspective view depicting configuration of a heat insulation partition that serves as a partition between a lower freezer compartment and a vegetable compartment.
Figure 16 is a plan view of the heat insulation partition as seen from above.
Figure 17 is an arrow view of a cross section taken along A-A in Figure 16.

Figure 18 is an arrow view of a cross section taken along B-B in Figure 16.

Figure 19 is an arrow view of a cross section taken along C-C in Figure 16.

Figure 20 is an arrow view of a cross section taken along D-D in Figure 16.

Figure 21 is a perspective view of the heat insulation partition as seen from below.

Figure 22 is a plan view of the heat insulation partition as seen from above in a state without an upper case.

Figure 23 is a partially enlarged perspective view of a portion indicated by broken lines F in Figure 22.

Figure 24 is a figure depicting schematic configuration of the ceiling portion in Example 2.

Figure 25 is a schematic cross-sectional view of a heat insulation structure.

Figure 26 is an image view depicting how it appears when the strength of shelves is maintained.

Description of Embodiments

[0007] Embodiments of the present invention are explained below with reference to the attached figures.

Example 1

[0008] A refrigerator according to Example 1 is explained specifically with reference to the attached figures. Figure 1 is a front view depicting the external appearance of a refrigerator 1. Note that directions relative to a viewpoint of a user in each figure are defined as front, back, left, right, up, and down.

<Basic Structure of Refrigerator>

[0009] As depicted in Figure 1, as storage compartments, the refrigerator 1 according to the present example has a cold compartment 2, an ice compartment 3, and an upper freezer compartment 4 that are arranged side by side on the left and right, a lower freezer compartment 5, and a vegetable compartment 6, in this order from above. The refrigerator 1 includes doors to open and close openings of the respective storage compartments. These doors are rotary cold compartment doors 2a and 2b that open and close the opening of the cold compartment 2, and are divided on the left and right, and a drawer-type ice compartment door 3a, upper freezer compartment door 4a, lower freezer compartment door 5a, and vegetable compartment door 6a that open and close the openings of the ice compartment 3, the upper freezer compartment 4, the lower freezer compartment 5, and the vegetable compartment 6, respectively. Note that whereas the refrigerator has the six doors in the example explained in the present example, the six-door refrigerator is not the sole example. The drawer-type doors are each provided with a housing container, and door-side rails extending in the front-back direction, and can slide on rails on the side of an inner box 8 of the refrigerator 1, for example.

[0010] The cold compartment 2 is a refrigeration storage compartment whose average inner temperature is kept at a temperature in the refrigeration temperature range which is approximately 4°C for example. The ice compartment 3, the upper freezer compartment 4, and the lower freezer compartment 5 are frozen storage compartments whose average inner temperatures are kept at temperatures in the freezing temperature range which are approximately -18°C, for example. The vegetable compartment 6 is a refrigeration storage compartment whose average inner temperature is kept at a temperature in the refrigeration temperature range which is approximately 6°C, for example, and is configured to cool foods indirectly to avoid dehydration of foods.

[0011] Shelf ribs 13 disposed on both side surfaces of the cold compartment 2 have front ends that are positioned apart from the front end of the refrigerator 1, and the shelf ribs 13 extend backward from there. Shelves on which foods can be placed are placed across the shelf ribs 13, and a plurality of the shelf ribs 13 are arrayed in the up-down direction in the present example.

[0012] A cooler for cooling the insides of the respective storage compartments is arranged behind the lower freezer compartment 5. Although not depicted in the figure, the cooler, a compressor, a condenser, and a capillary tube are connected with each other, and a refrigeration cycle is formed thereby. Then, a blower for circulating cold air cooled by the cooler is arranged above the cooler, and a discharge port for discharging the cold air into the storage compartments is formed downstream of the blower. Note that there may be a plurality of coolers, and the arrangement positions of them are not limited to positions behind the lower freezer compartment 5, but may be positions behind the cold compartment 2.

[0013] The rails are connected to the door-side rails connected to the drawer-type doors, and support the doors. Containers that can house foods are mounted on the doors or the door-side rails, and move along with the doors.

<Basic Structure of Heat Insulation Box>

[0014] Figure 2 is a perspective view depicting configuration of a heat insulation box in the refrigerator 1 according to the present example. As depicted in Figure 2, the heat insulation box has a box-type shape including a top surface, a bottom surface, both side surfaces, and a rear surface, and having an opening over its front plane. In addition, the heat insulation box includes an outer box 7 (not depicted in Figure 2) made of metal, and an inner box 8 made of synthetic resin, and the space inside the heat insulation box formed by the outer box 7 and the inner box 8 is filled with a foam heat-insulating material 9 such as rigid urethane foam by so-called foam-in-place, and thermally insulates the storage compartments from the outside.

[0015] The outer box 7 includes a top board and left and right side boards that are formed by bending a thin steel strip into a gate-like shape, a rear board formed of a separate member and a bottom board formed of a separate member, and is formed into a box shape. On the other hand, the inner box 8 is formed into a box shape by shaping a synthetic resin board. The top board, and the left and right side boards may be separate bodies.

[0016] In addition, the cold compartment 2 is separated from the ice compartment 3 and the upper freezer compartment 4 by a heat insulation partition 10 disposed as an approximately horizontal surface. In addition, the lower freezer compartment 5 is separated from the vegetable compartment 6 by a heat insulation partition 11 disposed as an approximately horizontal surface. These heat insulation partitions are provided at portions defining the storage compartments whose temperatures are kept in the different temperature ranges, and play a role of preventing the insides of the refrigeration temperature-range compartments from being cooled excessively by cold air of the freezing temperature-range compartment.

[0017] Furthermore, in addition to the foam heat-insulating material 9, a vacuum heat-insulating material 12 (not depicted in Figure 2) having thermal conductivity lower than the thermal conductivity of the foam heat-insulating material 9 is implemented between the outer box 7 and the inner box 8, and the heat insulation performance is increased without reducing the food housing volume. Here, in order to maintain the gas barrier performance, the vacuum heat-insulating material 12 includes a core material such as glass wool that is wrapped by an outer wrapping material formed of a metal layer such as aluminum, for example. The vacuum heat-insulating material 12 is pasted onto the inner wall surface of the outer box 7, that is, the inner wall surface of each of the top board, the side boards, the rear board, and the bottom board by using an adhesive such as a double-sided tape or a hot-melt adhesive at part of or over the whole of the vacuum heat-insulating material 12.

[0018] The foam heat-insulating material 9 applied by foam-in-place is inferior to the vacuum heat-insulating material 12 in terms of thermal conductivity, but is useful in enhancing the strength of the heat insulation box since its bonding force can integrate the inner box 8 and the outer box 7. In an injection method for a urethane heat-insulating material to be the foam heat-insulating material 9 at a time of foam-in-place, the refrigerator 1 is placed such that its front plane faces vertically downward, and its rear surface faces vertically upward, and the urethane heat-insulating material is injected in the space between the inner box 8 and the outer box 7 of the refrigerator 1 via, for example, four injection ports provided through the rear surface of the outer box 7. The injected urethane heat-insulating material is dropped somewhere around the side-surface front ends in the heat insulation box, and foaming starts there. The urethane heat-insulating material runs up along the side surfaces, and goes around to the rear side, filling the space, and being solidified.

[0019] That is, the space between the vacuum heat-insulating material 12 and the inner box 8 is basically filled with the foam heat-insulating material 9 by injection-foaming, and is adhered with the inner box 8 to maintain the strength of the refrigerator. However, in the present example, portions that influence the strength less are not filled with the foam heat-insulating material 9 or is filled with a smaller amount of the foam heat-insulating material 9 (partially urethane-less). Specifically, in the present example, the urethane flow thickness (the gap between the inner box 8 and the vacuum heat-insulating material 12) of the entire area or entire circumference of the partially urethane-less portions is reduced to a thickness smaller than 6 mm, for example. Thereby, it becomes possible to provide an area which is intentionally not filled with urethane or is intentionally filled with a smaller amount of urethane which area is not an area (voids) unintentionally not filled with urethane resulting from dimensional variations of the vacuum heat-insulating material 12 or the like; as a result, it is possible to reduce the injection volume of the urethane heat-insulating material of the refrigerator 1 as a whole. Regarding connection between a portion with a larger flow thickness (e.g., a portion equal to or greater than 8 mm) filled with the foam heat-insulating material 9, and a portion with a smaller flow thickness which is intentionally not filled with urethane or is intentionally filled with a smaller amount of urethane, for example, the inner box 8 is formed in a taper shape to approach the outer box 7, and thereby the flow thickness changes continuously. Thereby, concentration of stress due to weight, generated by a rapid change of the rigidity can be avoided. In addition, pressure loss of an air path can be reduced at locations where cold air flows. On the other hand, for example, if the inner box 8 is connected stepwise, the inner volumes of the storage compartments can be maximized, and the flow thickness can be increased. Accordingly, the risk of failure to fill the connection portion with urethane can be reduced.

[0020] Note that a member to be embedded between the outer box 7 and the inner box 8 along with the foam heat-insulating material 9 is not limited to the vacuum heat-insulating material 12, but may be anything with thermal conductivity λ which is lower than the thermal conductivity of the foam heat-insulating material 9. For example, the vacuum heat-insulating material 12 described in each example may be replaced with a heat insulation structure 30 like the one depicted in Figure 25. The heat insulation structure 30 is one that is formed by placing, one on another, a first board 31a and a second board 31b formed of a stainless steel strip, a PCM steel strip, a glass board or the like with board thicknesses of 0.5 to 2.0 mm such that an inner space 32 is created between the first board 31a and the second board 31b. The heat insulation structure 30 has joints 33 formed by joining the outer circumferences of the first board 31a and the second board 31b by welding, bonding or the like, a plurality of spherical spacer members 34 made of glass, ceramic, or the like are arranged in the inner space

32, and the height of the inner space 32 is made approximately 2 to 5 mm. The inner space 32 is evacuated through a discharge port 35 provided through either of the first board 31a and the second board 31b, and is sealed by a cap 36. By creating vacuum atmosphere in the inner space 32 of the heat insulation structure 30 in this manner, the thermal conductivity λ can be made lower than the thermal conductivity of the foam heat-insulating material 9.

<Overview of Partially Urethane-Less>

[0021] Figure 3 is a figure depicting results of analysis of filled portions that are necessary in terms of strength. The foam heat-insulating material 9 fills heat insulation spaces formed by the inner box 8 and the outer box 7, or the vacuum heat-insulating material 12, and the like, and is solidified to maintain the strength of the refrigerator, but does not make a contribution as a structure to all the spaces equally. Results of determination, by an optimization technique by a density method, of urethane portions that make a contribution to the rigidity required for the refrigerator are depicted in Figure 3. Since rigidity is a premise for the refrigerator to function as a refrigerator, the results were obtained under a condition that weight is applied to shelves placed across the shelf ribs 13, and rails 21 supporting drawer-type storage compartment containers.

[0022] Relative to results of a case that all heat insulation spaces are filled, the most effective urethane injection spaces in cases that 10%, 30%, and 70% urethane injection is performed are depicted from left. Spaces that are required to be filled with a small filling amount are mainly the front ends (opening) and middles in the front-back direction of the side portions, this represents that these portions make a great contribution to the rigidity. As the filling amount is increased, the filled portion spreads backward from portions near the opening on the front side, and connects to the middles of the side surfaces, but does not spread to spaces on the rear sides of the side surfaces, the bottom surface, the top surface, and the rear side unless the filling amount is increased, and this represents that urethane in the heat insulation space at these portions makes a small contribution to the rigidity. It is observed that, regarding the middles of the side surfaces, the spaces above the uppermost shelf ribs 13, and the spaces below the lowermost rails 21 also make a relatively smaller contribution.

[0023] The results representing that the side-surface front ends are important are because, since the refrigerator 1 has an approximately rectangular parallelepiped shape, and has an opening on its front plane, it is necessary to maintain the rigidity particularly at longer-side portions in sides forming the opening plane. The necessity for rigidity on the shorter-side sides (the front ends of the top surface and bottom surface) is relatively low. In addition, in a case that hinge portions 22 that support the rotary doors are provided, portions near the hinge portions 22 also need to be filled with urethane to increase the rigidity. Accordingly, the side-surface front ends are preferably filled with urethane over their entire up-down areas.

[0024] Next to the opening at the front plane, that is, next to particularly the longer sides extending in the up-down direction at the front ends of the heat insulation box, urethane makes a great contribution also at portions where the shelf ribs 13 and the rails 21 are provided on the middle sides of the side surfaces in the front-back direction. The results representing that these portions are important in terms of strength are because the rigidity of portions near the shelf ribs 13 and the rails 21 that are disposed on the side surfaces, and receive the weight of foods placed on or in the shelves or the containers is necessary for supporting the food weight. In this regard, in a case that portions to support shelves are located at other locations, the amount of urethane at these portions can be reduced. For example, in a case that portions to support shelves are located at certain locations on the rear surface, the portions to support the shelves on the rear surface, instead of the side surfaces, can be filled with a greater amount of urethane alternatively.

[0025] On the basis of these analysis results, on the side surfaces of the heat insulation box (the refrigerator 1) according to the present example, the flow thickness for the foam heat-insulating material 9 at the front ends of the heat insulation box, the shelf ribs 13 and the rails 21 is increased. Specifically, the side-surface front ends have an increased flow thickness over the entire up-down area of the refrigerator 1, and the foam heat-insulating material 9 (a front-end heat-insulating material 91) is provided to fill the side-surface front ends. In Figure 3, positional images of the front-end heat-insulating material are given a reference character 91'. Thereby, it is possible to omit filling of the foam heat-insulating material 9 on the rear-end sides of the side surfaces while the front-end sides which are important in terms of strength are filled with the foam heat-insulating material 9. Then, supposing that areas of the side surfaces from the front ends to positions that are apart backward from the front ends by a predetermined distance are called front-end sides (opening sides), and areas behind those areas are called rear-end sides, the flow thickness on the front-end sides as a whole is made larger than the flow thickness on the rear-end sides. The boundaries between the front ends and the rear ends can vary depending on up-down positions on the side surfaces, but, for example, can be at or behind the rear ends of the front-end heat-insulating material 91.

[0026] Specifically, as illustrated on the left surface in Figure 2, within the side surface, a partial area 81 above the uppermost shelf rib 13, and a partial area 84 below the lowermost rail 21 have a reduced flow thickness, and is not filled with the foam heat-insulating material 9 or is filled with a smaller amount of the foam heat-insulating material 9 in the refrigerator 1 according to the present example. Other than this, an area 82 defined by an up-down range from the uppermost shelf rib 13 to the lowermost rail 21, and a front-back range from the front-end heat-insulating material 91 to the shelf ribs 13 or the rails 21, and an area 83 sandwiched in the up-down direction by shelf ribs 13 or by rails 21 also can have a reduced flow thickness, and be not filled with the foam heat-insulating material 9 or are filled with a smaller amount of the foam heat-insulating material 9. Note that whereas the front end of the area 83 is drawn as being located behind the middle of the shelf ribs 13 or the rails 21 in the front-back direction in Figure 2, the area 83 may be expanded to the front end of the shelf ribs 13 or the rails 21.

[0027] For example, the boundaries between the front-end sides and the rear-end sides can be considered in the following manner in a case that the shelf ribs 13/rails 21 are provided in the refrigerator 1 as in the present example.

[0028] First, regarding up-down positions where the shelf ribs 13/rails 21 are provided, the boundaries can be at positions before the front ends of the shelf ribs 13/rails 21 or at the middles of the front-back dimensions of the shelf ribs 13/rails 21. If the boundaries are at positions before the front ends of the shelf ribs 13 and/rails 21, this is preferrable in that the flow thickness of portions that influence the strength less (portions other than the side-surface front ends, the shelf ribs 13 and the rail 21) can be reduced; however, in a foam-in-place method in which a urethane undiluted solution is injected from an injection ports on the rear surface of the refrigerator 1, a foaming path from the side-surface front ends to the shelf ribs 13/rails 21 is likely to be blocked, and voids are likely to be generated at the shelf ribs 13/rails 21. In view of this, in the present example, the flow thickness of the area 82 is made greater to approximately the same degree as the front-end heat-insulating material.

[0029] On the other hand, if the boundaries are at positions at the middles of the front-back dimensions of the shelf ribs 13/rails 21, the urethane filling amount cannot be reduced at positions on the front side of those positions, but it is relatively easier to fill portions at the shelf ribs 13/rails 21 that influence the strength significantly with the foam heat-insulating material 9. Because of this, for example, the flow thickness of the area 83 may be reduced.

[0030] Second, regarding the up-down ranges above the uppermost shelf rib 13/below the lowermost rail 21, the boundaries can be at positions at or behind the rear end of the front-end heat-insulating material mentioned above. In the present example, regarding the range above the uppermost shelf rib 13, the area 81 with a reduced flow thickness is provided from the rear end of the front-end heat-insulating material 91 to the approximately rear end of the side surface. The position of the rear end of the area 81 is not restricted particularly. In addition, regarding the range below the lowermost rail 21, the rectangular area 84 with a reduce flow thickness is provided near the rear end of the front-end heat-insulating material. The rear end of the area 84 may be located behind its position depicted in Figure 2.

[0031] Note that the areas 81 to 84 can overlap the vacuum heat-insulating material 12 in the front view of the side surface, and additionally are located inward of the edge of the vacuum heat-insulating material 12 preferably.

[0032] Next, in a case of a refrigerator not provided with shelf ribs 13 and rails 21, the boundary between the front-end side and the rear-end side can be at a position which is at a distance from the front end, the distance being 1/3 or 1/2 of the front-back dimension from the front end to the rear surface of the inner box, for example.

[0033] In this manner, regarding the side surface of the refrigerator 1, the ratio of a filled area with an increase flow thickness for the foam heat-insulating material 9 (e.g., an area provided with the front-end heat-insulating material 91) to the sum of the filled area with the increased flow thickness, and an unfilled area or less filled area with a reduced flow thickness is higher on the side-surface front-end side than on the side-surface rear-end side. In Figure 2, regarding the left surface, each of the areas 81 to 84 can be given a reduced flow thickness, and the remaining area is given an increased flow thickness. In the present example, the areas 81 and 84 are given reduced flow thicknesses, and the remaining area is given an increased flow thickness. The right surface can be configured similarly to the left surface.

[0034] In this manner, in addition to being provided with the front-end heat-insulating material 91, the side surface of the refrigerator 1 is filled with the foam heat-insulating material 9 (food-support heat-insulating material) with an increased urethane flow thickness in projection planes of the shelf ribs 13 and the rails 21 also. By filling areas corresponding to the projection planes of the shelf ribs 13 and the rails 21 at least with the foam heat-insulating material 9, the strength can be maintained at portions that are important in terms of food weights.

[0035] In order to perform foam-in-place of the food-support heat-insulating material, for example, the entire area over the range from the uppermost shelf rib 13 to the lowermost rail 21 can be filled with the foam heat-insulating material 9 with an increased urethane flow thickness, or an area like the area 83 sandwiched in the up-down direction between shelf ribs 13 and rails 21 may not be filled with the foam heat-insulating material or may be filled with a smaller amount of the foam heat-insulating material by reducing the flow thickness. The present example adopts the former. In the latter case, the food-support heat-insulating material is in a so-called full-of-holes state.

[0036] Regarding the front-back direction of the side surface of the refrigerator 1, the foam heat-insulating material 9 may fill the area between the front-end heat-insulating material mentioned above and the food-support heat-insulating material such that the foam heat-insulating material 9 links the front-end heat-insulating material and the food-support heat-insulating material, or the area may not be filled with the foam heat-insulating material

9 or may be filled with a smaller amount of the foam heat-insulating material 9 by reducing the flow thickness (e.g. by reducing the flow thickness of part of or the entire area 82). If the area (e.g. the area 82) between the front-end heat-insulating material 91 and the food-support heat-insulating material is filled with the foam heat-insulating material 9, it is easy to fill the area with the food-support heat-insulating material in a case of foam-in-place, and if the area is not filled with the foam heat-insulating material 9 or is filled with a smaller amount of the foam heat-insulating material 9, the urethane amount can be reduced while reducing influence on the strength (rigidity) of the refrigerator 1. In a case that part of the area 82 is given a reduced flow thickness, if a plurality of areas that are given a reduced flow thickness are provided being spaced apart from each other in the up-down direction, areas with an increased flow thickness can also be left, the foam heat-insulating material 9 can easily flow therethrough, and so backward filling can be easily performed. That is, this is preferrable in that generation of voids of areas that should be the food-support heat-insulating material can be inhibited.

[0037] Note that if a separate component having rigidity higher than the rigidity of the foam heat-insulating material 9 filling areas and being solidified there is mounted in areas that should be the food-support heat-insulating material, and reinforces those areas, the necessity for performing foam filling in the areas that should be the food-support heat-insulating material is eliminated or reduced. Accordingly, the flow thickness of the entire area between the front-end heat-insulating material and the food-support heat-insulating material like the area 82, and the area 83 can be increased further, and the flow thickness of the entire area overlapping the shelf ribs 13 and the rails 21 can also be reduced. The shelf ribs 13 and the rails 21 are important only in a case that supporting of food weights is considered, the front-end heat-insulating material is important for the strength of the inner box and the outer box as structures, and supporting of food weights is permitted to be attained by reinforcement, not by the foam heat-insulating material 9. Figure 26 is an image view depicting how it appears when the strength of shelves is maintained by providing a reinforcement 23 which is a resin component or a metallic component between the inner box 8 and the vacuum heat-insulating material 12.

[0038] Details of the top surface and the bottom surface are mentioned later, and, since the front ends make a greater contribution to the strength as mentioned above, the flow thickness is made greater on the front-end side than on the rear-end side. Since the top surface and the bottom surface according to the present example are not provided with shelf ribs and rails, the boundaries can be set as positions which are at distances from the front end, the distances being 1/3 or 1/2 of the front-back dimension of the refrigerator 1, for example. Regarding the top surface and/or the bottom surface also, the front end(s) can be filled with the foam heat-insulating material 9, and, in this case, the foam heat-insulating material 9 can be continuous with the front-end heat-insulating material 91 of the side surfaces. The front ends of the top surface and the bottom surface also are filled with the foam heat-insulating material 9 in the present example, and the entire area of the front end of the heat insulation box, that is, the rectangular area, is given an increased flow thickness.

[0039] As a method of reducing the urethane flow thickness, for example, such a reduction can be realized by forming a recess toward the outer box 7 on the inner box 8. By doing so, the inner volumes of the storage compartments can be expanded. Since the vacuum heat-insulating material 12 makes a far greater contribution to the heat insulation performance of the refrigerator 1 than the foam heat-insulating material 9 does, in terms of expansion of the inner volumes and reduction of the urethane amount, the flow thickness of the area where the flow thickness is reduced is preferably reduced to such a degree that the foam heat-insulating material 9 does not fill the area. That is, in a case that the flow thickness (the distance over which there are no structures such as the vacuum heat-insulating material 12 in the area between the outer box 7 and the inner box 8) of the area where the vacuum heat-insulating material 12 is provided is reduced, when the vacuum heat-insulating material 12 has been mounted on the inner box 8, the distance between the vacuum heat-insulating material 12 and the outer box 7 as the flow thickness can be made equal to or shorter than 6 mm, preferably equal to or shorter than 3 mm, for example. In addition, when the vacuum heat-insulating material 12 has been mounted on the outer box 7, the distance between the vacuum heat-insulating material 12 and the inner box 8 can certainly be made similar. On the other hand, in an area where the flow thickness is increased, the distance over which there are no structures in the area between the outer box 7 and the inner box 8 as the flow thickness can be made equal to or longer than 8 mm, equal to or longer than 10 mm, equal to or longer than 12 mm, or equal to or longer than 15 mm, for example. In addition, it may be given a flow thickness approximately the same as the front-end heat-insulating material 91.

[0040] Note that in terms of reduction of the weight of urethane, as means for reducing the flow thickness, some separate component may be disposed between the inner box 8 and the outer box 7 to realize the reduction. In addition, for example, in a case that the unfilled or less filled area is formed into some geometrical shape, it is not necessarily necessary to reduce the flow thickness of the inside of the geometrical shape, and the flow thickness of only the entire edge of the geometrical shape (i.e., a closed curve) may be reduced. In this case, although the advantage of the expansion of the inner volumes is reduced, the reduction of the urethane amount is realized.

[0041] In other respects, regarding the top surface, the bottom surface, and the rear surface of the refrigerator

1, the filling amount of the foam heat-insulating material 9 is reduced taking supporting and protection of the vacuum heat-insulating material 12 into consideration. This is mentioned later.

<Details of Partially Urethane-Less>

[0042] Next, a specific structure of each portion of the heat insulation box in the refrigerator 1 according to the present example is explained. Figure 4 is a rear perspective view of the inner box 8 of the refrigerator 1, and Figure 5 is a plan view of the refrigerator 1 as seen from above (where the vacuum heat-insulating material is seen through). In addition, Figure 6 is an arrow view of a cross section taken along A-A in Figure 5, Figure 7 is an arrow view of a cross section taken along B-B in Figure 5, Figure 8 is an arrow view of a cross section taken along C-C in Figure 5, and Figure 9 is an arrow view of a cross section taken along D-D in Figure 5.

<<Ceiling Portion>>

[0043] First, the structure of the top surface (ceiling portion) of the heat insulation box is explained. The front side and the rear side of the vacuum heat-insulating material 12 of the ceiling portion are continuously filled with the foam heat-insulating material 9 as depicted in Figure 6. Here, regarding the area between the lower surface of the vacuum heat-insulating material 12 and the inner box 8, only the front area extending from the front end to an inside light 14 and the rear area extending from the rear end to the termination end of a corner 20 (an upper rear inclined portion at which the rear surface is continuous with the top surface) are filled with the foam heat-insulating material 9, and the middle area (between the front area and the rear area) is not filled with the foam heat-insulating material 9.

[0044] On the other hand, as depicted in Figure 7 to Figure 9, the left side and the right side of the vacuum heat-insulating material 12 of the ceiling portion are continuously filled with the foam heat-insulating material 9. Here, regarding the area between the lower surface of the vacuum heat-insulating material 12 and the inner box 8, the front area is continuously filled with the foam heat-insulating material 9 from the left end to the right end as depicted in Figure 7, but the middle area is not filled with the foam heat-insulating material 9 from the left end to the right end as depicted in Figure 8 and Figure 9.

[0045] By making the middle area (an area 85) corresponding to the vertically downward projection plane of the vacuum heat-insulating material 12 of the ceiling portion partially urethane-less in this manner, the injection volume of the urethane heat-insulating material can be reduced. In addition, even if the middle area is made partially urethane-less, there is the foam heat-insulating material 9 around (front, rear, left, and right side surfaces) of the vacuum heat-insulating material 12 of the ceiling portion. In particular, in the front area and the rear area, the foam heat-insulating material 9 is supporting the end of the vacuum heat-insulating material 12 like it wraps the vacuum heat-insulating material 12 from the lower surface to the side surfaces. Accordingly, falling or heat bridge of the vacuum heat-insulating material 12 is prevented. Simultaneously, since at least the urethane heat-insulating material fills the area around the inside light 14 arranged near the urethane-less portion, the fixation strength of components related to the inside light 14 can also be maintained.

[0046] Note that since similar advantages can be attained even if the foam heat-insulating material 9 supports the vacuum heat-insulating material 12 like it wraps the vacuum heat-insulating material 12 in its left and right areas, areas to be wrapped are not limited to the front area and the rear area.

[0047] The partially urethane-less area (the area 85) of the ceiling portion can be provided in the projection plane of the vacuum heat-insulating material 12, and on the inner side of the edge of the vacuum heat-insulating material 12, for example, as in the present example.
In addition, as depicted in Figure 9, the width dimension of the vacuum heat-insulating material 12 disposed on the top surface of the inner box 8 is smaller than the width dimension of the top surface of the inner box 8.
Accordingly, in each of areas 9a between left and right corners 8a on the top surface of the inner box 8 and the left end and right end of the vacuum heat-insulating material 12, the foam heat-insulating material 9 fills the area between the outer box 7 and the inner box 8. The thickness of the foam heat-insulating material 9 in these ranges is equivalent to the thickness of the vacuum heat-insulating material 12. Since the heat transfer coefficient of the foam heat-insulating material 9 is higher than the heat transfer coefficient of the vacuum heat-insulating material 12, these portions provide lower heat insulation performance. If heat insulation performance is insufficient, the outer box 7 is cooled by the inside of the refrigerator, condensation occurs to the outer box 7 due to the temperature difference of the refrigerator outside air, and this is not preferrable. In the refrigerator according to the present example, heat of a hot gas pipe (not depicted) installed between the outer box 7 and the foam heat-insulating material 9 prevents the outer box 7 from being cooled, and this reduces the temperature difference between the outer box 7 and the refrigerator outside air, and prevents occurrence of condensation.
In this manner, since the top surface (the vertically downward projection plane of the vacuum heat-insulating material 12 and the area 9a) of the inner box 8 is made approximately the same planar shape, expansion of the inner volume is possible also at portions other than the projection plane of the vacuum heat-insulating material 12.

<<Opening>>

[0048] Next, regarding the structure of the opening of the heat insulation box, as mentioned before, the refrigerator 1 is placed in a state that its rear surface faces upward, and the urethane heat-insulating material is injected toward the front plane, which is facing vertically downward, of the refrigerator 1 through, for example, four injection ports provided through the rear surface. In the present example, not only the entire up-down areas of the left surface and the right surface equivalent to longer sides on the front-plane side (opening) of the refrigerator 1, but the entire left-right areas of the top surface and the bottom surface equivalent to shorter sides are given an increased flow thickness. Because of this, the opening of the refrigerator 1 (the heat insulation box) can be filled with the foam heat-insulating material 9 continuously over the entire circumference. In this manner, filling with the front-end heat-insulating material can be performed.

<<Shelf Ribs>>

[0049] Next, the structure of portions in the heat insulation box where the shelf ribs 13 are formed is explained by using Figure 8 and Figure 9. On the side surfaces of the refrigerator 1, recessed areas (the areas 81) where the inner box 8 is recessed toward the outer box 7 are formed above the uppermost shelf ribs 13, and those recessed areas are given a reduced flow thickness. The recessed areas (the areas 81) are not provided at the front ends of the side surfaces (see Figure 7).

[0050] Foam-in-place of the urethane heat-insulating material injected through the injection ports on the rear surface of the refrigerator 1 is performed in a state that the rear surface of the refrigerator 1 faces vertically upward as mentioned above. For example, the urethane heat-insulating material having started foaming first in an area where the front-end heat-insulating material is formed next starts filling areas with an increased flow thickness. Because of this, filling with the foam heat-insulating material 9 proceeds in the inner box 8 in the range including the uppermost shelf rib 13 to the lowermost rail such that the foam heat-insulating material 9 runs up toward the rear side of the refrigerator 1. In this manner, filling with the food-support heat-insulating material proceeds entirely continuously from the area of the front-end heat-insulating material.

[0051] On the other hand, side surfaces positioned above the uppermost shelf ribs 13 in Figure 8 (in terms of directions at a time of use of the refrigerator 1) which side surfaces do not make a contribution to supporting of the shelf ribs 13 are given a reduced flow thickness. Since the thickness is a flow thickness which is reduced to such a degree that urethane cannot flow therethrough in the present example, the urethane heat-insulating material does not run up at all at the front ends of the refrigerator 1.

<Ceiling Panel>

[0052] Figure 10 is a figure of the ceiling portion of the cold compartment 2 as seen from the front side, and Figure 11 is a partial cross-sectional perspective view depicting portions near the inside light 14 at the ceiling portion of the cold compartment 2. The inside light 14 is covered with a light-transmitting cover member. The quality of the material of the cover member is not limited particularly, but is desirably a transparent synthetic resin.

[0053] Since the inside light 14 is mounted on the inner box 8 at the front side of the ceiling portion as depicted in Figure 11, the area between the inner box 8 and the vacuum heat-insulating material 12 is filled with the foam heat-insulating material 9, and the support strength for the inside light 14 is enhanced. On the other hand, since the gap between the vacuum heat-insulating material 12 and the inner box 8 is small (e.g., smaller than 1 mm) on the rear side of the ceiling portion, and the inner box 8 is located at a high position, the food housing space for the uppermost shelf is increased. It should be noted that it is better not to make the vacuum heat-insulating material 12 contact the inner box 8 but to form at least a small gap as a buffer for a case that a user hits the ceiling portion with a can or the like.

[0054] Since the area with a small gap between the vacuum heat-insulating material 12 and the inner box 8 is not filled with the foam heat-insulating material 9 in this manner, the inner box 8 is not adhered to the outer box 7 or the vacuum heat-insulating material 12 via the foam heat-insulating material 9. As a result, the inner box 8 droops undesirably due to its own weight, and this is not preferrable in terms of external appearance. In view of this, injection foaming of the urethane heat-insulating material is performed in a state that a ceiling panel 16 made of synthetic resin is mounted below the inner box 8 of the urethane-less portion in the present example, and the ceiling panel 16 forms part of the ceiling surface of the cold compartment 2.

<Support Structure for Ceiling Panel>

[0055] Since the ceiling panel 16 has an inclined surface 16a whose front side is extending downward, is fastened at the inclined surface 16a by a screw 17 from the outside of the inner box 8, and is prevented from falling off, it is difficult for a user to visually recognize the presence of the screw 17. In addition, since the head of the screw 17 is covered with the foam heat-insulating material 9 in the end, this not only inhibits loosening of the screw 17 but also prevents a user from removing the screw 17, the screw 17 from contacting and damaging the vacuum heat-insulating material 12, and so on.

[0056] Note that since the front side of the ceiling panel 16 is formed as the inclined surface 16a, cold air discharged from the rear side of the cold compartment 2 is guided diagonally downward, and it becomes easier to cool foods in door pockets. In addition, this provides a merit that it is easier to take out and put in foods, and a merit that it is easier for the urethane heat-insulating material to flow, as compared with a step without an inclination.

[0057] Figure 12 is a perspective view of the ceiling portion of the cold compartment 2 as seen from above without the outer box 7, the inner box 8, and the vacuum heat-insulating material 12, and Figure 13 is a partial cross-sectional view of the ceiling portion of the cold compartment 2 as seen from front. As depicted in Figure 12, a claw 16b is formed at the middle, in the left-right direction, on the rear side of the ceiling panel 16, and engages with the inner box 8. Since this claw 16b is formed to occupy only a partial left-right width of the ceiling panel 16 having a left-right width dimension which is approximately the same as the inner box 8, this provides high installation working efficiency about the ceiling panel 16.

[0058] Since the left and right ends of the ceiling panel 16 are simply placed on ribs (not depicted) extending in the front-back direction from the side walls of the inner box 8, the ceiling panel 16 is not constrained in the horizontal direction. In addition, the rear end of the ceiling panel 16 also is simply constrained in the up-down direction by the claw 16b. Because of this, thermal deformation of the ceiling panel 16 due to an environment temperature change, warping of the ceiling panel 16 due to foaming pressure of the foam heat-insulating material 9 received via the inner box 8, and the like can be inhibited. Note that as long as either the left and right ends or the front and rear ends of the ceiling panel 16 are unconstrained in the horizontal direction, the ceiling panel 16 may be supported by another method.

[0059] In addition, a first rib 16c extending in the front-back direction at the middle in the left-right direction, and a second rib 16d extending in the left-right direction at the middle in the front-back direction are formed on the upper surface of the ceiling panel 16, and this increases the rigidity of the ceiling panel 16. Note that a plurality of first ribs 16c or second ribs 16d may be formed. In addition, since a plurality of reinforcement pieces 16e extending in the left-right direction are formed side by side in the front-back direction at the left and right ends of the ceiling panel 16, deformation of the ceiling panel 16 due to foaming pressure of the foam heat-insulating material 9 that fills the area between the inner box 8 and the outer box 7 forming the left and right side surfaces can be inhibited.

[0060] Here, the inner box 8 and the ceiling panel 16 are not bonded together, a gap is formed between the inner box 8 and the ceiling panel 16 as depicted in Figure 13, and load is not applied to the ceiling panel 16 even if the inner box 8 droops to some degree. Note that the first rib 16c and the second rib 16d also play a role of preventing the entire surface from contacting the ceiling panel 16 even if the inner box droops. In addition, since mass % of a glass filler used to shape the ceiling panel 16 according to the present example is equal to or lower than 10, warping at a time of shaping is reduced. Note that the quality of the material of the ceiling panel is not limited to a synthetic resin, but the ceiling panel may be a structure mounted after injection foaming of the urethane heat-insulating material.

<Wire of Ceiling Portion>

[0061] Figure 14 is a plan view of the ceiling portion of the cold compartment 2 as seen from above, in which the vacuum heat-insulating material 12, the inside light 14, and a wire (cord 15) for the inside light 14 can be seen through. As depicted in Figure 14, the cord 15 led out from the inside light 14 passes by the vacuum heat-insulating material 12, reaches the rear side, further goes down on the rear side, and is connected to a control substrate which is not depicted.

[0062] Here, the area between the lower surface of the vacuum heat-insulating material 12 of the ceiling portion and the inner box 8 is not filled with the foam heat-insulating material 9 except for the front area and the rear area as depicted in Figure 6. If the cord 15 is arranged at a portion not filled with the foam heat-insulating material 9, there is a possibility that the inner box 8 is pressed by the cord 15, and marks, the cord 15 damages the vacuum heat-insulating material 12, and so on, when a jig is used to press from the side of the inner box 8 at a time of foaming of the urethane heat-insulating material. Accordingly, in the present example, the cord 15 is arranged at a portion filled with the foam heat-insulating material 9. That is, the wire arranged in the area corresponding to the vertically downward projection plane of the vacuum heat-insulating material 12 is arranged only in the front area and the rear area which are portions where there is the foam heat-insulating material 9, and, in areas therebetween, the wire is arranged at portions outside the vertical projection plane of the vacuum heat-insulating material 12 where there is the foam heat-insulating material 9.

[0063] It should be noted that by providing an intervening member such as a foaming body that has been formed by foaming in advance between the cord 15 and the inner box 8, providing a space for avoiding the cord 15 on the side of the inner box 8 or on the side of the vacuum heat-insulating material 12, and so on, the cord 15 can be arranged even at portions not filled with the foam heat-insulating material 9.

<Heat Insulation Partition>

[0064] Next, the heat insulation partition 11 that separates the lower freezer compartment 5 from the vegetable compartment 6 is explained specifically. Figure 15 is a perspective view depicting configuration of the heat insulation partition 11 that serves as a partition between the lower freezer compartment 5 (freezing temperature-range compartment) and the vegetable compartment 6 (refrigeration temperature-range compartment). As depicted in Figure 15, the heat insulation partition 11 includes a combination of an upper case 111 and a lower case 112. Furthermore, in a space surrounded by the upper case 111 and the lower case 112, the heat insulation partition 11 includes the vacuum heat-insulating material 12 and a heater 113, in this order from above. Then, when the space between the outer box 7 and the inner box 8 is filled with the foam heat-insulating material 9, the urethane heat-insulating material injected through the four injection ports mentioned before provided on the side of the rear surface of the heat insulation box flows into the heat insulation partition 11 through urethane inflow ports 11a formed on the left and right sides on the front side of the heat insulation partition 11. Filling with the urethane heat-insulating material having flowed into the heat insulation partition 11 proceeds in areas around the vacuum heat-insulating material 12, and the urethane heat-insulating material is adhered to the heat insulation box along with the upper case 111 and the lower case 112 in the end.

<<Upper Case>>

[0065] Although the upper case 111 faces the lower freezer compartment 5, as depicted in Figure 15, the upper case 111 has two upper-surface recesses 111a on the left and right, so it becomes possible to increase the inner volume of the lower freezer compartment 5. Note that as a shape corresponding to lower-surface recesses 112a (see Figure 21) of the lower case 112, and the front side of a bent portion 12a (see Figure 18) of the vacuum heat-insulating material 12 positioned thereabove, the front sides of the upper-surface recesses 111a have shallow bottom surfaces as compared with the rear sides. In addition, a bridge portion 111b which has the same height as the peripheries of the upper-surface recesses 111a is formed at a portion sandwiched by the left and right upper-surface recesses 111a.

[0066] Figure 16 is a plan view of the heat insulation partition 11 as seen from above (the side of the lower freezer compartment 5). Figure 17 is an arrow view of a cross section taken along A-A in Figure 16, Figure 18 is an arrow view of a cross section taken along B-B in Figure 16, Figure 19 is an arrow view of a cross section taken along C-C in Figure 16, and Figure 20 is an arrow view of a cross section taken along D-D in Figure 16.

[0067] As depicted in Figure 17 and Figure 18, one vacuum heat-insulating material 12 having the bent portion 12a is positioned below the upper case 111. The front-back dimension of the vacuum heat-insulating material 12 is the same as or greater than the front-back dimension of the upper-surface recesses 111a, the left end of the vacuum heat-insulating material 12 is at the same position as or on the left side of the left end of the left upper-surface recess 111a, and the right end of the vacuum heat-insulating material 12 is at the same position as or on the right side of the right end of the right upper-surface recess 111a. Here, as compared with the lower portion of the bridge portion 111b which is a portion between the two upper-surface recesses 111a (see Figure 17), the lower portion of the portion where the upper-surface recesses 111a are formed (see Figure 18) has a smaller gap between the upper case 111 and the vacuum heat-insulating material 12 (e.g., smaller than 6 mm). Accordingly, the urethane heat-insulating material having flowed into the heat insulation partition 11 through the urethane inflow ports 11a cannot flow into the space sandwiched by the portion where the upper-surface recesses 111a are formed and the vacuum heat-insulating material 12, but flows into the space sandwiched by a portion where the upper-surface recesses 111a are not formed and the vacuum heat-insulating material 12. That is, as indicated by dotted lines E in Figure 16, the flow path of the urethane heat-insulating material goes through a gap below the periphery of each upper-surface recess 111a, and hits a lower portion of the bridge portion 111b in the front-back direction in the end.

[0068] Since the foam heat-insulating material fills the lower portion of the bridge portion 111b of the upper case 111 in the front-back direction near the middle of the heat insulation partition 11 in this manner, the rigidity of the heat insulation partition 11 is increased as exhibited by reduction of warping of the upper case 111 or the like, and damage to the vacuum heat-insulating material 12 and the like are inhibited. In addition, the urethane heat-insulating material having flowed in through the urethane inflow ports 11a branches into a plurality of directions due to the upper-surface recesses 111a. Since the urethane heat-insulating material the flow of which has branched hits any portion (final filled portion) in the heat insulation partition 11, there is the risk of voids. However, by providing the bridge portion 111b, it is possible to form a flow of the urethane heat-insulating material that flows to the front end and rear end of the lower portion of the bridge portion 111b. Since urethane that has flowed from the front end and rear end of the lower portion of the bridge portion 111b hits, voids, if generated, can be kept within the area of the bridge portion 111b. Furthermore, there is the vacuum heat-insulating material 12 in the area corresponding to the vertically downward projection plane of the bridge portion 111b. That is, even if voids are generated, generation positions of the voids can be kept within the area of the vacuum heat-insulating material 12, so influence of the voids on the heat insulation performance of the heat insulation partition wall can be minimized. Note that the present example adopts configuration in which the upper-surface recesses 111a are arranged side by side on the left and right, and the bridge portion 111b is formed in the front-back direction, configuration in which the upper-surface recesses 111a are arranged side by side in the up-down direction, and the bridge portion 111b is formed in the left-right direction may be adopted. In addition, since it is sufficient if the height of the bridge portion 111b is at least taller than the lower surfaces of the upper-surface recesses 111a in order to make sure that there is an inflow of urethane, the present example is not limited in this respect.

[0069] In addition, the front side and rear side of the vacuum heat-insulating material 12 are filled with the foam heat-insulating material 9 as depicted in Figure 17 and Figure 18, and the left side and right side of the vacuum heat-insulating material 12 are also filled with the foam heat-insulating material 9 as depicted in Figure 19 and Figure 20. On the other hand, a double-sided tape (not depicted) is applied onto part of the lower-surface side of the vacuum heat-insulating material 12, and the part is bonded with the lower case 112. Because of this, the area between the vacuum heat-insulating material 12 and the lower case 112 also is basically not filled with the foam heat-insulating material 9. However, as depicted in Figure 20, since the area below the front side of the bent portion 12a of the vacuum heat-insulating material 12 has a relatively large gap with the lower case 112 except for the area of the lower-surface recesses 112a formed on the front side of the lower case 112, the area below the front side of the bent portion 12a is filled with the foam heat-insulating material 9.

[0070] Since the upper-surface side and lower-surface side of the vacuum heat-insulating material 12 in the heat insulation partition 11 is partially urethane-less in the present example in this manner, this provides a merit that the filling amount of the foam heat-insulating material 9 in the refrigerator 1 as a whole can be reduced. Since, in addition to this, portions in front of, behind, and to the left and right of the vacuum heat-insulating material 12 are filled with the foam heat-insulating material 9, the vacuum heat-insulating material 12 is stably supported in the heat insulation partition 11, and the strength as the heat insulation partition 11 is maintained.

<<Lower Case>>

[0071] Figure 21 is a perspective view of the heat insulation partition 11 as seen from below (the side of the vegetable compartment 6). As indicated by broken lines and dotted lines in Figure 21, there is the heater 113 above the lower case 112, and there is the vacuum heat-insulating material 12 above the heater 113. In addition, although not depicted, the refrigerator 1 according to the present example has a structure in which a vegetable compartment cover that can open and close the upper plane of the container of the vegetable compartment 6 can be installed. This vegetable compartment cover is for inhibiting dehydration of vegetables in the container by increasing the degree of sealing of the container, and is supported by a vegetable-compartment cover mounting portion 112b provided to the lower case 112 of the heat insulation partition 11.

[0072] The front side of the lower case 112 has the vegetable-compartment cover mounting portion 112b, and the lower-surface recesses 112a that are provided side by side to the left and right of the vegetable-compartment cover mounting portion 112b. The lower-surface recesses 112a have a shape protruding upward on the rear side of the vegetable-compartment cover mounting portion 112b, and can restrict the position of the vacuum heat-insulating material 12. Because of this, it is possible to prevent the vacuum heat-insulating material 12 from abutting on the vegetable-compartment cover mounting portion 112b, and being damaged. In addition, since surfaces on the rear sides of the lower-surface recesses 112a facing the vacuum heat-insulating material 12 are inclined surfaces 112c, damage to the vacuum heat-insulating material 12 due to contact with the lower-surface recesses 112a is also inhibited. Furthermore, since a plurality of the lower-surface recesses 112a are provided side by side in the left-right direction, and the lower-surface recesses 112a are not formed continuously over the entire area in the left-right direction, the urethane heat-insulating material can easily flow in; as a result, the support strength of the front side of the heat insulation partition 11 can be enhanced.

[0073] The heater 113 is for heating the vegetable compartment 6 that the heat insulation partition 11 (lower case 112) faces, and keeping the temperature of the inside of the vegetable compartment 6 in a predetermined temperature range, and, although not depicted, includes a heat transfer wire, an aluminum sheet covering the heat transfer wire, and a lead connected with the heat transfer wire. Since the planar heater 113 used in the present example cannot form the bent portion 12a unlike the vacuum heat-insulating material 12 can, it is difficult to be extended forward up to the inclined surfaces 112c of the lower-surface recesses 112a. However, since the vacuum heat-insulating material 12 is positioned also above the area on the front side where the heater 113 cannot reach, occurrence of condensation can be prevented.

[0074] Since, behind the lower-surface recesses 112a, there is an area not filled with the foam heat-insulating material 9 above the lower case 112 in the present example, there is a possibility that the lower case 112 droops due to its own weight or warping. However, since there is a drawer-type container in the vegetable compartment 6 faced by the lower case 112, and the lower surface of the heat insulation partition 11 is a location where a user is difficult to see visually, it is attempted in the present example to reduce the filling amount of the foam heat-insulating material 9 while reducing the negative influence on the aesthetic look.

[0075] As mentioned already, in the heat insulation partition 11 according to the present example, there are the upper-surface recesses 111a of the upper case 111, and the lower-surface recesses 112a of the lower case 112. Here, since the temperature range of the lower freezer compartment 5 faced by the upper case 111 is lower than the temperature range of the vegetable compartment 6 faced by the lower case 112, it is necessary to increase the circulatory flow amount of cold air. Accordingly, by making the volume of the overall recesses of the upper-surface recesses 111a greater than the volume of the overall recesses of the lower-surface recesses 112a, it is possible to preferentially increase the air path dimension of cold air flowing through the bottom of the lower freezer compartment 5.

<<Cord Temporary Housing Portion>>

[0076] Figure 22 is a plan view of the heat insulation partition 11 as seen from above (the side of the lower freezer compartment 5) in a state without the upper case 111 and Figure 23 is a partially enlarged perspective view of a portion indicated by broken lines F in Figure 22. Cords such as the lead of the heater 113 that pass through the heat insulation partition 11 need to be arranged at predetermined positions before the heat insulation partition 11 is installed on the heat insulation box, and injection-foaming of the urethane heat-insulating material is performed. In view of this, in the present example, in order to enhance the working efficiency at a time of installation of the heat insulation partition 11 on the heat insulation box, a cord temporary housing portion 11b is formed at a front-side portion of the lower case 112 as a recessed space for temporarily housing the cords. The cords that are housed primarily are taken out from the cord temporary housing portion 11b when the installation of the heat insulation partition 11 is ended, and are linked at predetermined positions, and injection foaming of the urethane heat-insulating material is performed.

[0077] As depicted in Figure 23, the cord temporary housing portion 11b is defined by inner walls 11b1 that prevent the cords from contacting the vacuum heat-insulating material 12, and being damaged, and an outer wall 11b2 that prevents the cords from coming out. In addition, since a plurality of the inner walls 11b1 are provided in the front-back direction, and inner openings 11b3 are formed therebetween, the urethane heat-insulating material can flow in through the inner openings 11b3. On the other hand, a first outer opening 11b4 is formed behind the outer wall 11b2, and it becomes possible to draw the cords into the cord temporary housing portion 11b. In addition, since a second outer opening 11b5 is formed before the outer wall 11b2 such that the second outer opening 11b5 faces the inner openings 11b3, the urethane heat-insulating material injected through the urethane inflow ports 11a to the heat insulation partition 11 can easily pass through the cord temporary housing portion 11b. Note that since the urethane inflow ports 11a are formed not only at a position facing the second outer opening 11b5 but also at a position facing the first outer opening 11b4, the urethane heat-insulating material flows in also through the first outer opening 11b4. Since the cord temporary housing portion 11b is formed at a position facing the urethane inflow ports 11a to the heat insulation partition 11 in this manner, the recessed space is filled with the foam heat-insulating material 9, and the heat insulation properties is maintained.

[0078] In addition, the inner walls 11b1 of the cord temporary housing portion 11b also play a role of restricting the position of the vacuum heat-insulating material 12 such that the vacuum heat-insulating material 12 does not block the urethane inflow ports 11a. Furthermore, the inner walls 11b1 and the outer wall 11b2 extend upward from the lower case 112, but do not contact the upper case 111, desirably. Thereby, it becomes possible to inhibit generation of heat conduction between storage compartments with different temperature ranges that are located above and below the heat insulation partition 11. Note that whereas the inner walls 11b1 and the outer wall 11b2 are formed on the lower case 112 in the present example, heat conduction via the heat insulation partition 11 can be inhibited even in a case that the inner walls 11b1 and the outer wall 11b2 are formed on the upper case 111 such that they extend downward, by spacing the lower ends of the inner walls 11b1 and the outer wall 11b2 apart from the lower case 112.

Example 2

[0079] The refrigerator 1 according to Example 2 is explained by using Figure 24. In the present example, the ceiling panel 16 like the one according to Example 1 is not provided, but an adhesive 18 fixes the inner box 8 and the vacuum heat-insulating material 12 together.

[0080] As mentioned before, in conventional refrigerators, since the area between the vacuum heat-insulating material 12 of the ceiling portion and the inner box 8 is filled with the foam heat-insulating material 9, the inner box 8 is adhered to the vacuum heat-insulating material 12. Accordingly, drooping of the inner box 8 hardly occurs even if there is the own weight of the inner box 8, or linear expansion of the inner box 8 at high temperature. However, in a case that the area between the vacuum heat-insulating material 12 and the inner box 8 is not filled with the foam heat-insulating material 9, the inner box 8 easily warps, and droops. In view of this, as depicted in Figure 24, in the present example, the vacuum heat-insulating material 12 and the inner box 8 are fixed together by the adhesive 18 such as a hot-melt adhesive, and thereby drooping of the inner box 8 is inhibited. Note that the adhesive 18 to be used is desirably a material that can elastically deform such that it can be deformed along with warping of the inner box 8.

[0081] In addition, if only the adhesive 18 is used, there is a possibility that it cannot deform along with warping of the inner box 8, and the vacuum heat-insulating material 12 and the inner box 8 are peeled off from each other undesirably. Furthermore, there are variations of the thickness, warping and surface irregularity of the vacuum heat-insulating material 12, and there are necessarily variations of the thicknesses of the inner box 8 and the adhesive 18 also. In view of this, in the present example, in order to absorb warping of the inner box 8, and dimensional variations of each component, and keep the clearance between the vacuum heat-insulating material 12 and the inner box 8 constant, spacers 19 are provided between the outer box 7 and the vacuum heat-insulating material 12. The spacers 19 are intervening members having a certain degree of thickness, and additionally have a functionality of bonding the outer box 7 and the vacuum heat-insulating material 12 together. For example, a double-sided tape or the like obtained by forming polyethylene or the like into a sheet is used as the spacers 19. Note that if a certain degree of thickness can be maintained, an adhesive such as a hot-melt adhesive may be used as the spacers 19. In addition, it is not necessary to provide the spacers 19 over the entire upper surface of the vacuum heat-insulating material 12, and it is desirable if the spacers 19 are arranged at at least part or the whole of the area of the urethane-less portion.

[0082] Furthermore, since the inner box 8, the foam heat-insulating material 9 and the like are deformed easily depending on temperature as compared with the vacuum heat-insulating material 12, the front, rear, left, and right portions of the vacuum heat-insulating material 12 may be covered with, and protected by an elastic member, and damage to the vacuum heat-insulating material 12 due to deformation of the inner box 8 or the like may be prevented. Note that regarding the up-down direction of the vacuum heat-insulating material 12, the spacers 19 function as cushions, and damage to the vacuum heat-insulating material 12 is prevented while the gap between the outer box 7 and the inner box 8 is filled thereby.

Example 3

[0083] In the refrigerator 1 according to Example 1 and Example, as mentioned before, while partially urethane-less portions of the heat insulation box are realized, the front side of the heat insulation box is filled with the foam heat-insulating material 9 taking maintenance of the strength into consideration. That is, in the top surface, the side surface and the bottom surface of the inner box 8, the distance to the vacuum heat-insulating material 12 is increased in the front areas, and the distance to the vacuum heat-insulating material 12 is narrowed in the middle areas. Because of this, there are portions where the dimension of the inner box 8 on the rear side is greater than the dimension of the inner box 8 on the front side. This means that, when the refrigerator 1 of the same model is mass-produced, even if one attempts to stock a plurality of inner boxes 8 in such a manner that the plurality of inner boxes 8 are placed one on another, one inner box 8 hits the narrow opening of another inner box 8, and it is difficult to fit the one to the other. In view of this, in the present example, at least a partially urethane-less area of the inner box 8, that is, an area where the dimension is increased on the rear side than on the front end, is formed as a deformable area by adopting a bellow structure or the like. As a result, it becomes possible to stock the plurality of inner boxes 8 by causing them to shrink when they are placed one on another, and it becomes possible to expand them by pressing a jig from inside when the urethane heat-insulating material is caused to foam.

[0084] The present invention is not limited to each example mentioned before, but various modifications are possible. For example, whereas the ceiling panel 16 is provided below the inner box 8 of the ceiling portion in Example 1, instead of providing the ceiling panel 16, the inside light cover may be expanded backward, and cover the portion below the inner box 8, in another possible configuration. In addition, the examples mentioned before are illustrated as examples in order to explain the present invention in an easy-to-understand manner, and are not necessarily limited to those including all the constituent elements explained. Furthermore, some of the constituent elements of an example can be replaced with constituent elements of another example, and constituent elements of an example can be added to the constituent elements of another example. In addition, some of the constituent elements of each example can additionally have other constituent elements, can be eliminated or replaced with other constituent elements.

<Technical Ideas Covered by Present Specification>

[0085] The present specification covers the following technical ideas.

[Additional Note 1-1]

[0086] A refrigerator including a box that forms a storage compartment having an opening front, includes an area between an inner box and an outer box which area is foam-filled with a foam heat-insulating material, and has an up-down dimension which is greater than a left-right dimension,
in which a left surface and/or a right surface of the box

> have or has a front end(s) including a front-end heat-insulating material foam-filled with the foam heat-insulating material continuously in an up-down direction;
> have or has an area(s) where an area(s) having a flow-permitting thickness for a foam heat-insulating material which is smaller than those of surrounding areas; and
> include(s) another heat-insulating material that provides heat insulation performance higher than that of the foam heat-insulating material.

[Additional Note 1-2]

[0087] The refrigerator according to additional note 1-1,
in which the area(s) having the smaller flow-permitting thickness is or are provided with a portion(s) where the inner box is recessed toward the outer box.

[Additional Note 1-3]

[0088] The refrigerator according to additional note 1-2,

> in which the left surface and the right surface include shelf ribs or rails, and
> the area(s) having the smaller flow-permitting thick-

ness is or are provided above uppermost shelf ribs or below lowermost rails.

[Additional Note 1-4]

[0089] The refrigerator according to additional note 1-2,

in which the left surface and the right surface include shelf ribs or rails, and
the area(s) having the smaller flow-permitting thickness is or are provided at an up-down position where any of the shelf ribs or the rails is provided and before a front end of the shelf rib or the rail.

[Additional Note 1-5]

[0090] The refrigerator according to additional note 1-2,

in which the left surface and the right surface include shelf ribs or rails,
a plurality of the shelf ribs or the rails are arrayed in the up-down direction, and
the area(s) having the smaller flow-permitting thickness is or are provided in an area sandwiched in the up-down direction by the shelf ribs or the rails.

[Additional Note 1-6]

[0091] The refrigerator according to additional note 1-5,
in which each of the shelf ribs or the rails is reinforced.

[Additional Note 1-7]

[0092] The refrigerator according to additional note 1-2,

in which the left surface and the right surface include shelf ribs or rails,
a flow-permitting thickness for a foam heat-insulating material is great in a range that extends forward from front ends of the shelf ribs or the rails to the front-end heat-insulating material, and
an area that overlaps the shelf ribs or the rails is filled with a foam heat-insulating material.

[Additional Note 1-8]

[0093] The refrigerator according to additional note 1-2,

in which the left surface and the right surface are not provided with shelf ribs and rails, and
the area(s) having the smaller flow-permitting thickness is or are provided at a position which is on a rear-end side relative to a position which is at a distance from front ends of the left surface and the right surface, the distance being 1/3 of a front-back dimension from the front ends to a rear surface of the inner box.

[Additional Note 1-9]

[0094] The refrigerator according to additional note 1-2,
in which the area(s) having the smaller flow-permitting thickness is or are provided with a portion not filled with the foam heat-insulating material.

[Additional Note 1-10]

[0095] The refrigerator according to additional note 1-2,
in which the area(s) having the smaller flow-permitting thickness is or are formed in an area(s) that is or are on a projection plane of the other heat-insulating material, and inside an edge of the other heat-insulating material.

[Additional Note 1-11]

[0096] The refrigerator according to any one of additional note 1-1 to additional note 1-10,
in which a front end(s) of a top surface and/or a bottom surface of the box is or are filled with a foam heat-insulating material continuously from the front-end heat-insulating material.

[Additional Note 1-12]

[0097] The refrigerator according to additional note 1-2,

in which at a top surface of the box, the foam heat-insulating material is not positioned at at least part of a lower surface of the other heat-insulating material, and
the inner box is fixed to a lower-surface side of the other heat-insulating material by an adhesive.

[Additional Note 1-13]

[0098] The refrigerator according to additional note 1-12,
in which a spacer is provided between an upper surface of the other heat-insulating material and the outer box.

[Additional Note 1-14]

[0099] The refrigerator according to additional note 1-12,

in which at a top surface of the box, the foam heat-insulating material is not positioned at at least part of a lower surface of the other heat-insulating mate-

rial, and
in an area where the foam heat-insulating material is not positioned on the lower surface of the other heat-insulating material, a ceiling panel is provided below the inner box.

[Additional Note 1-15]

[0100] The refrigerator according to additional note 1-12 or additional note 1-14,
in which, at the top surface of the box, the foam heat-insulating material is positioned on front, rear, left, and right side surfaces of the other heat-insulating material.

[Additional Note 1-16]

[0101] The refrigerator according to additional note 1-12, including:

another storage compartment having a temperature range lower than a temperature range of the storage compartment; and
a heat insulation partition that serves as a partition between the storage compartment and the other storage compartment,
in which the heat insulation partition has therein a foam heat-insulating material, and another heat-insulating material that provides heat insulation performance higher than that of the foam heat-insulating material, and
the heat insulation partition has, on a projection plane in a direction from the storage compartment toward the other storage compartment, an area having a flow-permitting thickness for a foam heat-insulating material which is smaller than those of surrounding areas.

[Additional Note 1-17]

[0102] The refrigerator according to additional note 1-16,
in which the area having the smaller flow-permitting thickness is provided with a portion not filled with the foam heat-insulating material.

[Additional Note 1-18]

[0103] The refrigerator according to additional note 1-16,
in which, in the area having the smaller flow-permitting thickness, at least a surface of the heat insulation partition on which the heat insulation partition faces the other storage compartment is provided with a recess.

[Additional Note 2-1]

[0104] A refrigerator comprising a box having a vacuum heat-insulating material and a foam heat-insulating material between an outer box and an inner box,
in which at a top surface of the box, the foam heat-insulating material is positioned on front, rear, left, and right side surfaces of the vacuum heat-insulating material, and the foam heat-insulating material is not positioned at at least part of a lower surface of the vacuum heat-insulating material.

[Additional Note 2-2]

[0105] The refrigerator according to additional note 2-1,
in which the foam heat-insulating material is positioned in a front area and a rear area of the lower surface of the vacuum heat-insulating material.

[Additional Note 2-3]

[0106] The refrigerator according to additional note 2-1, comprising an inside light at the top surface,
in which a wire of the inside light is provided in an area that is at the lower surface of the vacuum heat-insulating material, and is foam-filled with the foam heat-insulating material.

[Additional Note 2-4]

[0107] The refrigerator according to additional note 2-1,
in which, in an area where the foam heat-insulating material is not positioned at the lower surface of the vacuum heat-insulating material, a ceiling panel is provided below the inner box.

[Additional Note 2-5]

[0108] The refrigerator according to additional note 2-1,
in which the inner box is fixed to a lower-surface side of the vacuum heat-insulating material by using an adhesive different from the foam heat-insulating material.

[Additional Note 2-6]

[0109] The refrigerator according to additional note 2-5,
in which a spacer is provided between an upper surface of the vacuum heat-insulating material and the outer box.

Reference Signs List

[0110]

1	refrigerator
2	cold compartment
3	ice compartment
4	upper freezer compartment
5	lower freezer compartment

6	vegetable compartment
7	outer box
8	inner box
9	foam heat-insulating material
10, 11	heat insulation partition
11a	urethane inflow port
11b	cord temporary housing portion
111	upper case
111a	upper-surface recess
111b	bridge portion
112	lower case
112a	lower-surface recess
113	heater
12	vacuum heat-insulating material
13	shelf rib
14	inside light
15	cord
16	ceiling panel
17	screw
18	adhesive
19	spacer
21	rail
22	hinge portion
23	reinforcement

Claims

1. A refrigerator comprising a box that forms a storage compartment having an opening front, includes an area between an inner box and an outer box which area is foam-filled with a foam heat-insulating material, and has an up-down dimension which is greater than a left-right dimension,
wherein a left surface and/or a right surface of the box

have or has a front end(s) including a front-end heat-insulating material foam-filled with the foam heat-insulating material continuously in an up-down direction;
have or has an area(s) where an area(s) having a flow-permitting thickness for a foam heat-insulating material which is smaller than those of surrounding areas; and
include(s) another heat-insulating material that provides heat insulation performance higher than that of the foam heat-insulating material.

2. The refrigerator according to claim 1,
wherein the area(s) having the smaller flow-permitting thickness is or are provided with a portion(s) where the inner box is recessed toward the outer box.

3. The refrigerator according to claim 2,

wherein the left surface and the right surface include shelf ribs or rails, and
the area(s) having the smaller flow-permitting thickness is or are provided above uppermost shelf ribs or below lowermost rails.

4. The refrigerator according to claim 2,

wherein the left surface and the right surface include shelf ribs or rails, and
the area(s) having the smaller flow-permitting thickness is or are provided at an up-down position where any of the shelf ribs or the rails is provided and before a front end of the shelf rib or the rail.

5. The refrigerator according to claim 2,

wherein the left surface and the right surface include shelf ribs or rails,
a plurality of the shelf ribs or the rails are arrayed in the up-down direction, and
the area(s) having the smaller flow-permitting thickness is or are provided in an area sandwiched in the up-down direction by the shelf ribs or the rails.

6. The refrigerator according to claim 5,
wherein each of the shelf ribs or the rails is reinforced.

7. The refrigerator according to claim 2,

wherein the left surface and the right surface include shelf ribs or rails,
a flow-permitting thickness for a foam heat-insulating material is great in a range that extends forward from front ends of the shelf ribs or the rails to the front-end heat-insulating material, and
an area that overlaps the shelf ribs or the rails is filled with a foam heat-insulating material.

8. The refrigerator according to claim 2,

wherein the left surface and the right surface are not provided with shelf ribs and rails, and
the area(s) having the smaller flow-permitting thickness is or are provided at a position which is on a rear-end side relative to a position which is at a distance from front ends of the left surface and the right surface, the distance being 1/3 of a front-back dimension from the front ends to a rear surface of the inner box.

9. The refrigerator according to claim 2,
wherein the area(s) having the smaller flow-permitting thickness is or are provided with a portion not filled with the foam heat-insulating material.

10. The refrigerator according to claim 2, wherein the area(s) having the smaller flow-permitting thickness is or are formed in an area(s) that is or are on a projection plane of the other heat-insulating material, and inside an edge of the other heat-insulating material.

11. The refrigerator according to any one of claims 1 to 10,
wherein a front end(s) of a top surface and/or a bottom surface of the box is or are filled with a foam heat-insulating material continuously from the front-end heat-insulating material.

12. The refrigerator according to claim 2,

wherein at a top surface of the box, the foam heat-insulating material is not positioned at at least part of a lower surface of the other heat-insulating material, and
the inner box is fixed to a lower-surface side of the other heat-insulating material by an adhesive.

13. The refrigerator according to claim 12,
wherein a spacer is provided between an upper surface of the other heat-insulating material and the outer box.

14. The refrigerator according to claim 2,

wherein at a top surface of the box, the foam heat-insulating material is not positioned at at least part of a lower surface of the other heat-insulating material, and
in an area where the foam heat-insulating material is not positioned on the lower surface of the other heat-insulating material, a ceiling panel is provided below the inner box.

15. The refrigerator according to claim 12 or 14,
wherein, at the top surface of the box, the foam heat-insulating material is positioned on front, rear, left, and right side surfaces of the other heat-insulating material.

16. The refrigerator according to claim 2, comprising:

another storage compartment having a temperature range lower than a temperature range of the storage compartment; and
a heat insulation partition that serves as a partition between the storage compartment and the other storage compartment,
wherein the heat insulation partition has therein a foam heat-insulating material, and another heat-insulating material that provides heat insulation performance higher than that of the foam heat-insulating material, and
the heat insulation partition has, on a projection plane in a direction from the storage compartment toward the other storage compartment, an area having a flow-permitting thickness for a foam heat-insulating material which is smaller than those of surrounding areas.

17. The refrigerator according to claim 16,
wherein the area having the smaller flow-permitting thickness is provided with a portion not filled with the foam heat-insulating material.

18. The refrigerator according to claim 16,
wherein, in the area having the smaller flow-permitting thickness, at least a surface of the heat insulation partition on which the heat insulation partition faces the other storage compartment is provided with a recess.

FIG. 1

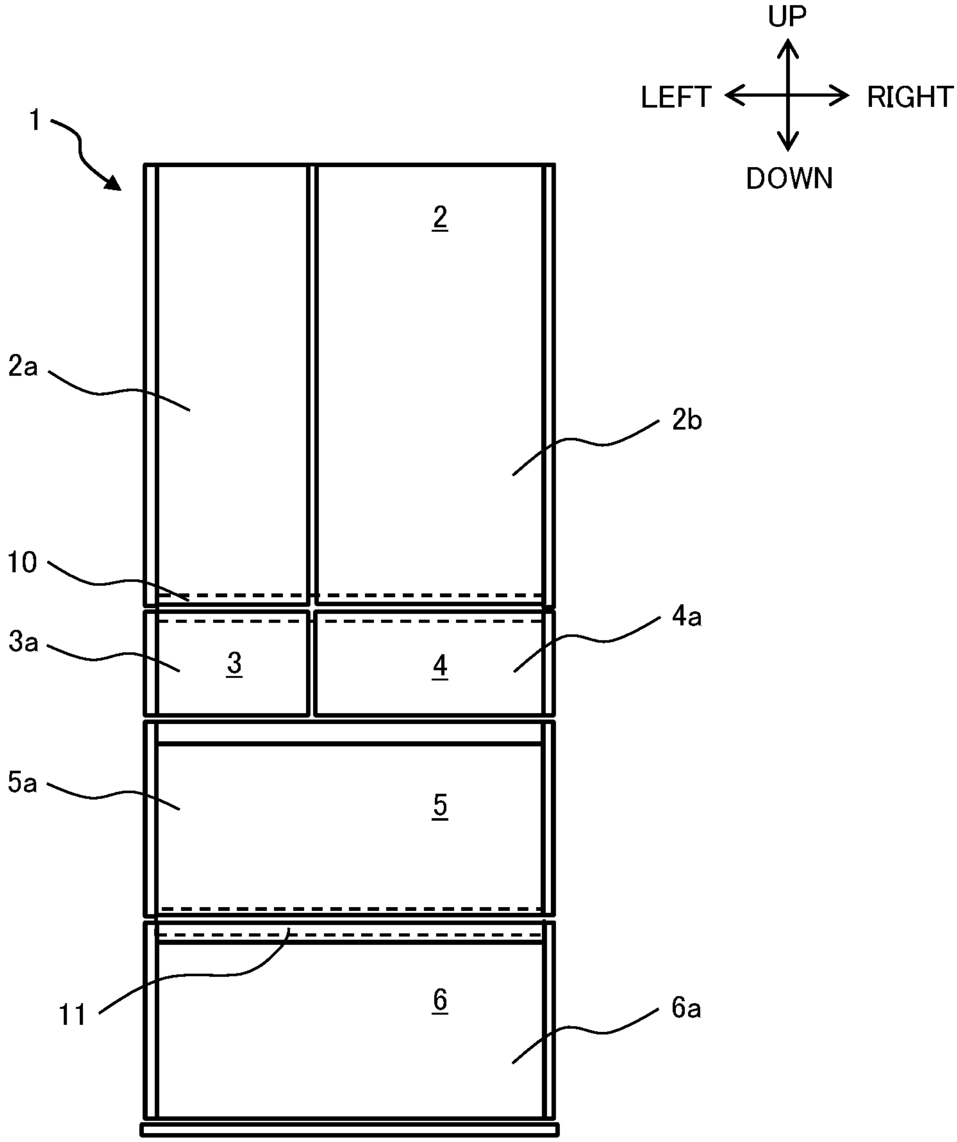


FIG. 2

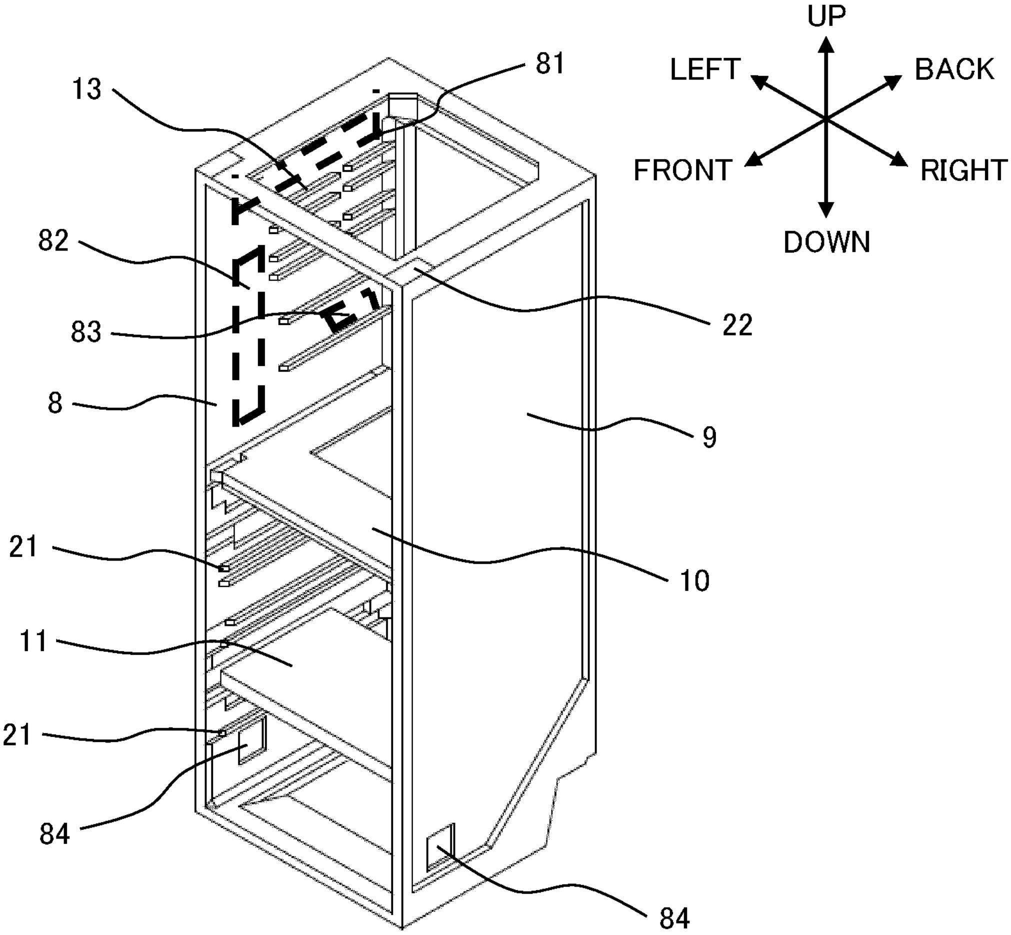


FIG. 3

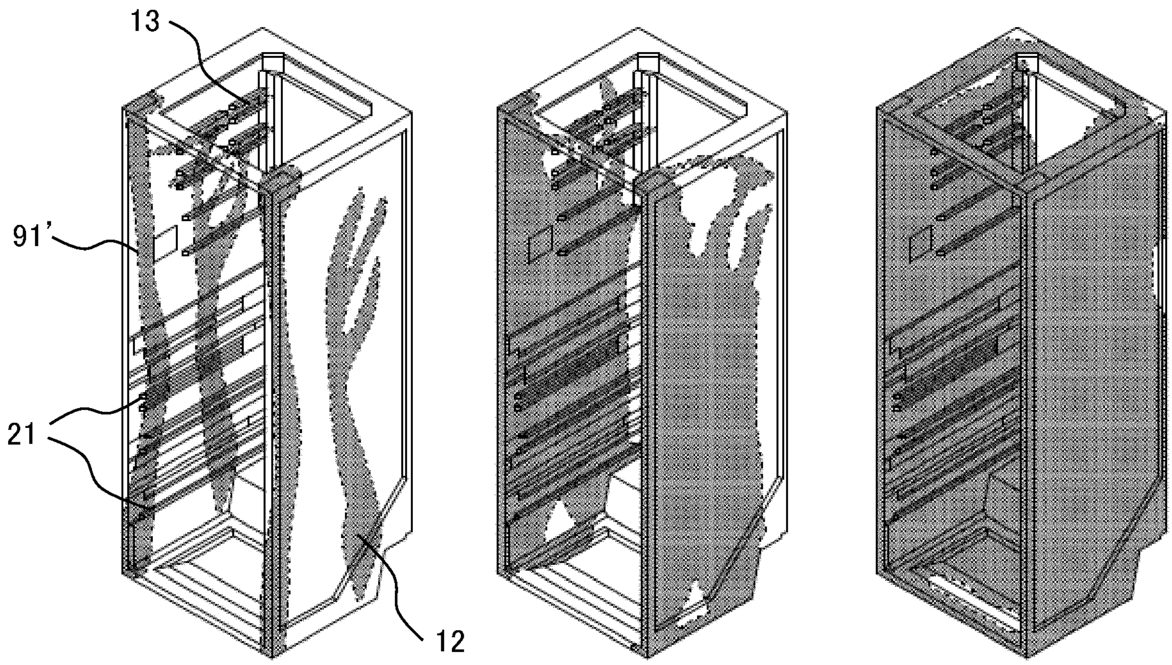


FIG. 4

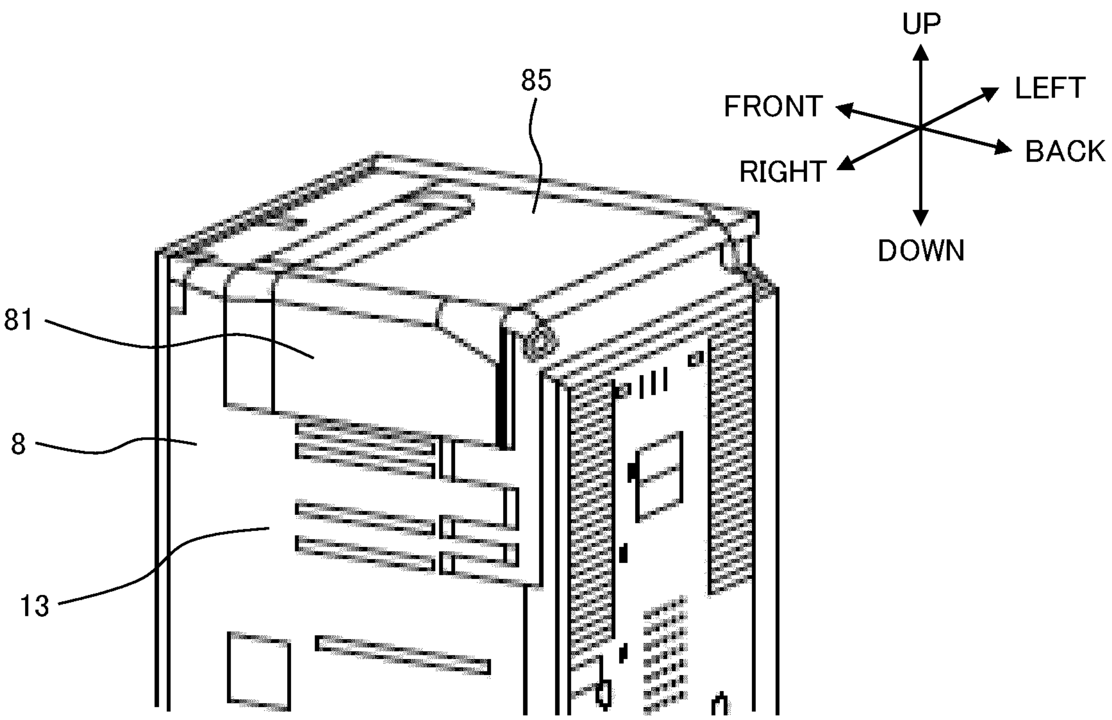


FIG. 5

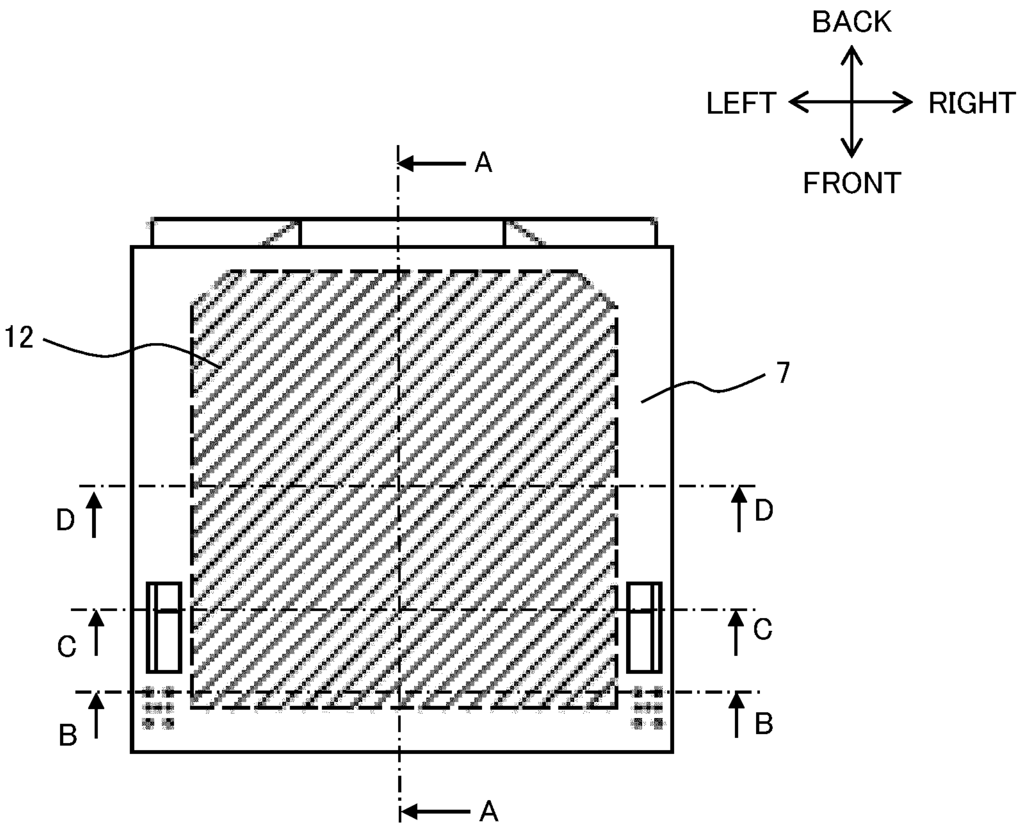


FIG. 6

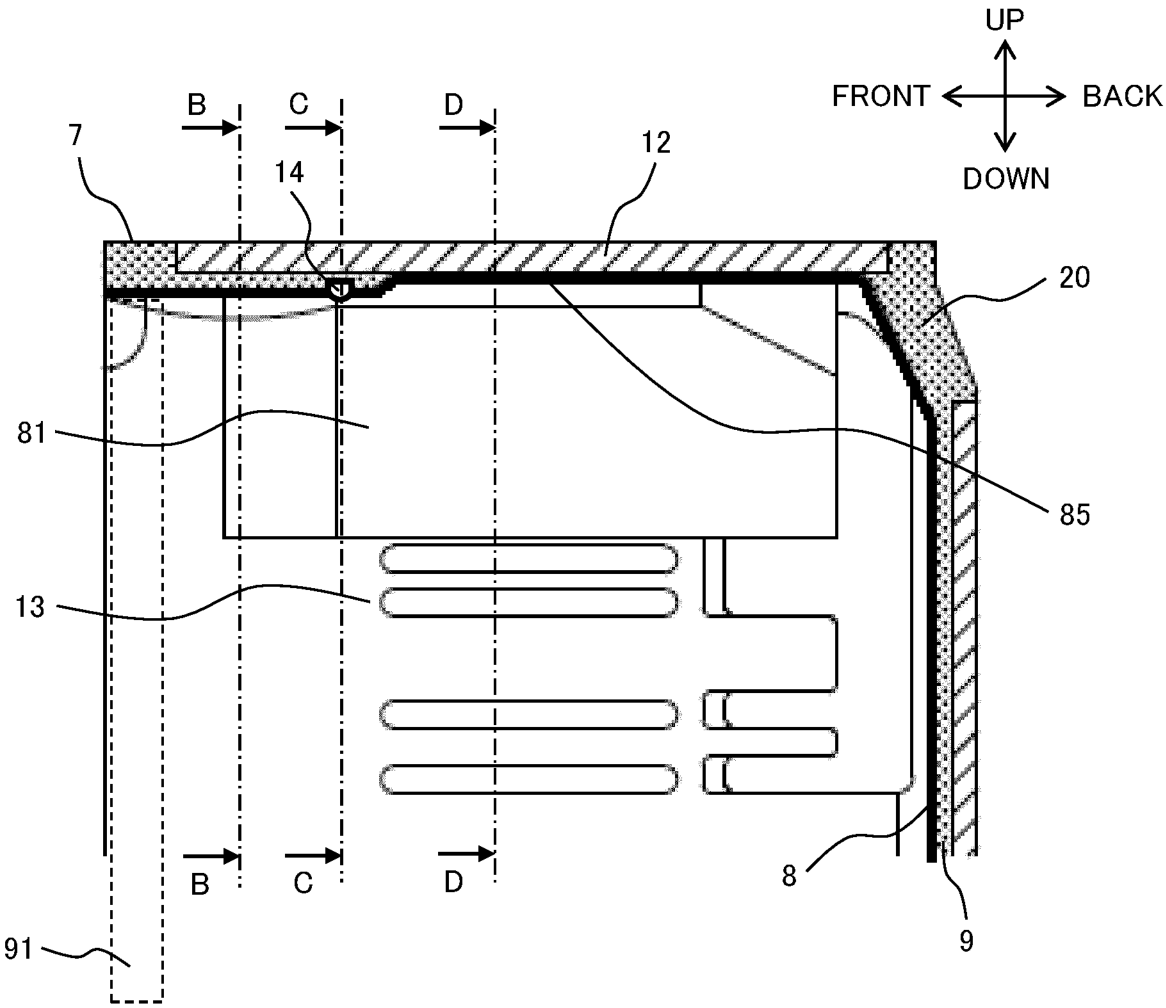


FIG. 7

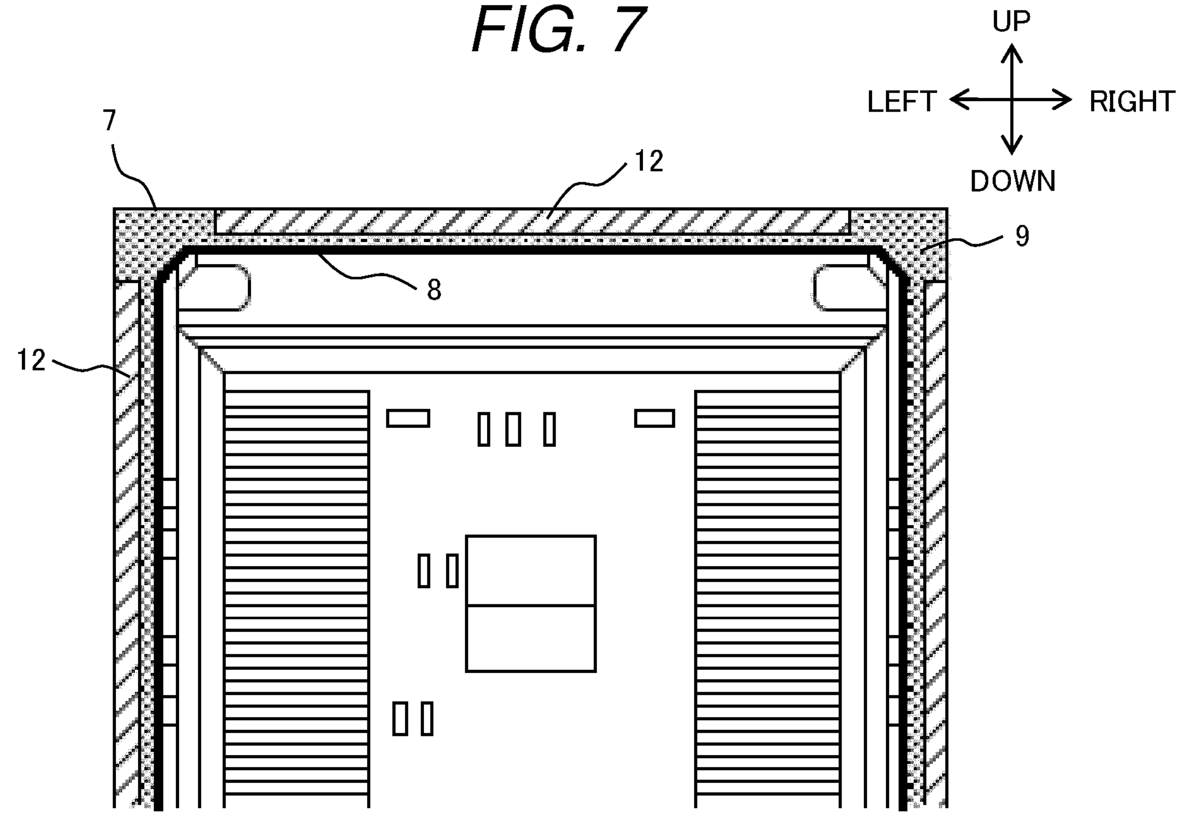

UP
LEFT
RIGHT
DOWN
7
12
9
8
12

FIG. 8

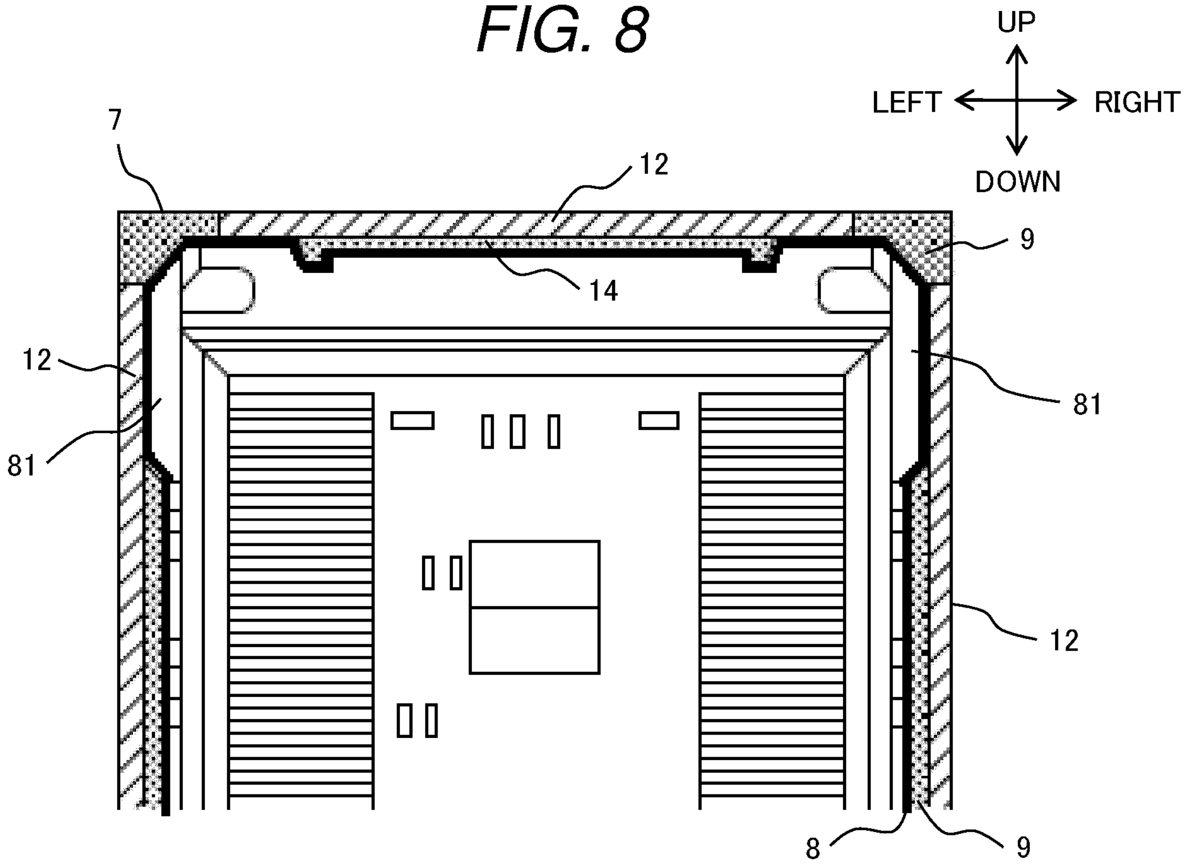

UP
LEFT
RIGHT
DOWN
7
12
9
14
12
81
81
12
8
9

FIG. 9

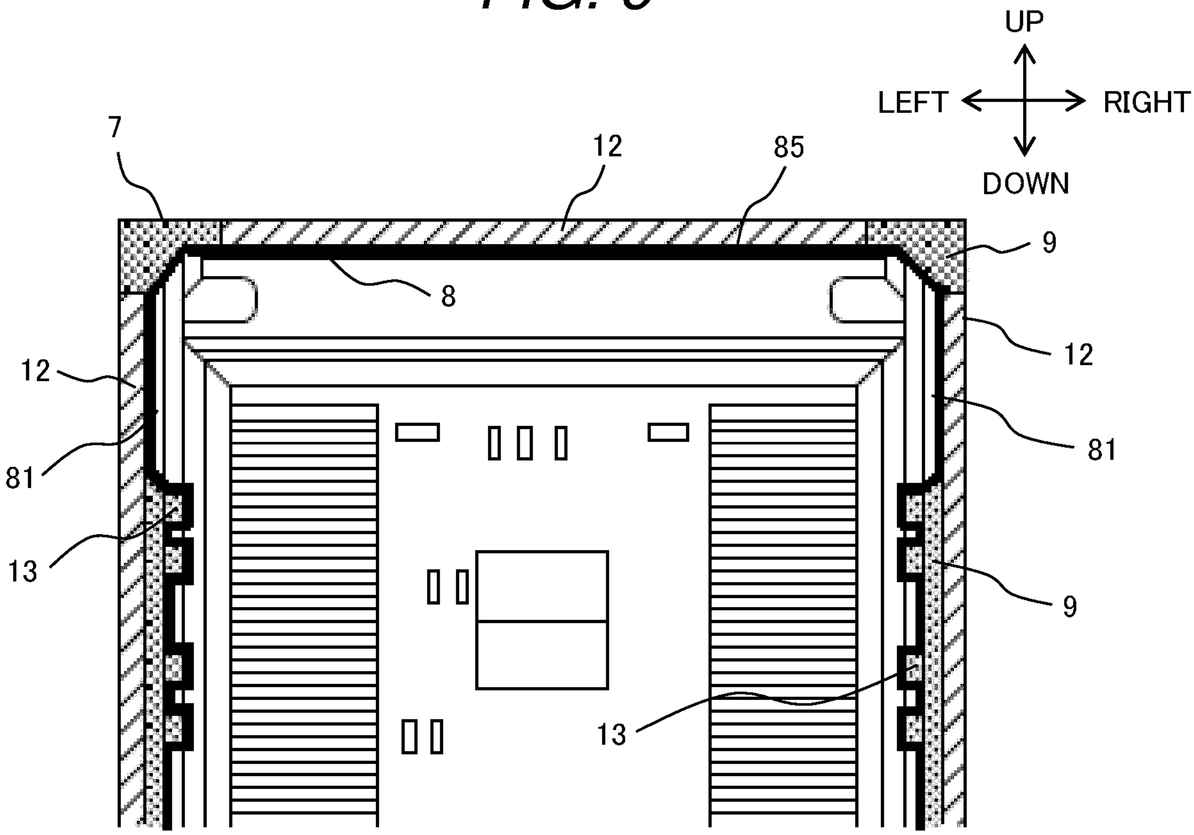

UP
LEFT
RIGHT
DOWN
7
12
85
9
8
12
12
81
81
13
9
13

FIG. 10

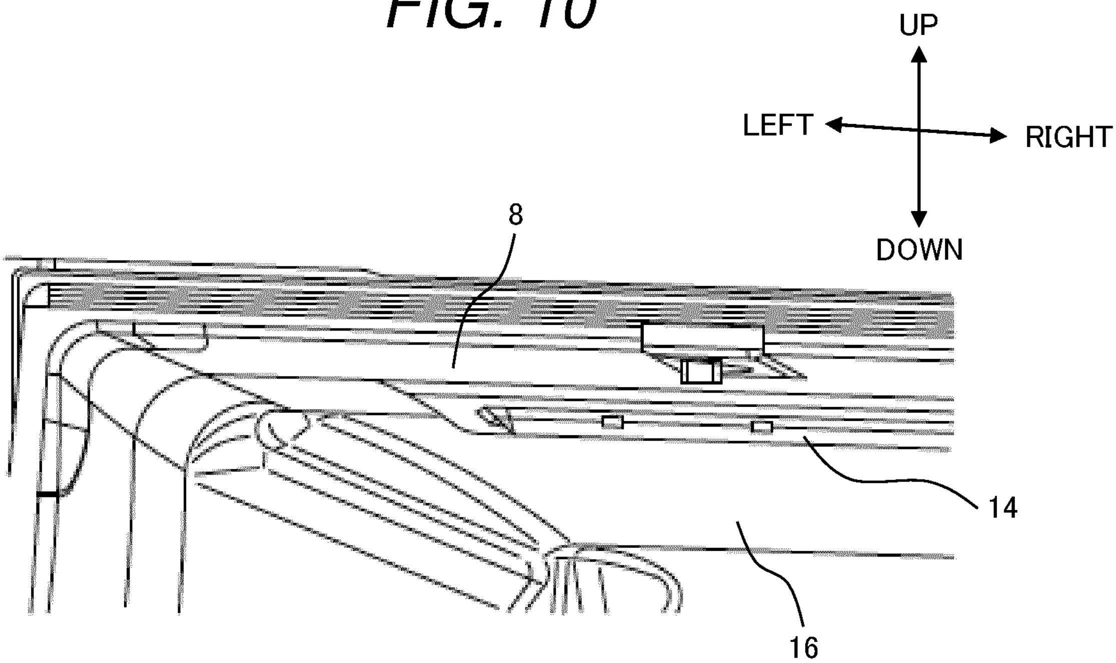

UP
LEFT
RIGHT
DOWN
8
14
16

FIG. 11

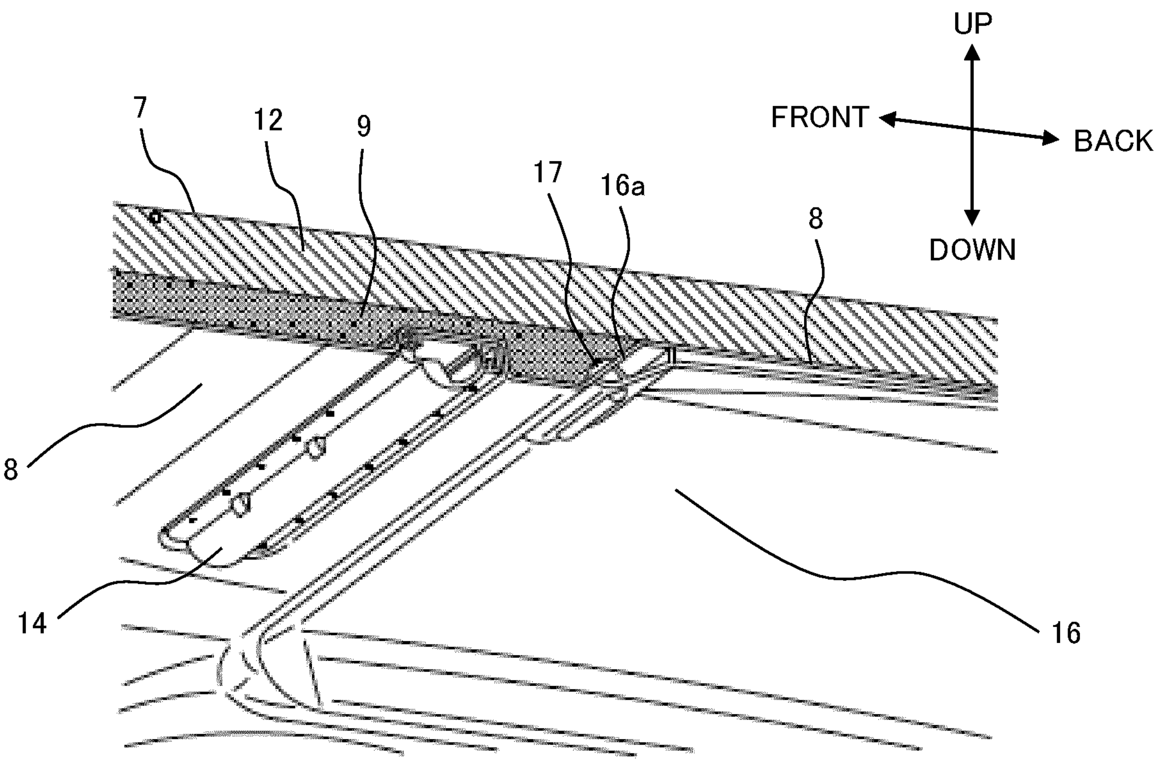


FIG. 12

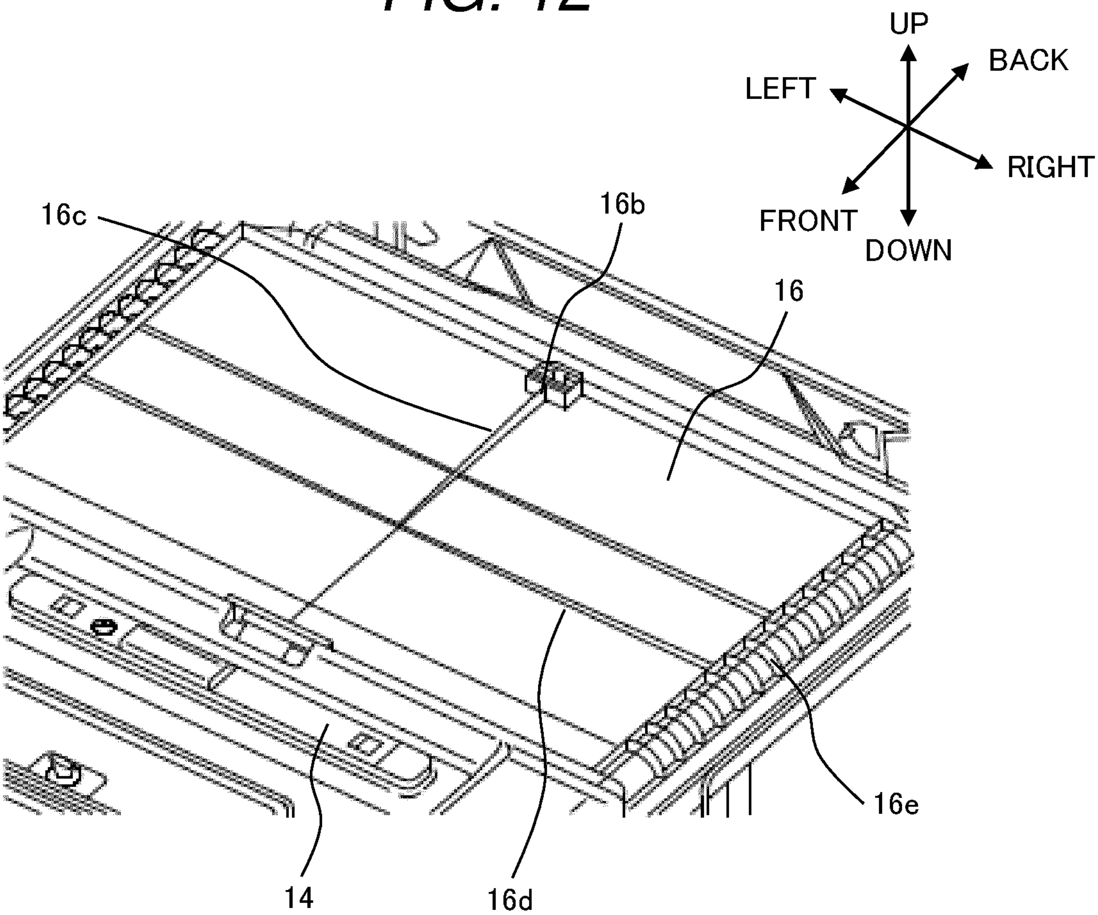

UP
BACK
LEFT
RIGHT
FRONT
DOWN
16c
16b
16
16e
14
16d

FIG. 13

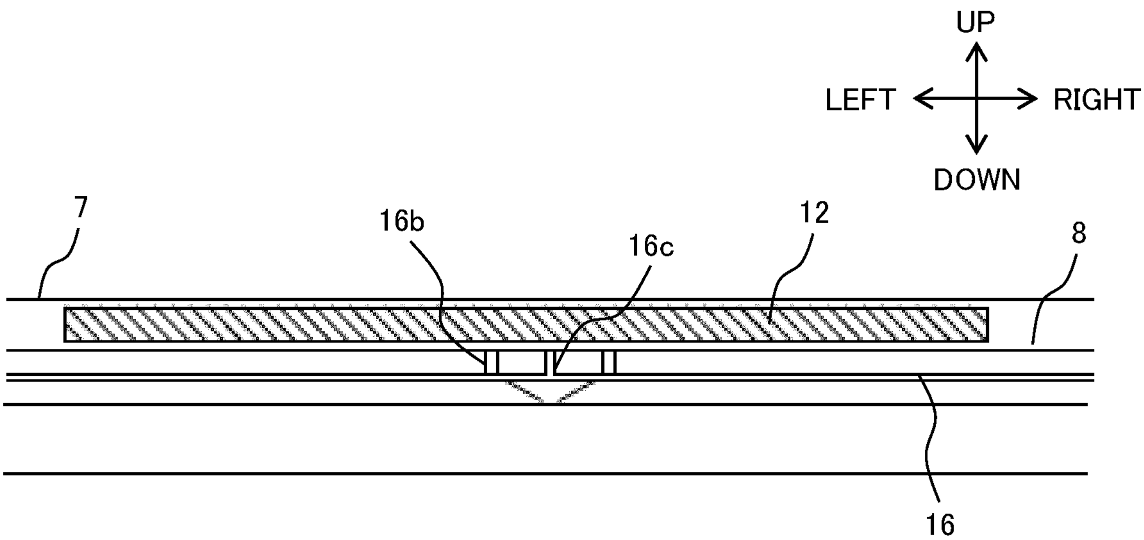

UP
LEFT
RIGHT
DOWN
7
16b
16c
12
8
16

FIG. 14

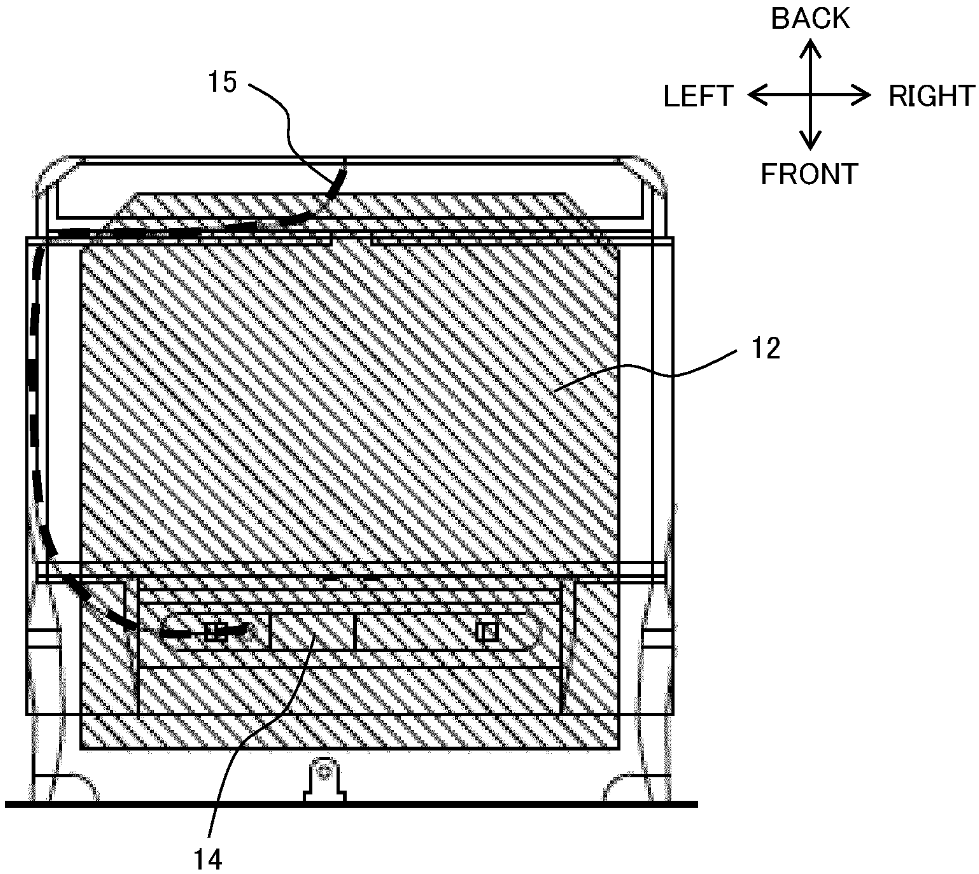

BACK
LEFT
RIGHT
FRONT
15
12
14

FIG. 15

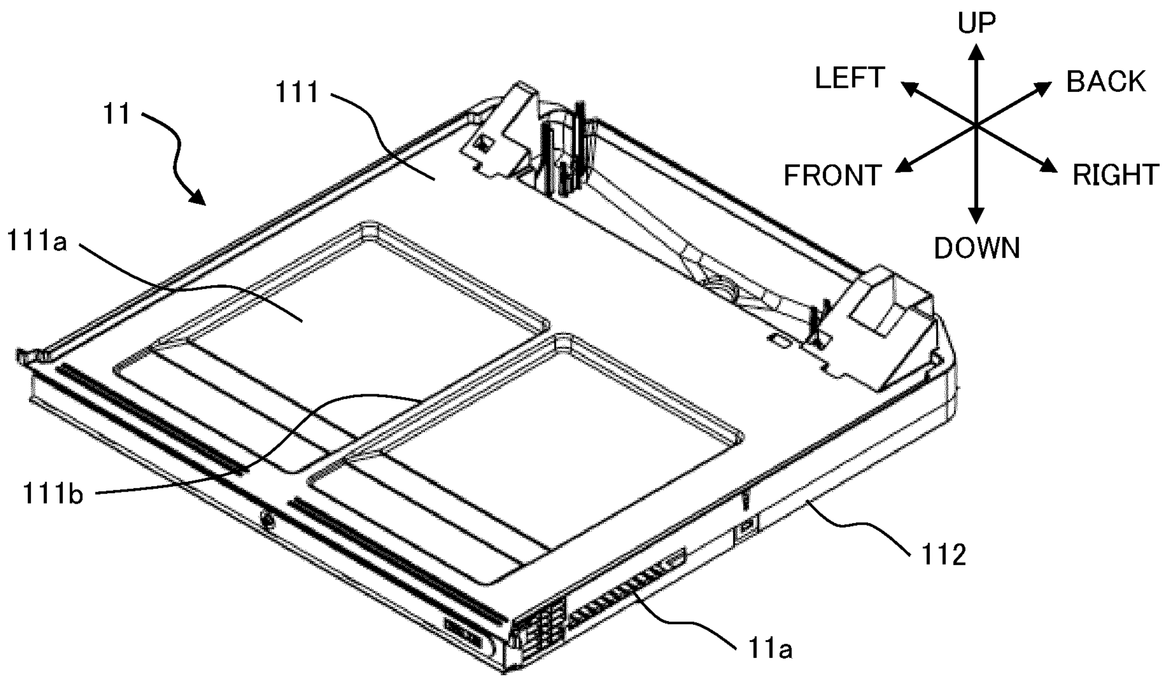

UP
LEFT
BACK
FRONT
RIGHT
DOWN
11
111
111a
111b
112
11a

FIG. 16

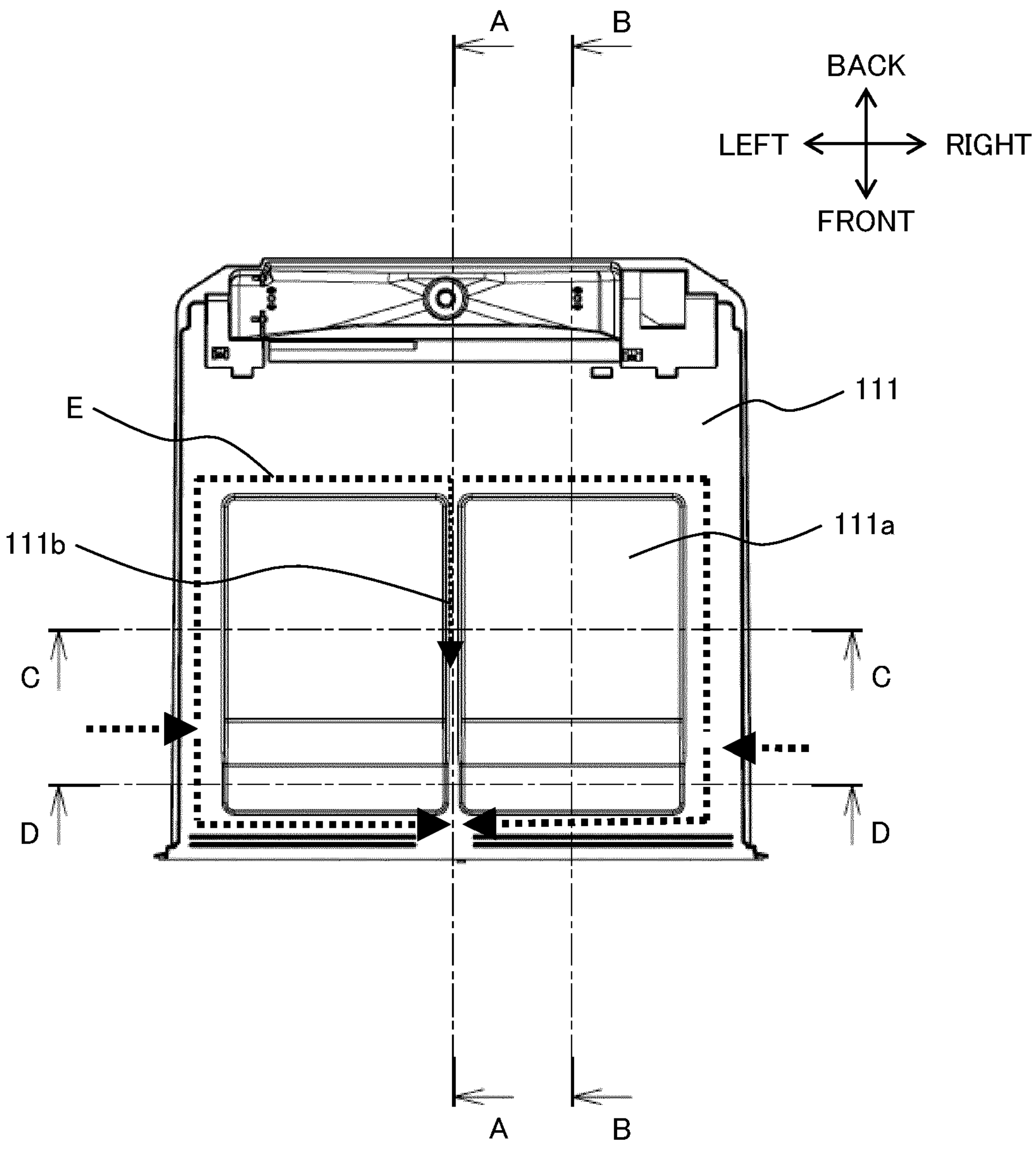


FIG. 17

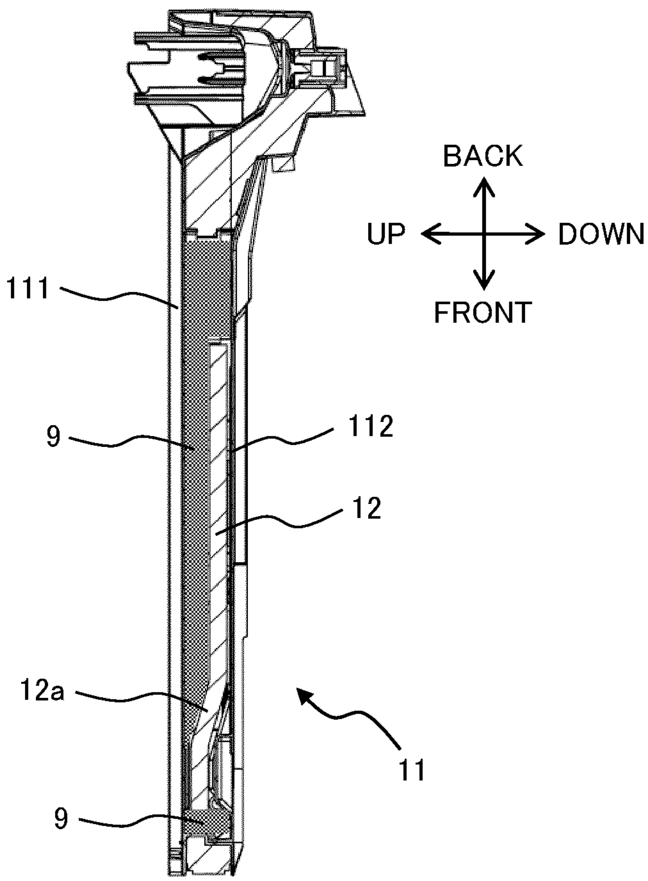


FIG. 18

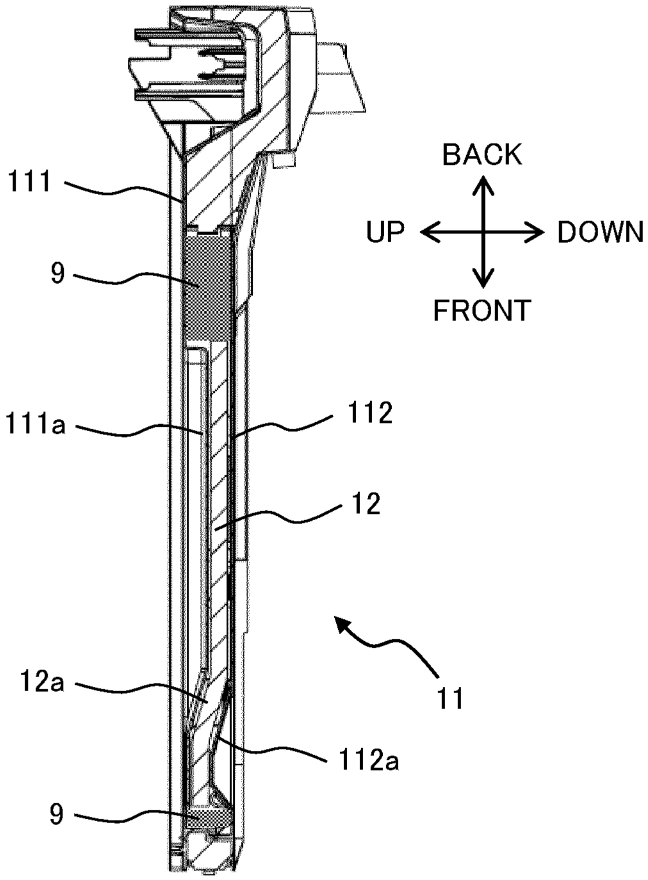

111
9
111a
112
12
12a
112a
9
11
BACK
UP
DOWN
FRONT

FIG. 19

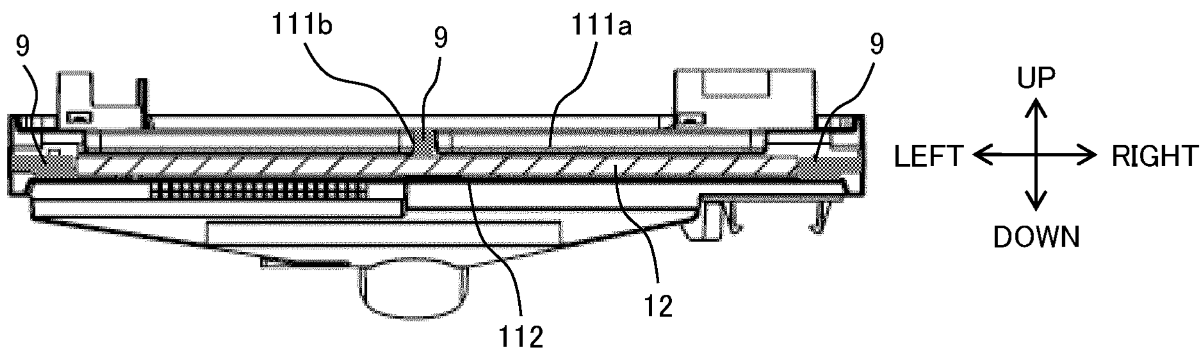

9
111b
9
111a
9
112
12
UP
LEFT
RIGHT
DOWN

FIG. 20

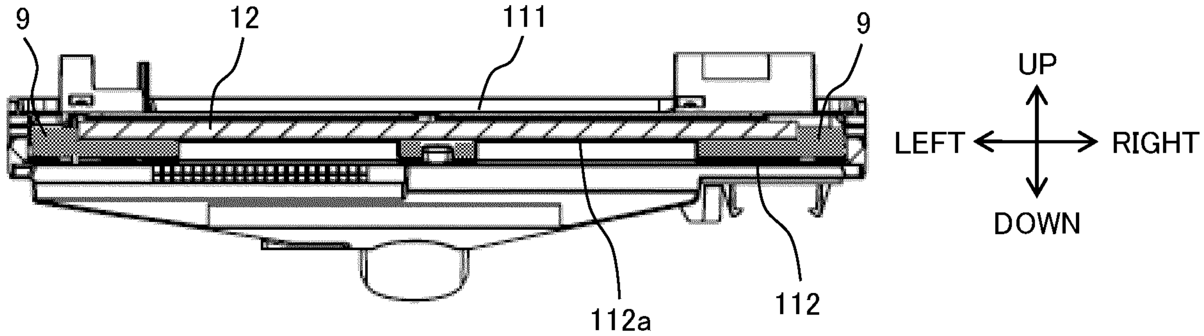

9
12
111
9
UP
LEFT
RIGHT
DOWN
112a
112

FIG. 21

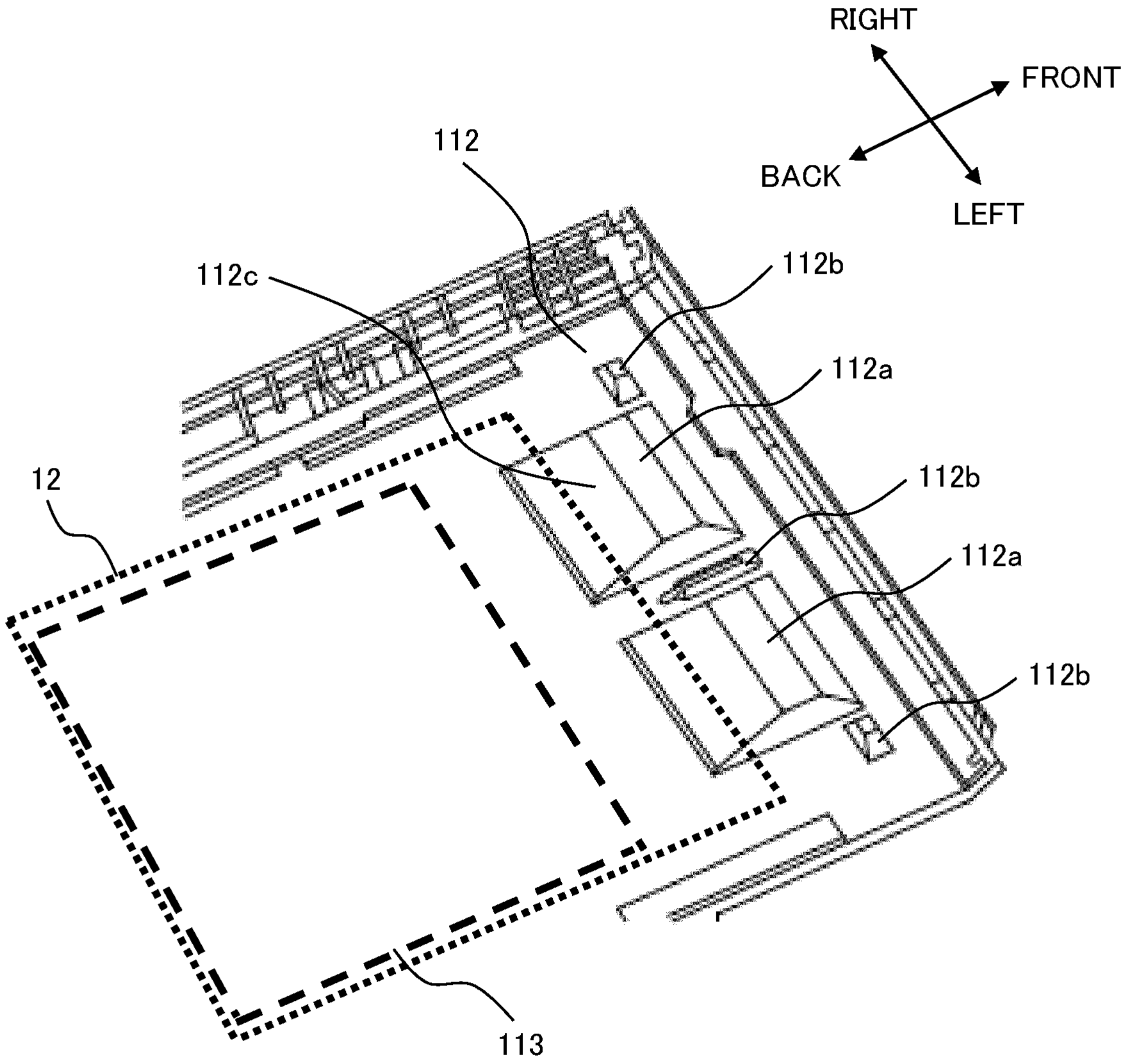

RIGHT
FRONT
BACK
LEFT
112
112c
112b
112a
112b
112a
112b
12
113

FIG. 22

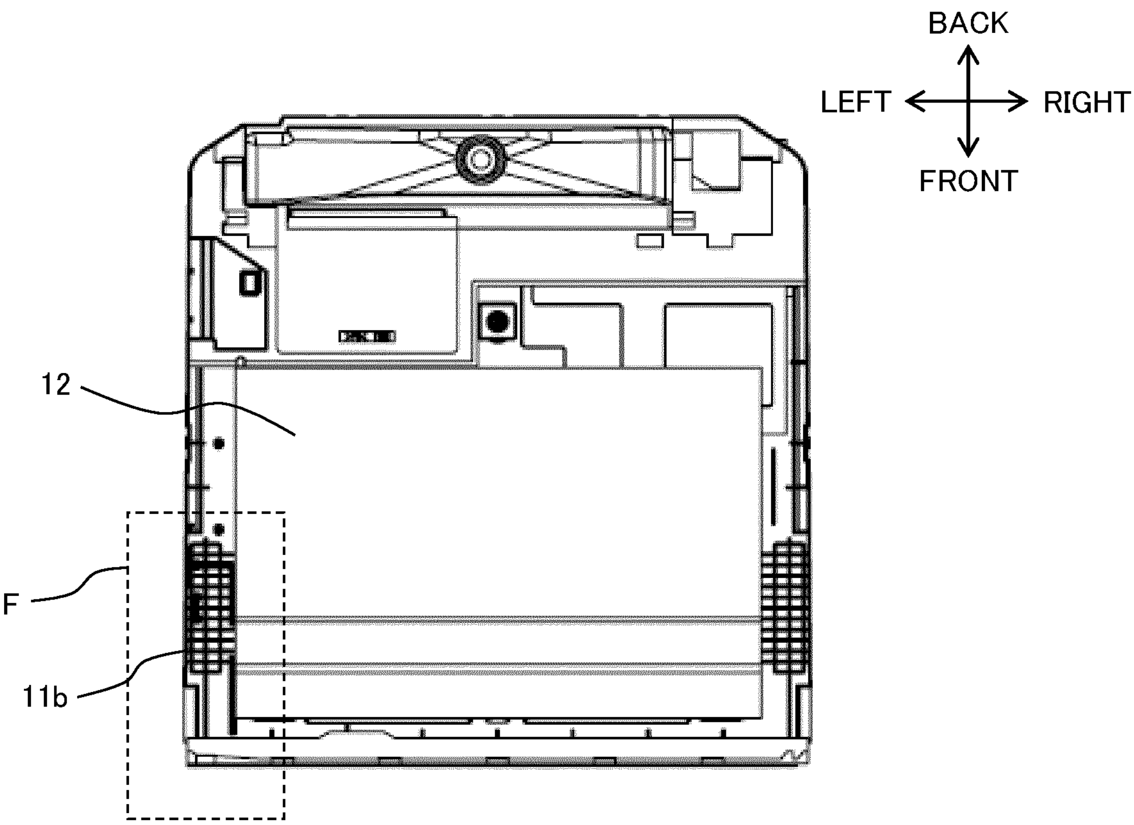

BACK
LEFT
RIGHT
FRONT
12
F
11b

FIG. 23

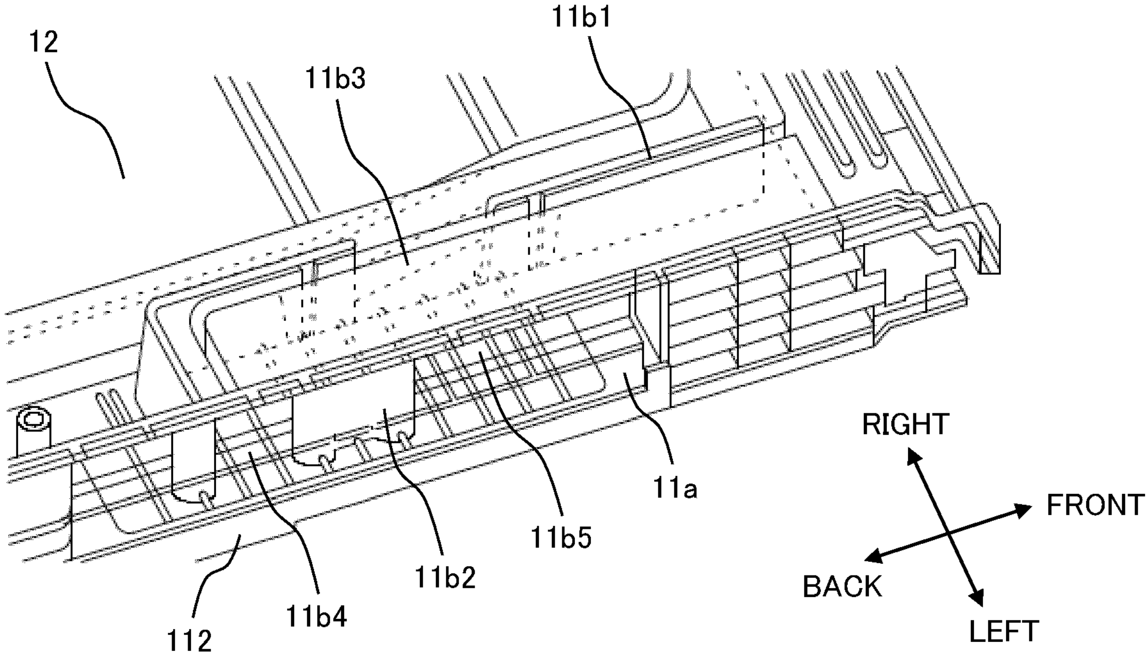

12
11b1
11b3
11a
11b5
11b2
11b4
112
RIGHT
FRONT
BACK
LEFT

FIG. 24

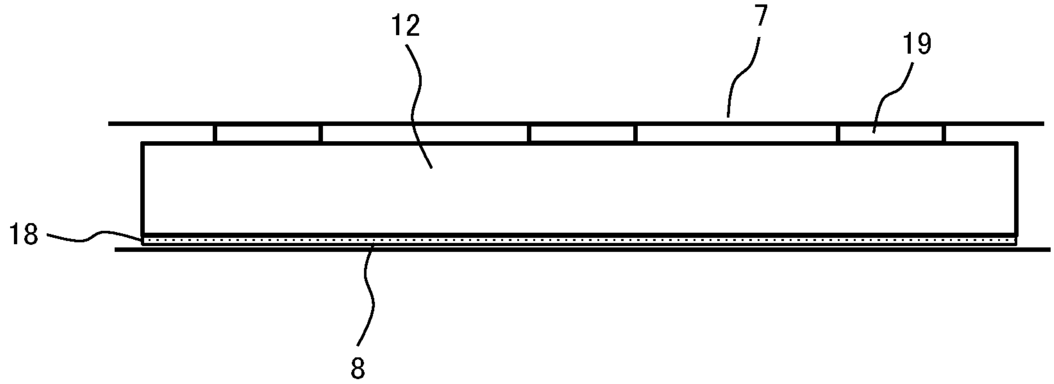


FIG. 25

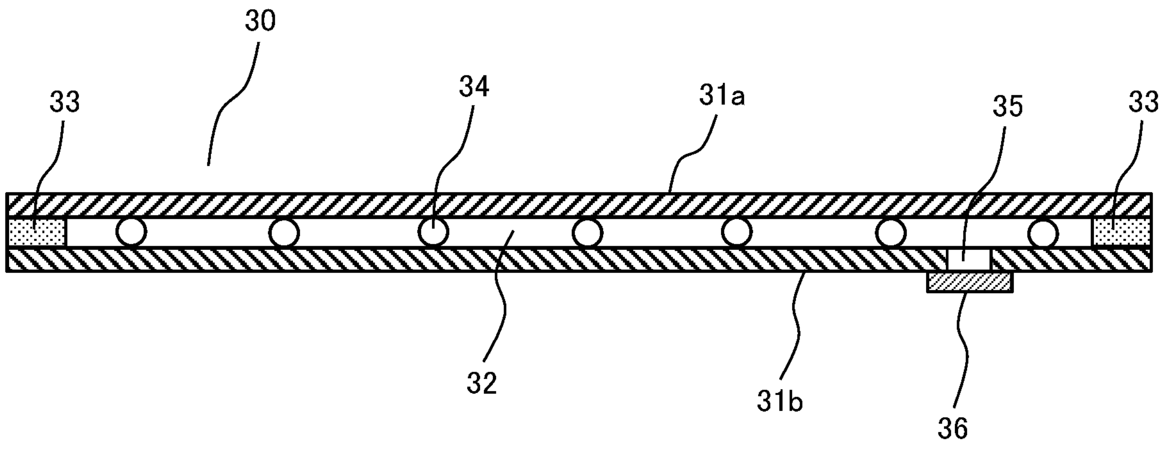
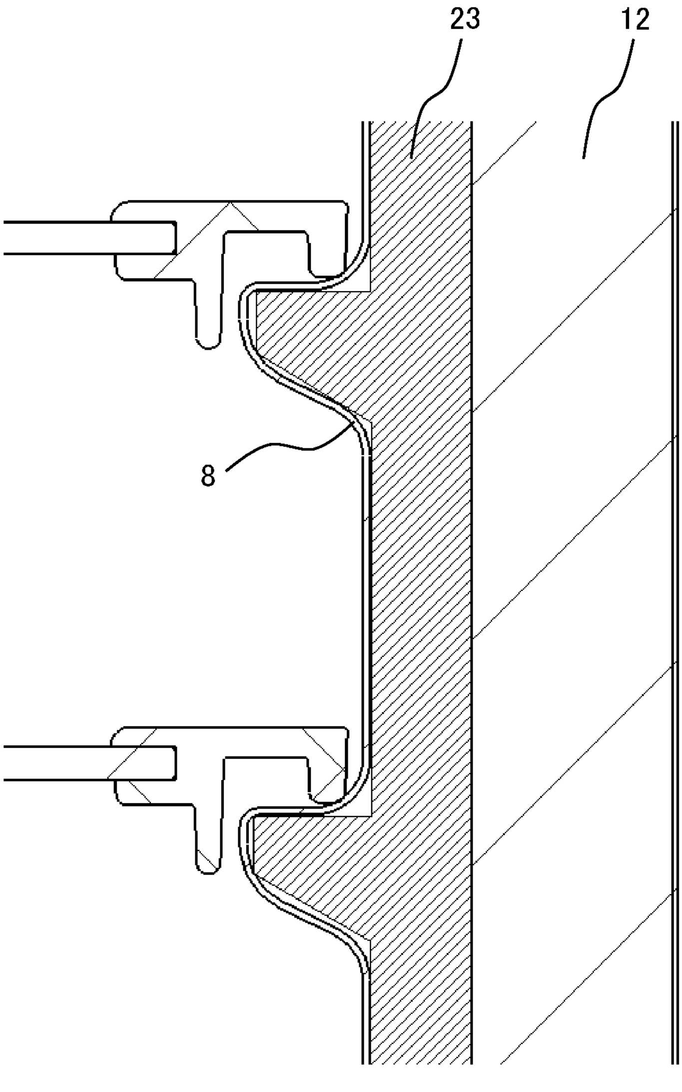


FIG. 26



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/031317

A. CLASSIFICATION OF SUBJECT MATTER

F25D 23/06(2006.01)i; ***F25D 23/08***(2006.01)i
FI: F25D23/06 W; F25D23/06 K; F25D23/08 E; F25D23/08 Q

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F25D23/02-23/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2021
Registered utility model specifications of Japan 1996-2021
Published registered utility model applications of Japan 1994-2021

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2018/0299060 A1 (SAMSUNG ELECTRONICS CO., LTD.) 18 October 2018 (2018-10-18) paragraphs [0080]-[0138], fig. 1-6	1-18
Y	JP 2000-105069 A (MITSUBISHI ELECTRIC CORP) 11 April 2000 (2000-04-11) paragraphs [0009], [0022], [0026], [0030], fig. 6, 10	1-18
Y	JP 60-78276 A (MATSUSHITA REIKI KK) 02 May 1985 (1985-05-02) p. 2, upper right column, line 9 to lower right column, line 17, fig. 2-3	3-6, 8, 11
Y	JP 2016-53472 A (MITSUBISHI ELECTRIC CORP) 14 April 2016 (2016-04-14) paragraph [0203], fig. 11, 24	3-8, 11
Y	JP 2010-276308 A (HITACHI APPLIANCES INC) 09 December 2010 (2010-12-09) paragraphs [0008]-[0010], [0028], [0063], fig. 2, 10, 13-14	13, 15-18

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 October 2021	**12 October 2021**

Name and mailing address of the ISA/JP	Authorized officer
Japan Patent Office (ISA/JP) **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/031317

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
US 2018/0299060 A1	18 October 2018	WO 2017/069440 A1 EP 3336466 A1 KR 10-2017-0045645 A CN 108139142 A	
JP 2000-105069 A	11 April 2000	(Family: none)	
JP 60-78276 A	02 May 1985	(Family: none)	
JP 2016-53472 A	14 April 2016	WO 2014/196219 A1 CN 104697278 A	
JP 2010-276308 A	09 December 2010	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 6023941 B **[0003]**