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(54) **REFRIGERATOR**

(57) A refrigerator having resin foam and a vacuum heat insulator between an outer box and an inner box adopts any one of the following configuration whereby it is possible to provide a refrigerator having an outward appearance, which is good in attractiveness, and effecting an efficient heat insulation. An outer surface of an outer box on which the heat insulator is arranged are set to have a center line average roughness (Ra) of 0.1 µm or more, or the outer surface is set to have a glossiness of 80 or less; The heat insulator is stuck to an inner plate of a door which constitute a front surface; an intermediate member is provided between the heat insulator and the outer box to prevent deformation of the outer surface of the outer box; A radiating pipe is provided between the heat insulator and the outer box, and an air gap defined by the heat insulator and the radiating pipe is communicated to outside; A small hole is provided on a surface of the outer box on which the heat insulator is provided; The heat insulators are arranged on both side surfaces of an upper portion, a roof surface, a back surface, and a front surface to contact with the outer box, and on a bottom surface, both side surfaces of a lower portion, and surfaces which define a machine room provided in the lower portion to contact with the inner box; and The heat insulator having a radiating pipe assembled into a surface thereof, which contact with the outer box, are arranged inside the outer box.

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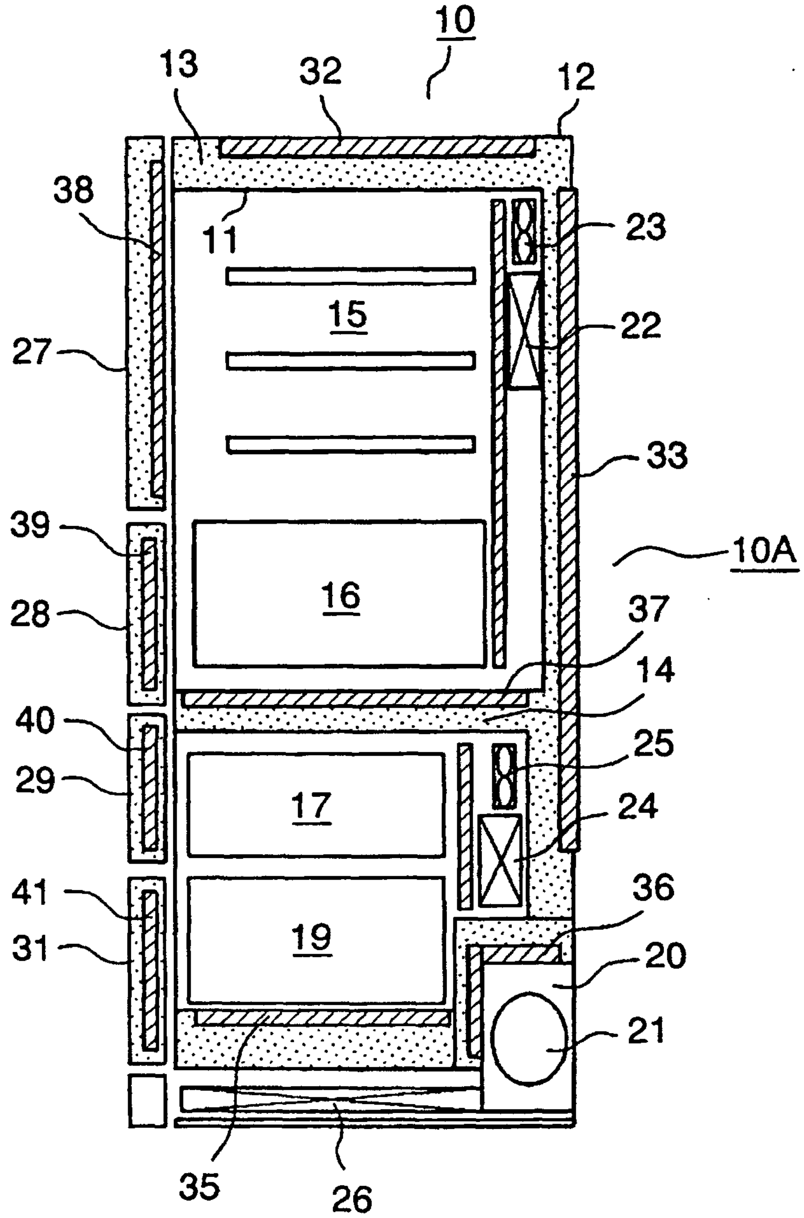
FIG. 2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Description

Technical Field

[0001] The present invention relates to a refrigerator making use of a vacuum heat insulator.

Background Art

[0002] In recent years, use of vacuum heat insulators having a high adiabatic performance (heat insulating efficiency) is examined in order to enhance the adiabatic performance of refrigerators with a view to energy saving and space saving in refrigerators. A vacuum heat insulator has an adiabatic performance several times to ten times as large as that of rigid urethane foam being resin foam. In these days of an increasing demand for energy saving, it is of urgent necessity to increase the adiabatic performance through making use of such vacuum heat insulators to the maximum within an appropriate range. On the other hand, in case of layering vacuum heat insulators on rigid urethane foam to apply the same to an adiabatic box of a refrigerator, the adiabatic box is deformed in outward appearance due to a difference in contraction coefficient between the rigid urethane foam and the vacuum heat insulator. Japanese Utility Model Unexamined Publication No.S61-141690 discloses a method that solves such a problem. The above conventional refrigerator will be described below with reference to the drawings.

[0003] Fig. 40 is a cross sectional view showing a door in a front opening of a conventional refrigerator, and Fig. 41 is a view showing, in enlarged scale, a portion A in Fig. 40. In the figures, the refrigerator has metallic shell plate 1, door frame 2 made of a synthetic resin, inner box 3 made of a synthetic resin, foamy heat insulator 4, and vacuum heat insulator 5. Mould releasing sheet 6 interposed between vacuum heat insulator 5 and shell plate 1 is formed to be larger than the vacuum heat insulator 5. In this manner, vacuum heat insulator 5 is disposed on an inner surface of shell plate 1 with mould releasing sheet 6 therebetween. With such constitution, foamy heat insulator 4 shrinks after foaming of foamy heat insulator 4 but mould releasing sheet 6 acts to generate a clearance x between shell plate 1 and mould releasing sheet 6 to prevent deformation of shell plate 1.

[0004] With such a refrigerator, however, deformation of the shell plate in outward appearance can be prevented but a clearance is generated between the shell plate and foamy heat insulator. Accordingly, the sense of touch is bad due to denting of the shell plate when a user touches the same.

[0005] Japanese Patent Unexamined Publication No. H6-159922 also discloses a refrigerator provided with vacuum heat insulators. Fig. 42 is a side, cross sectional view showing such a conventional refrigerator. Refrigerator body 7 is composed of outer box 1A and inner box 3. Moldable paper material 8 in the form of a bag covers a whole space defined by outer box 1A and inner box 3, and filler 4A made of an inorganic porous substance is filled in paper material 8. Further, vacuum heat insulator 5 is arranged along a shape of a space enclosed by outer and inner boxes 1A, 3. Also, vacuum heat insulator 5 has metallic foil on both surfaces thereof and is wholly planar in shape.

[0006] The present constitution makes it possible to readily accommodate vacuum heat insulator 5 between outer and inner boxes 1A, 3, and dispenses with the work of stopping up a clearance between outer and inner boxes 1A, 3 and vacuum heat insulator 5. Also, since the adiabatic box can be constituted only with vacuum heat insulator 5 without rigid urethane foam, it is possible to ensure an exceedingly high adiabatic performance.

[0007] Since only vacuum heat insulator 5, which is poor in strength as compared with rigid urethane foam, is used, however, such a refrigerator is very weak in strength while being high in adiabatic performance. That is, deformation in outward appearance is liable to occur. Also, since the outer and inner boxes are not planar in shape, it is difficult to use a plate-shaped vacuum heat insulator for non-planar portions such as convex and concave surfaces of radiating pipes or the like. Also, while the use of vacuum heat insulator with an evaporated aluminum film on one surface thereof takes effect in increasing the adiabatic performance, it is difficult in terms of reliability to use vacuum heat insulators with evaporated aluminum films.

Disclosure of the Invention

[0008] A refrigerator having both resin foam and a vacuum heat insulator between an outer box and an inner box adopts any one of the following constitutions;

(1) An outer surface of the outer box, on which the vacuum heat insulator is arranged, are set to have a center line average roughness (Ra) of 0.1 μm or more. Alternatively, the outer surface of the outer box is set to have a glossiness of 80 or less.
(2) A vacuum heat insulator being arranged on a door, which constitutes a front surface, are stuck to an inner plate of the door.
(3) An intermediate member is provided between the vacuum heat insulator and the outer box to prevent defor-

mation of the outer surface of the outer box.

(4) A Radiating pipe is provided between the vacuum heat insulator and the outer box, and an air gap defined by the vacuum heat insulator and the radiating pipe is made to be communicated to outside.

(5) A Small hole is provided on the outer box, on the surface of which is provided the vacuum heat insulator.

(6) A machine room is provided in a lower portion, and the vacuum heat insulators are arranged on both side surfaces of an upper portion, a roof surface, a back surface, and a front surface of a refrigerator to contact with the outer box, and on a bottom surface and both side surfaces of the lower portion of the refrigerator, and surfaces, which define the machine room, to contact with the inner box.

(7) The vacuumheat insulator having the radiating pipe assembled into the surface thereof, which contacts with the outer box, is arranged inside the outer box.

Brief Description of the Drawings

[0009]

Fig. 1 is a front view showing a refrigerator according to a first exemplary embodiment of the present invention.

Fig. 2 is a side, cross sectional view showing the refrigerator of Fig. 1.

Fig. 3 is a front, cross sectional view showing the refrigerator of Fig. 1.

Fig. 4 is an exploded view showing a door of a cold storage room of the refrigerator prior to foaming according to the first exemplary embodiment of the invention.

Fig. 5 is a cross sectional view showing a state after the foaming in Fig. 4.

Fig. 6 is a cross sectional view showing a door of a freezing room of the refrigerator according to the first exemplary embodiment of the invention.

Fig. 7 is an exploded view showing a door of another cold storage room of the refrigerator prior to foaming according to the first exemplary embodiment of the invention.

Fig. 8 is a cross sectional view showing a state after the foaming in Fig. 7.

Fig. 9 is a cross sectional view showing an essential part of a side wall of a refrigerator according to a third exemplary embodiment of the invention.

Fig. 10 is a perspective view showing an essential part of the refrigerator according to the third exemplary embodiment of the invention.

Fig. 11 is a cross sectional view showing an essential part of a side wall of a refrigerator according to a fourth exemplary embodiment of the invention.

Fig. 12 is a cross sectional view showing an essential part of a side wall of a refrigerator according to a fifth exemplary embodiment of the invention.

Fig. 13 is a cross sectional view showing a vacuum heat insulator used for a refrigerator according to a sixth exemplary embodiment of the invention.

Fig. 14 is a cross sectional view showing another vacuum heat insulator used for the refrigerator according to the sixth exemplary embodiment of the invention.

Fig. 15 is a cross sectional view showing a still other vacuum heat insulator used for the refrigerator according to the sixth exemplary embodiment of the invention.

Fig. 16 is a plan view showing a state before an outer box of a refrigerator according to a seventh exemplary embodiment of the invention is bent.

Fig. 17 is a perspective view showing a state after the outer box of the refrigerator according to the seventh exemplary embodiment of the invention is bent.

Fig. 18 is a cross sectional view showing an essential part of a vacuum heat insulator used for the refrigerator according to the seventh exemplary embodiment of the invention.

Fig. 19 is an enlarged, cross sectional view showing a part, to which the vacuum heat insulator used for the refrigerator according to the seventh exemplary embodiment of the invention is applied.

Fig. 20 is an exploded, perspective view showing an essential part of one end of aluminum tape in the refrigerator according to the seventh exemplary embodiment of the invention after urethane is poured and foamed.

Fig. 21 is an enlarged, cross sectional view showing an essential part of a refrigerator according to an eighth exemplary embodiment of the invention.

Fig. 22A is a cross sectional view showing a side of a refrigerator according to a ninth exemplary embodiment of the invention.

Fig. 22B is an enlarged view showing an essential part in Fig. 22A.

Fig. 23A is a front, cross sectional view showing the refrigerator in Fig. 22A.

Figs. 23B and 23C are enlarged views showing an essential part in Fig. 23A.

Fig. 24 is a longitudinal, cross sectional view showing, in enlarged scale, an essential part of a vacuum heat insulator applied to a refrigerator according to a tenth exemplary embodiment of the invention.

Fig. 25 is a cross sectional view showing, in enlarged scale, a portion of the refrigerator according to the tenth exemplary embodiment of the invention.

Fig. 26 is another cross sectional view showing, in enlarged scale, a portion of the refrigerator according to the tenth exemplary embodiment of the invention.

Fig. 27 is an enlarged, cross sectional view showing an essential part of a refrigerator according to an eleventh exemplary embodiment of the invention.

Fig. 28 is a view showing a transverse section of an essential part of a refrigerator according to a twelfth exemplary embodiment of the invention.

Fig. 29 is a cross sectional view showing, in enlarged scale, a portion in the vicinity of a radiating pipe of the refrigerator according to the twelfth exemplary embodiment of the invention.

Fig. 30 is a perspective view showing a state before a flat sheet for an outer box of a refrigerator according to a thirteenth exemplary embodiment of the invention is bent.

Fig. 31 is an enlarged view showing an essential part of a refrigerator according to a fourteenth exemplary embodiment of the invention.

Fig. 32 is an enlarged, cross sectional view showing an essential part of a refrigerator according to a fifteenth exemplary embodiment of the invention.

Fig. 33 is an enlarged, cross sectional view showing an essential part in a position, in which a vacuum heat insulator is positioned on an outer box of a refrigerator according to a sixteenth exemplary embodiment of the invention.

Fig. 34 is a view showing a structure of a vacuum heat insulator applied to a refrigerator according to a seventeenth exemplary embodiment of the invention.

Fig. 35 is a side, cross sectional view showing the refrigerator according to the seventeenth exemplary embodiment of the invention.

Fig. 36 is a front, cross sectional view showing the refrigerator according to the seventeenth exemplary embodiment of the invention.

Fig. 37 is a circuit diagram of a refrigerating cycle of a refrigerator according to an eighteenth exemplary embodiment of the invention.

Fig. 38 is a view showing a structure of a vacuum heat insulator according to the eighteenth exemplary embodiment of the invention.

Fig. 39 is a schematic view showing the vacuum heat insulator of Fig. 38.

Fig. 40 is a cross sectional view showing a door arranged on a front opening of a conventional refrigerator.

Fig. 41 is a view showing, in enlarged scale, a portion A in Fig. 40.

Fig. 42 is a side, cross sectional view showing another conventional refrigerator.

Detailed Description of Preferred Embodiments Embodiments of the invention will be described below with reference to the drawings. Same constituents are denoted by same reference numerals to be explained, and detailed explanations therefor will be omitted.

(First Exemplary Embodiment)

[0010] A first exemplary embodiment of the invention will be described with reference to Figs. 1 to 6.

[0011] Refrigerator 10 has a space defined by inner box 11 made of a synthetic resin such as a copolymer of acrylonitrile, butadiene, styrene, (ABS) or the like, and outer box 12 made of metal such as sheet iron, or the like, the space being filled with rigid urethane foam (referred below to as urethane foam) 13 being a resin foam. Cold storage room 15 and vegetable room 16 are provided above adiabatic partition 14, and changeover room 17, ice making room 18, and freezing room 19 are provided therebelow. Compressor 21 is arranged inside machine room 20 disposed below a rear portion of refrigerator 10. Refrigerator 10 also has refrigerating cooler 22, refrigerating fan 23, freezing cooler 24, and freezing fan 25. Condenser 26 is arranged on a bottom portion of refrigerator 10.

[0012] Provided on a front opening of refrigerator 10 are hinge type door (referred below to as door) 27 for the cold storage room, drawer type door (referred below to as door) 28 for the vegetable room, drawer type door (referred below to as door) 29 for the changeover room, drawer type door (referred below to as door) 30 for the ice making room, and drawer type door (referred below to as door) 31 for the freezing room. Vacuum heat insulators 32, 33, 34, 35, 36, 37, 38, 39, 40, and 41 cooperate with urethane foam 13 to constitute a body of refrigerator 10.

[0013] Vacuumheat insulators 32, 33, 34, 36 respectively contact with inner sides of a roof surface, a back surface, side surfaces of outer box 11, inner surfaces that constitutes the machine-room to be stuck thereon. Vacuum heat insulator 35 contacts with a bottom surface of inner box 12. Vacuum heat insulator 37 is arranged in adiabatic partition 14. Vacuum heat insulator 38 is arranged within door 27 in a manner to contact with the inner box. Vacuum heat insulators 39, 40, 41, respectively, are arranged within doors 28, 29, 31 in a manner to be disposed intermediate between external sheet iron of the respective doors and the inner box. Although not shown, a vacuum heat insulator is likewise arranged intermediate between the external sheet iron of door 30 and the inner box.

[0014] Urethane foam 13 surrounding freezing room 19 and changeover room 17 in a freezing region and vacuum heat insulators 33, 34, 35, 36 form an adiabatic box (a heat insulating box). Preferably, an adiabatic wall thickness of the adiabatic box except the doors is in the range of 25 to 50 mm including a portion having a thin wall at the opening. Meanwhile, urethane foam 13 surrounding cold storage room 15 and vegetable room 16 in a cold storage region and vacuum heat insulators 32, 33, 34 also form an adiabatic box. The thickness of an adiabatic wall of the adiabatic box is set to be in the range of 25 to 40 mm including a portion of a thin wall at the opening except the doors. Since a vacuum heat insulator having a thickness of 10 to 15 mm is arranged in the adiabatic wall, a thickness of 10 mm at the minimum is ensured to fill thereinto urethane foam 13. Therefore, flowability of urethane foam 13 at the time of foaming is not obstructed and degradation of adiabatic performance due to roughness of the foam and failure in filling is not caused. Thus it is possible to effectively enhance the adiabatic performance and to maintain the adiabatic property of urethane foam 13 as a multilayered adiabatic wall while ensuring the thickness of the vacuum heat insulator to adequately provide its adiabatic property. In particular, it is more effective in a refrigeration temperature range, in which temperature gradient is large between inside and outside of the refrigerator. A thickness of an adiabatic wall surrounding freezing room 19 and changeover room 17 in the freezing region is set not to exceed 50 mm. Thereby, it is possible to apply and make use of the vacuum heat insulators in increasing an internal volume of freezing room 19 and change-over room 17, which are relatively small in volume ratio, without any influence on apparent layout, thus enabling the usefulness of the vacuum heat insulator. A thickness of the adiabatic wall of cold storage room 15 and vegetable room 16 is set not to exceed 40 mm. Thereby, energy saving by application of the vacuum heat insulators and the effect in increasing the internal volumetric efficiency inside and outside of the adiabatic box can be caused to balance each other in a cold storage region, in which temperature gradient is relatively small between inside and outside of the refrigerator.

[0015] Refrigerator 10 has component parts (not shown), irregular-shaped portions, and specific structures such as portions, in which pipes or a drain tube are mounted. In case of arranging a large number of vacuum heat insulators to enhance the coverage to the utmost limits, vacuum heat insulators in specific form adapted to such portions are needed. Alternatively, the work efficiency in sticking of the vacuum heat insulator is exceedingly decreased. Therefore, even when it is tried to arrange the vacuum heat insulator over substantially 80 % of the surface area of outer box 11, the insulator is extended to locations, in which the efficiency in use is low and the usefulness saturates. That is, the effect on an increase in adiabatic performance is exceedingly decreased relative to charging of the vacuum heat insulator.

[0016] Accordingly, by setting the coverage of the vacuum heat insulator relative to the surface area of outer box 11 to 80 % or less according to the present embodiment, the effect produced by the use of a large number of vacuum heat insulators does not saturate. That is, an endothermic load is effectively restricted in a state of high usefulness, so that the effect of energy saving is enhanced.

[0017] Peripheral portions of the respective surfaces and partition portions between the cooling rooms overlap each other in adiabatic wall thickness. The filling and closely contacting quality of urethane foam 13 is decreased at opening peripheral edges to cause a decrease in adiabatic performance. By avoiding the inefficient coverage of the vacuum heat insulator in view of the above, the equivalent adiabatic effect to that at the coverage of 80 % is obtained at the coverage of 70 %.

[0018] In case of the coverage of 80 %, the sticking work becomes favorable in workability by arranging vacuum heat insulators sized to be able to substantially cover respective surfaces composed of both side surfaces, a roof surface, a back surface, a bottom surface, and a front surface of the adiabatic box.

[0019] Therefore, it is possible to avoid the use of vacuum heat insulators of nonstandard configuration and the work of arranging the vacuum heat insulators on those portions, which are low in workability, so that cost performance becomes favorable. That is, balance between an increase in initial cost of refrigerator 10 due to application of the adiabatic box and a decrease in running cost due to energy saving is not lost. Therefore, it is possible to increase the value as life cycle cost.

[0020] When arrangement from locations, in which thermal gradient is large inside and outside of the adiabatic box presents the coverage amounting 50 % or more of the surface area of outer box 12, the endothermic load of the adiabatic box is effectively restricted, so that the effect of energy saving is enhanced.

[0021] From the viewpoint of cost-effectiveness, the effect of energy saving to investment is large in the range of 50 to 70 % in rate of contribution.

[0022] For such reason, it is preferable that the vacuum heat insulators be arranged on respective surfaces composed of both the side surfaces, the roof surface, the back surface, the bottom surface, and the front surface of refrigerator 10 to have the coverage of vacuum heat insulators amounting 50 % or more but 80 % or less and more preferably 50 % or more but 70 % or less of the surface area of the outer box.

[0023] Temperature gradient of, for example, respective doors 27, 28, 29, 30, 31 between inside and outside of the refrigerator is relatively smaller than that of those other portions of the adiabatic box, with which exhaust heat of machine room 20 is associated. Strength is necessary for articles, which are received in the refrigerator and supported by respective doors, and for mechanical peel of the vacuum heat insulator, which is caused by opening and closing of the doors. In view of this, it is conceivable to restrain arrangement of the vacuum heat insulators on respective doors and to effectively obtain the effect of application of the vacuum heat insulators to other body portions of the adiabatic box. At this time, the coverage of the vacuum heat insulator amounts to about 53 % in a refrigerator, which has a height of 1800 mm, a width of 675 mm, and a depth of 650 mm, to provide an energy-saving refrigerator, to which a vacuum heat insulator having a stuck area of 50 to 80 % is reasonably applied.

[0024] Outer surfaces of outer box 11, on which vacuum heat insulators 32, 33, 34 are arranged, are set to have a center line average roughness (Ra) of 0.1 μm or more to be rougher than conventional ones having a center line average roughness of less than 0.1 μm.

[0025] A method of manufacturing cold storage room door 27 will be described with reference to Figs. 4 and 5. Door inner plate 42 has projections 43 and vacuum heat insulator 38 is stuck thereto in a manner to contact with a surface of forefront portion 44. After urethane foam 13 is poured inside door outer plate 27A, it covers door inner plate 42 to be foamed to form door 27.

[0026] Fig. 6 is a cross sectional view showing drawer type door 31 for the freezing room. Door inner plate 45 has fixing portions 47 to fix thereto rails 46, which support a casing (not shown) for storage of frozen food. Urethane foam 13 together with reinforcement plate 48 fixes door inner plate 45 to rails 46 at fixing portions 47. Spacers 49 are fixed to a part of reinforcement plate 48 by an adhesive or the like in a manner to arrange vacuum heat insulator 41 in a space between door inner plate 45 and door outer plate 50. Spacers 49 are made of softer members, such as foamed styrene, and polyethylene foam, than vacuum heat insulator 41. Spacers 49 are substantially shaped in a rectangular solid and arranged to have a flow direction of urethane foam 13 at the time of foaming and a longitudinal direction of spacers 49 agreeing with each other.

[0027] With the above construction, a cooling apparatus is composed of compressor 21, refrigerating cooler 22, refrigerating fan 23, freezing cooler 24, freezing fan 25, and condenser 26. Such a cooling apparatus cools cold storage room 15 and vegetable room 16 substantially to 0 to 10 °C and changeover room 17, ice making room 18, and freezing room 19 substantially to a temperature of -15 to -25 °C.

[0028] When the vacuum heat insulators are arranged from locations, in which thermal gradient is large inside and outside of the box body, to have the coverage amounting 50 % or more of the surface area of the outer box, an endothermic load of the refrigerator can be effectively restricted. Thereby, it is possible to enhance the effect of energy saving. By making the coverage 80 % or less, the use of vacuum heat insulators of nonstandard configuration and the work of arranging the vacuum heat insulators on those portions, which are low in workability are avoided. That is, it is possible to avoid a sudden increase in cost ratio relative to a decrease in endothermic load of the vacuum heat insulators and to effectively restrict the endothermic load in a state of high usefulness of the vacuum heat insulators to enhance the effect of energy saving.

[0029] Since vacuum heat insulators 32, 33, and 34 are stuck to outer box 11 in contact therewith, deformation possiblyoccurs on outer surfaces of outer box 11 due to the cause of dispersion in flatness, such as irregularities, warpage, or the like, of surfaces of vacuum heat insulators 32, 33, and 34. Since the outer surfaces of outer box 11 are set to have a center line average roughness (Ra) of 0.1 μm or more to be rougher than conventional ones, the outer surfaces of the outer box are decreased in light reflectance with the same coating material. Thereby, deformation of the outer surfaces of the outer box caused by sticking of the vacuum heat insulators is visually decreased. Accordingly, it is possible to cope with deformation of refrigerator 10 in outward appearance without the use of any complex construction or any specific parts and materials. Desirably, the center line average roughness (Ra) of the outer surfaces of outer box 11 is 1 μm or less, which does not mar the quality in outward appearance.

[0030] After sticking vacuum heat insulator 38 to forefront portion 44 of door inner plate 42 in a manner to contact with the same and pouring urethane foam 13, the urethane foam is caused to cover door inner plate 42 to be foamed to form door 27. Therefore, vacuumheat insulator 38 does not contact directly with the outer surface of door 27 and the outer surface of door 27 for the cold storage room is not deformed due to shrinkage after the foaming of urethane foam 13.

[0031] Since vacuum heat insulator 38 is stuck to forefront portion 44 of door inner plate 42 in a manner to contact with the same, vacuum heat insulator 38 can be arranged to the maximum to enhance the adiabatic performance. Further, urethane foam 13 is filled into projections 43 formed inside door inner plate 42 from a space between vacuum heat insulator 38 and door inner plate 42, so that projections 43 are increased in strength.

[0032] Vacuum heat insulator 41 provided on door 31 is arranged in a space between door outer plate 50 and door inner plate 45 partially with spacers 49 therebetween. Therefore, the outer surface of door outer plate 50 is not deformed due to shrinkage after foaming of urethane foam 13. Urethane foam 13 is surely formed in the vicinity of fixing portions 47 of rails 46 and reinforcement plate 48 disposed on door inner plate 45, so that rail fixing portions 47 are increased in strength.

[0033] Since spacers 49 are made of a softer material than vacuum heat insulator 41, the covering of vacuum heat insulator 41 is not damaged and so can be heightened in reliability.

[0034] Spacers 49 are substantially shaped in a rectangular solid and arranged to have a flow direction of urethane foam 13 at the time of foaming and a longitudinal direction of spacers 49 agreeing with each other. Therefore, the construction decreases hamper against the flow of urethane foam 13 by spacers 49at the time of foaming, so that urethane is improved in filling quality and rail fixing portions 47 are surely increased in strength.

[0035] While door 31 for the freezing room is described as a drawer door of the refrigerator according to the present embodiment, it is effective that door 28 for the vegetable room and door 29 for the changeover room, which constitute drawer doors, be constructed in the same manner.

[0036] In the above description, single vacuum heat insulator 38 is used for door 27 for the cold storage room. As shown in Figs. 7 and 8, however, vacuum heat insulators 38A, 38B may be arranged in the vicinity of projections 43 with gaps therebetween to contact with door inner plate 42 of a single door. In this case, urethane foam 13 is more surely filled into projections 43, so that projections 43 on door 27B for the cold storage room are increased in strength.

(Second Exemplary Embodiment)

[0037] A refrigerator according to a second exemplary embodiment of the invention is the same in fundamental construction as that according to the first exemplary embodiment. According to the first exemplary embodiment, the center line average roughness of the outer surfaces of outer box 11 is prescribed. According to the present embodiment, those outer surfaces of outer box 12, on which vacuum heat insulators 32, 33, and 34 are provided, are decreased in glossiness below the order of 90, which is conventional, and set to 80 or less.

[0038] Here, glossiness is prescribed in JIS standard (JIS Z8741) such that glossiness 100 corresponds to reflectance 10 % in case of an incidence angle of 60 degrees on a glass surface having a refractive index of 1.567, or glossiness 100 corresponds to reflectance 5 % in case of an incidence angle of 20 degrees.

[0039] Likewise the first exemplary embodiment, vacuum heat insulators 32, 33, and 34 are stuck to outer box 12 in contact therewith. Therefore, deformation possibly occurs on the outer surfaces of outer box 12 due to the cause of dispersion in flatness , such as irregularities, warpage, or the like, of surfaces of vacuum heat insulators 32, 33, and 34. Hereupon, since the outer surfaces of outer box 12 have the glossiness of 80 or less, the outer surfaces of the outer box are decreased in light reflectance with the same surface roughness. Accordingly, deformation of the outer surfaces of the outer box caused by sticking of the vacuum heat insulators is visually decreased. Therefore, it is possible to cope with deformation of refrigerator 10, to which the vacuum heat insulators are applied, in outward appearance without the use of any complex construction or any specific parts and materials. Desirably, the glossiness of the outer surfaces of outer box 12 is preferably around 50, which does not mar the quality in outward appearance.

(Third Exemplary Embodiment)

[0040] Fig. 9 is a cross sectional view showing an essential part of a side wall of a refrigerator according to a third exemplary embodiment of the invention, and Fig. 10 is a perspective view showing the essential part. The fundamental construction except the essential part is the same as that according to the first exemplary embodiment.

[0041] In the figures, arranged between outer box 51 and inner box 52 are soft member 53, vacuum heat insulator 54, and rigid urethane foam 55 as intermediate members, which prevent deformation of outer surfaces of outer box 51 from a side of the outer box. It is preferred that soft member 53 be larger than vacuum heat insulator 54 and made of a softer material than vacuum heat insulator 54. Preferably, the soft member is resin foam structured of, for example, independent foam.

[0042] Preferably, soft member 53 has a thickness t1 of at least the flatness of vacuum heat insulator 54 and at most the thickness of the vacuum heat insulator. Concretely, the thickness is set to be at least 3 mm and at most 15 mm.

[0043] With the above structure, soft member 53 provided between vacuum heat insulator 54 and outer box 51 prevents deformation of the outer surfaces of the outer box. Thereby, the cause of dispersion in flatness, such as irregularities, warpage, or the like, of surfaces of vacuum heat insulator 54 is absorbed and deformation of the outer surfaces of the outer box is prevented.

[0044] When soft member 53 is larger than vacuum heat insulator 54, dispersion in mounting at the time of sticking vacuum heat insulator 54 to outer box 51 is absorbed and the work efficiency is enhanced.

[0045] When soft member 53 is softer than vacuum heat insulator 54, the covering of vacuum heat insulator 54 is not damaged at the time of manufacture and so vacuum heat insulator 54 is heightened in reliability.

[0046] When soft member 53 as an intermediate member is a member made of resin foam, pressure of foaming generated at the time of foaming of rigid urethane foam (referred below to as urethane foam) 13 is absorbed by compression of the resin foam. Shrinkage of the urethane foam after the foaming is absorbed by expansion of the resin foam, so that deformation of the outer surfaces of the outer box is surely prevented.

[0047] When soft member 53 is a member structured of independent foam, entry of gases such as foamed gas, air, or the like into soft member 53 is prevented, so that deformation of the outer surfaces of the outer box due to temperature changes is prevented.

[0048] The thickness t1 of soft member 53 is at least the flatness of vacuum heat insulator 54 and at most the thickness of the vacuum heat insulator, and is concretely set to be at least 3 mm and at most 15 mm. Thereby, dispersion in flatness of the vacuum heat insulator is surely absorbed by the soft member and soft member 53 is not larger in thickness than needed, whereby degradation in adiabatic performance is not caused.

[0049] Vacuum heat insulator 54 may be stuck to soft member 53 after the soft member is stuck to outer box 51, or soft member 53 may be stuck to outer box 51 after the soft member is beforehand stuck to outer box 51.

(Fourth Exemplary Embodiment)

[0050] Fig. 11 is a cross sectional view showing an essential part of a side wall of a refrigerator according to a fourth exemplary embodiment of the present invention. The fundamental construction except the essential part is the same as that according to the first exemplary embodiment.

[0051] Hard member 56 as an intermediate member provided between vacuum heat insulator 54 and outer box 51 is a harder member than vacuum heat insulator 54. The hard member is made of, for example, ABS sheet and preferably has a thickness of at least the flatness of vacuum heat insulator 54, concretely at least 3 mm.

[0052] With the above structure, the cause for deformation of the outer box, such as irregularities, warpage, or the like, of surfaces of vacuum heat insulator 54 is prevented, and deformation of the outer surfaces of the outer box is prevented. Since hard member 56 can be made relatively small in thickness, it is possible to restrict an influence on the adiabatic performance.

(Fifth Exemplary Embodiment)

[0053] Fig. 12 is a cross sectional view showing an essential part of a side wall of a refrigerator according to a fifth exemplary embodiment of the present invention. The fundamental construction except the essential part is the same as that according to the first exemplary embodiment.

[0054] In the figure, soft member 53 and hard member 56 are arranged between vacuum heat insulator 54 and outer box 51. Hard member 56, soft member 53, and vacuum heat insulator 54 from a side of outer box 51 are arranged in this order.

[0055] With the above structure, soft member 53 absorbs the cause for deformation of the outer box, such as irregularities , warpage, or the like, of surfaces of vacuum heat insulator 54, and hard member 56 prevents transmission of the cause for deformation of the outer box, so that deformation of the outer surfaces of the outer box is surely prevented.

[0056] Since hard member 56, soft member 53, and vacuum heat insulator 54 from a side of outer box 51 are arranged as intermediate members in this order, damage to the covering of the vacuum heat insulator is prevented by soft member 53.

(Sixth Exemplary Embodiment)

[0057] Figs. 13 to 15 are cross sectional views showing various vacuum heat insulators used in a refrigerator according to a sixth exemplary embodiment of the invention. The fundamental construction except the vacuum heat insulators is the same as that according to the first exemplary embodiment.

[0058] Core material 57 charged in the vacuum heat insulator is sealed at its periphery by first covering 58 and kept in a vacuum state after its interior is exhausted. An outer periphery of first covering 58 is covered by second covering 59 to provide for a dual structure. In Fig. 13, gas is charged in space 60 between first covering 58 and second covering 59. As the gas, air or inert gas is used.

[0059] In this manner, the outer periphery of first covering 58, on which deformation of the outer box, such as irregularities, warpage, or the like, of surfaces of core material 57 charged in the vacuum insulator occurs, is covered by second covering 59 to provide for the dual structure. Thereby, second covering 59 absorbs the cause for deformation of the outer box to prevent deformation of the outer surfaces of the outer box. And gas is charged between coverings 58, 59 of the dual structure. Thereby, the cause for deformation of the outer box, such as irregularities, warpage, or the like, of surfaces of the vacuum heat insulator is absorbed by space 60 for the gas charged between coverings 58, 59 of the dual structure, so that deformation of the outer surfaces of the outer box is prevented.

[0060] As shown in Fig. 14, covering 59B of the dual structure may have a larger thickness t3 than a thickness t2 of covering 59A and covering 59B may be stuck to outer box 12. In this case, since thickness t3 of covering 59B is large, the cause for deformation of the outer box, such as irregularities, warpage, or the like, of surfaces of the vacuum heat insulator is absorbed by thickness t3, so that deformation of the outer surfaces of the outer box is prevented.

[0061] As shown in Fig. 15, covering 59 may cover an outer periphery of first covering 58 to provide for a dual structure, and soft member 61 may be charged between the coverings of the dual structure. In this case, soft member 61 absorbs the cause for deformation of the outer box, such as irregularities, warpage, or the like, of surfaces of the vacuum heat insulator to prevent deformation of the outer surfaces of the outer box. Soft member 61 acts to protect the vacuum heat insulator to heighten the vacuum heat insulator in reliability.

(Seventh Exemplary Embodiment)

[0062] Fig. 16 is a plan view showing a state before an outer box of a refrigerator according to a seventh exemplary embodiment of the invention is bent, and Fig. 17 is a perspective view showing a state after the outer box of the refrigerator is bent. Fig. 18 is a cross sectional view showing an essential part of a vacuum heat insulator used for the refrigerator, Fig. 19 is an enlarged, cross sectional view showing a part, to which the vacuum heat insulator used for the refrigerator is applied, and Fig. 20 is an exploded, perspective view showing an essential part of one end of aluminum tape in the refrigerator after urethane is poured and foamed. The fundamental construction except the above parts is the same as that according to the first exemplary embodiment.

[0063] Outer box 62 made of steel sheet is in the form of a flat sheet before bending. Radiating pipe 63 constituting a refrigerating cycle is fixed to outer box 62 by aluminum tape 64, which serves as a fixing member, and to an upper surface of which is fixed vacuum heat insulators 65, 66, 67 with the use of an adhesive such as hot melt, etc. Outer box 62 is bent at bends 69 to assemble thereto back surface plate 70, bottom plate 71, and an inner box (not shown). Thereafter, rigid urethane foam is filled into a space, which is defined by outer box 62 and the inner box, to be foamed. Accordingly, the urethane foam is not filled into machine room constituting portion 68, which accommodates therein a compressor of the refrigerating cycle, the portion being communicated to outside. One end 64A of aluminum tape 64 for fixing radiating pipe 63 is extended to machine room constituting portion 68. Other end 64B of aluminum tape 64 is positioned inside vacuum heat insulator 65.

[0064] After completion, vacuum heat insulator 65 is provided with groove 74 by means of pressing portion 73 of press machine 72. Vacuum heat insulator 65 is arranged on and fixed to outer box 62 such that radiating pipe 63 enters groove 74.

[0065] When radiating pipe 63 is arranged between outer box 62 and vacuum heat insulator 65, first air gap 76 is defined between outer box 62 and aluminum tape 64. Second air gap 77 is defined between aluminum tape 64 and groove 74 on vacuum heat insulator 65.

[0066] With the above structure, first air gap 76 and second air gap 77 are communicated to outside because one end 64A of aluminum tape 64 is extended to machine room constituting portion 68. Accordingly, gas such as foaming gas does not stay in air gaps 76, 77. Therefore, air gaps 76, 77 are neither expanded nor contracted by changes in ambient temperature, so that an outer surface of outer box 62 in an area, in which radiating pipe 63 is arranged, is prevented from being deformed.

[0067] One end 64A of aluminum tape 64 is extended to machine room constituting portion 68 and other end 64B is positioned inside an end of vacuum heat insulator 65. When rigid urethane foam 75 is foamed, some urethane foam 75 enters from a clearance between vacuum heat insulator 65 and radiating pipe 63. With such construction, however, the urethane foam does not reach other end 64B of aluminum tape 64 as shown in Fig. 20. Accordingly, since air gaps 76, 77 in the vicinity of other end 64B of aluminum tape 64 are communicated to each other, gas in air gaps 76, 77 is smoothly discharged outside the refrigerator. Thereby, the air gaps are neither expanded or nor contracted by changes in ambient temperature, so that an outer surface of outer box 62 in an area, in which radiating pipe 63 is arranged, is surely prevented from being deformed.

[0068] Groove 74 formed in vacuum heat insulator 65 in opposition to radiating pipe 63 is formed by pressing portion 73 of press machine 72 after vacuum heat insulator 65 is completed. Accordingly, there is no need of beforehand providing a groove on a core material of vacuum heat insulator 65, so that it is possible to make the manufacturing process of the vacuum heat insulator simple.

[0069] While the aluminum tape is explained as a fixing member, the material is not specifically limited thereto provided that it is a tape material having stickiness. Further, the material more preferably has a thermal conductivity.

(Eighth Exemplary Embodiment)

[0070] Fig. 21 is an enlarged, cross sectional view showing an essential part of a refrigerator according to an eighth exemplary embodiment of the invention. The fundamental construction except the essential part is the same as that according to the first exemplary embodiment.

[0071] Small holes 78 beforehand formed on outer surfaces of outer box 62 by means of press machine or the like are linearly provided on outer box 62 to correspond to an area, in which vacuum heat insulator 65 is provided.

[0072] With the above structure, gas in an air gap between vacuum heat insulator 65 and outer box 62 constitutes the cause for deformation of the outer box, such as irregularities, warpage, or the like, of surfaces of vacuum heat insulator 65. The gas passes through small holes 78 to be smoothly discharged outside the refrigerator. Thereby, the air gap is neither expanded nor contracted by changes in ambient temperature, so that an outer surface of outer box 62 in an area, in which vacuum heat insulator 65 is arranged, is prevented from being deformed.
[0073] A pattern, in which small holes 78 are arranged, is not limited to be linear but may be curved or polygonal.

(Ninth Exemplary Embodiment)

[0074] Fig. 22A is a cross sectional view showing a left side among left and right sides, into which a refrigerator according to a ninth exemplary embodiment of the invention is divided, as viewed from the right side, and Fig. 23A is a cross sectional view showing a rear portion among front and rear portions, into which the refrigerator is cut into, as viewed from the front.
[0075] The fundamental construction of the refrigerator according to this embodiment is different from that according to the first exemplary embodiment in a way of arranging vacuum heat insulators. That is, vacuum heat insulators 32, 33A, 33B, and 34 contact with a roof surface, a back surface, inner sides of upper side surfaces of outer box 12, respectively, to be stuck thereto. Vacuum heat insulators 35, 34A, and 36 contact with a bottom surface, and lower side surfaces of inner box 11, and constituent surfaces of machine room 20, respectively, to be stuck thereto. Vacuum heat insulators 38, 39, 40, and 41, respectively, are arranged inside cold storage room door 27, vegetable room door 28, and freezing room doors 29, 31, which are arranged on a front opening of refrigerator 10, to contact with outer sheet iron of the respective doors.
[0076] According to this embodiment, the respective vacuum heat insulators are arranged from locations, in which thermal gradient is large inside and outside of an adiabatic box, and an endothermic load is effectively restricted in a state of high usefulness of the vacuum heat insulators, so that the effect of energy saving is enhanced.
[0077] Further, the respective vacuum heat insulators are arranged on the both upper side surface, the roof surface, the back surface, and the front surface of refrigerator to contact with outer box 12, and on the bottom surface and the constituent surfaces of machine room 20 to contact with inner box 11. Accordingly, vacuum heat insulators 35, 34A, 36, and 37 arranged on the both lower side surfaces, the bottom surface, and machine room 20, where outer box 12 rises in surface temperature, are not exposed to high temperatures. Therefore, deterioration in vacuum adiabatic performance with the passage of time can be restricted to the minimum, so that reliability of vacuum heat insulators 35, 34A, 36, and 37 over a long term is heightened.
[0078] Since vacuum heat insulators 34A on the both lower side surfaces are arranged to contact with inner box 11, complex fitting portions and complex piping of outer box 12 are avoided and breakage of vacuum heat insulators 34A is prevented. That is, reliability is heightened by arranging vacuum heat insulators 34A to contact with inner box 11 on the both lower side surfaces where outer box 12 are complex in shape.
[0079] Since vacuum heat insulator 32 on the roof surface is arranged to contact with outer box 12, a mount member for inside illumination or electric wire (not shown) can be mounted on the roof surface of inner box 11. Accordingly, it is possible to provide the illumination on the roof surface of refrigerator 15, thus improving convenience in use.
[0080] By arranging vacuum heat insulators 33A and 33B on the back surface of the adiabatic box, the vacuum heat insulators are not in the way of piping for cooling devices and drain tubes (not shown) for draining of defrosting water from coolers 22 and 24. A back panel and vacuum heat insulators 33A, 33B can be assembled to be unitary, which is preferable in manufacturing process.
[0081] Further, since the respective vacuum heat insulators are arranged to contact with either outer box 12 or inner box 11, which constitute the adiabatic box of the refrigerator, it is possible to ensure adequate spatial distances, over which rigid urethane foam 13 being resin foam is formed. Accordingly, degradation in adiabatic performance due to roughness and insufficient foaming of urethane foam 13 is not brought about but the box is maintained in strength and becomes impressive.
[0082] Adiabatic wall thicknesses of the adiabatic box, which forms freezing rooms 18A, 19 in a freezing region, and the adiabatic box, which forms cold storage room 15 and vegetable room 16 in a cold storage region, are the same as those in the first exemplary embodiment, and so an explanation therefor is omitted. The same is the case with the coverage of outer surfaces of refrigerator 10.
[0083] Vacuum heat insulators 33A, 33B are beforehand arranged on the back panel, and then joined to side surfaces and the roof surface, which are formed by bending a flat sheet in a C-shaped manner, to form outer box 12. At this time, vacuum heat insulators 33A, 33B are preferably arranged to be positioned in the vicinity of joints, which is made when outer box 12 is constituted. That is, vacuum heat insulators 33A, 33B are fabricated to be of substantially the same size in width of back panel as that of the back panel. Thereby, the adiabatic performance is heightened.
[0084] Preferably, the respective vacuum heat insulators are beforehand arranged on outer box 12 or inner box 11. Manufacture is facilitated by assembling the box in such a manner.

[0085] Vacuum heat insulators 35, 34A, 36, and 37 arranged in contact with inner box 11 are preferably made smaller in projected area than inner box 11. In other words, vacuum heat insulators 35, 34A, 36, and 37 arranged in contact with inner box 11 do not protrude beyond respective surfaces of inner box 11, with which vacuum heat insulators 35, 34A, 36, 37 are arranged in contact.

[0086] With such a constitution, urethane foam 13 is caused to flow between outer box 12 and inner box 11 after vacuum heat insulators 35, 34A, 36, 37 are arranged in predetermined locations. In this case, forces acting in directions, in which vacuum heat insulators 35, 34A, 36, 37 arranged on inner box 11 are peeled off from inner box 11, are not exerted on the vacuum heat insulators. Therefore, it is possible to prevent peeling-off of vacuum heat insulators 35, 34A, 36, 37 caused by inflowing of urethane foam 13. Further, sticking of vacuum heat insulators 35, 34A, 36, and 37 can be readily stabilized, and flowability of urethane foam 13 is not hindered.

[0087] Those surfaces of inner box 11, with which vacuum heat insulators 35, 34A, 36 are arranged in contact, are preferably provided with projection 11A, which surrounds an outer periphery of each vacuum heat insulator as shown in Fig. 23B, or recess 11B, which receives each vacuum heat insulator as shown in Fig. 23C. Both projection 11A and recess 11B have a step in contact with an outer periphery of the vacuum heat insulator. The step reduces an exposed area of an end surface of each vacuum heat insulator.

[0088] By providing the step in this manner, positioning is made easy when vacuum heat insulators 35, 34A, 36 are stuck, so that breakage of respective vacuum heat insulators is prevented. Further, peeling-off of respective vacuum heat insulators caused by inflowing of urethane foam 13 is prevented. Differences in level between inner box 11 and vacuum heat insulators 35, 34A, 36 are decreased by the provision of projections 11A, and so flowability of urethane foam 13 is not hindered. Working of a metal mold for inner box 11 is facilitated by the provision of recesses 11B. Further, the steps themselves serve for reinforcement of inner box 11 to facilitate sticking of vacuum heat insulators 35, 34A, 36.

[0089] In case of arranging vacuum heat insulator 36 below cooler 24, heat insulator 36A is preferably arranged below cooler 24, or on an inner surface of inner box 11 to ensure a planar configuration as shown in Fig. 22B. Heat insulator 36A is formed on an upper surface thereof with a predetermined inclined configuration for treatment of defrosting water, and on a lower surface thereof with a planar configuration to be brought into close contact with inner box 11. A hole is provided on a lowermost portion of the upper surface of heat insulator 36A and a path is provided to afford discharging defrosting water outside from the hole.

[0090] A surface of inner box 11 positioned below cooler 24 is made planar by heat insulator 36A and provided with no inclined portion, so that it is possible to efficiently stick vacuum heat insulator 36 to the surface. It is possible to prevent peeling-off of vacuum heat insulator 36 caused by inflowing of urethane foam 13. Since that portion, to which vacuum heat insulator 36 is stuck, is not inclined in shape but planar, side length is shortened to enable reducing vacuum heat insulator 36 in size. Since side length is shortened, it is possible to decrease an endothermic load into the refrigerator.

[0091] In the above explanation, the inner surface of inner box 11 below cooler 24, on which heat insulator 36A is arranged, is planar. However, a portion below cooler 24 in inner box 11 may be made an inclined surface and heat insulator 36A may be arranged on an outer surface of inner box 11 corresponding to the portion. In this case, vacuum heat insulator 36 is beforehand arranged on heat insulator 36A and the box can be assembled, so that manufacture is facilitated.

[0092] Preferably, air vent holes 11C are disposed on a back surface of inner box 11 for releasing air from urethane foam 13 as shown in Fig. 23A. With such a constitution, any air vent hole is unnecessary for the back surface of outer box 12 and vacuum heat insulator 33A can be arranged thereon. Further, air vent holes disappear from outer box 12, thus enabling ensuring a beautiful view in outward appearance. The back surface can also be used for back surfaces of outer boxes of otherwise constructed refrigerators, so that it is possible to reduce the number of parts and manhour.

[0093] Preferably, a boundary between vacuum heat insulators 34 and 34A is structured such that vacuum heat insulators 34 and 34A overlap each other as shown in Fig. 23A. According to this embodiment, lower ends of vacuum heat insulators 34 arranged in contact with outer box 12 on both upper side surfaces of refrigerator 10 are positioned to be lower than upper ends of vacuum heat insulators 34A arranged in contact with inner box 11 on both lower side surfaces of the refrigerator. When vacuum heat insulators 34, 34A are arranged on both side surfaces of refrigerator 10, they may be shifted in a vertical direction. Vacuum heat insulators 34, 34A may be low in dimensional accuracy. Even in such cases, the vacuum heat insulators are present on at least one of outer box 12 and inner box 11 over the entire both side surfaces of refrigerator 10. Therefore, vacuum heat insulators 34, 34A are not damaged in adiabatic effect. Further, urethane foam 13 can be made to flow stably without hamper.

[0094] Inner box 11 is preferably planar in a widthwise direction so as to make sticking of vacuum heat insulators 35, 36 easy and effective. According to this embodiment, vacuum heat insulators 35, 36 are arranged in contact with outer sides of bottom surfaces of inner box 11, on which flat surfaces are formed in a widthwise direction of refrigerator 10. Such a constitution makes it possible to enlarge an area, in which vacuum heat insulators 35, 36 are stuck on bottom surfaces of inner box 11, and to decrease the bottom surfaces in area, thus enabling enhancing the energy saving effect. Further, the sticking quality of vacuum heat insulators 35, 36 is improved.

[0095] In arranging vacuum heat insulators 32, 33A, 33B, 35, 34, 34A, 36, 37, 38, 39, 40, and 41, it is preferable to remove foreign matters from those surfaces, to which they are stuck, before sticking. According to this embodiment, foreign matters on those surfaces in contact with the respective vacuum heat insulators before sticking of the vacuum heat insulators are removed. Thereby, damage to the respective vacuum heat insulators due to foreign matters can be eliminated, so that reliability in the sticking process is enhanced.

(Tenth Exemplary Embodiment)

[0096] Fig. 24 is a cross sectional view showing an essential part of a vacuum heat insulator applied to a refrigerator according to this exemplary embodiment, and Figs. 25 and 26 are partial, cross sectional views showing, in enlarged scale, the refrigerator according to this embodiment. The fundamental construction of the whole refrigerator is the same as that according to the first exemplary embodiment or the ninth exemplary embodiment.

[0097] Vacuum heat insulator 91 has core material 92 therein. Core material 92 is made of an inorganic fiber aggregate such as glass wool etc. Vacuum heat insulator 91 is formed by inserting core material 92 into a covering member, which is formed by sticking deposited layer film 93 and metallic foil layer film 97 together after the core material is heated and dried, and vacuumizing an interior of the covering member to seal an opening thereof.

[0098] Deposited layer f ilm 93 has a composite plastic film formed by interposing aluminum deposited film 95 between nylon film 94 and high-density polyethylene film 96. Metallic foil layer film 97 has a composite plastic film formed by interposing aluminum foil 99 between nylon film 98 and high-density polyethylene film 100.

[0099] Sealing surfaces of deposited layer film 93 and metallic foil layer film 97 serves a flat surface on a side of deposited layer film 93 and a three-dimensional surface on a side of metallic foil layer film 97. Deposited layer film 93 is arranged in contact with outer box 12 or inner box 11. That is, that flat surface of vacuum heat insulator 91, which needs a high adiabatic quality, is composed of deposited layer film 93 having aluminum deposited film 95. The other surface, which needs a high gas-barrier quality, is composed of metallic foil layer film 97 having metallic foil 99. The sealing surfaces of both films 93, 97 are caused to be positioned on the same plane as that of the flat surface on the side of deposited layer film 93. With such a constitution, it becomes easy to treat fins of the sealing surfaces and it is possible to make use of vacuum heat insulator 91 having a high reliability and an excellent adiabatic performance.

[0100] According to the embodiment, the flat surface of vacuum heat insulator 91 on the side of deposited layer film 93 is arranged in contact with an inside of outer box 12 or an outside of inner box 11 as shown in Figs. 25 and 26. Thereby, vacuum heat insulator 91 having a high reliability and an excellent adiabatic performance can be effectively positioned and treatment of fins on the sealing surfaces is made unnecessary.

[0101] A vacuum heat insulator having metallic foil films on both surfaces thereof is used for those portions of both inner box 11 and outer box 12, which are too complex in shape to permit a vacuum heat insulator to be stuck thereto, or for which it is important to ensure reliability for the vacuumheat insulator.

[0102] By using metallic foil films of high gas-barrier quality for both surface f ilms , which constitute a vacuum heat insulator, a vacuum heat insulator having a high reliability can be made use of even in the case where both surfaces of the vacuum heat insulator are put in contact with complex-shaped surfaces. Since the both surfaces are made of the same material, cost can be reduced. Further, since the both surfaces are made of the same material, there is no need of caring so as not to take a stuck surface of the vacuum heat insulator for another when the vacuum heat insulator is stuck to outer box 12 or inner box 11, so that the work is made easy.

[0103] Preferably, the inorganic fiber aggregate, which constitutes core material 92, has a fiber diameter in the range of 0.1 µm to 1. 0 µm to constitute a vacuum heat insulator having a thermal conductivity about one tenth as large as the thermal conductivity of rigid urethane foam 13. When the thermal conductivity of urethane foam 13 is 0.015 W/mK, the thermal conductivity of vacuum heat insulator 91 is 0.0015 W/mK. The thermal conductivity of vacuum heat insulator 91 may 0.0010 W/mK to 0.0030 W/mK depending upon selection of the fiber diameter of the inorganic fiber aggregate. That is, the thermal conductivity may be 1/15 to 1/5 as large as the of urethane foam 13. This is because the adiabatic performance as a composite-layer heat insulating wall serves effectively even when vacuum heat insulator 91 is decreased in thickness so as not to hinder flowability of urethane foam 13 in the case where the composite-layer heat insulating wall composed of urethane foam 13 and vacuum heat insulator 91 is relatively small in thickness. Further, this is because it is directed to having the energy-saving effect served in an expected manner by virtue of arranging a vacuum heat insulator also in locations, in which the wall thickness is relatively small, with a view to realizing a high coverage.

(Eleventh Exemplary Embodiment)

[0104] Fig. 27 is an enlarged, cross sectional view showing an essential part of a refrigerator according to an eleventh exemplary embodiment of the invention. The construction except the above part is the same as that according to the first exemplary embodiment.

[0105] In the figure, one surface of a covering of vacuum heat insulator 79 has film 80 including an aluminum deposit layer and the other surface thereof has film 81 having an aluminum foil. Film 80 is stuck to outer box 62. Sealed portions 82 of film 80 and film 81 are bent toward rigid urethane foam 75 to be arranged.

[0106] With such a constitution, film 80 having the aluminum deposit layer is lower in thermal conductivity but larger in gas permeability than film 81. Film 81 having the aluminum foil is lower in gas permeability but larger in thermal conductivity than film 80. Accordingly, when sealed portions 82 are bent toward film 81 susceptible to thermal conduction, that is, toward urethane foam 75, a heat transfer path to outer box 62 along film 81 is made long. A distance between sealed portions 82 and outer box 62 is increased. Thereby, heat transfer toward outer box 62 via the films is suppressed, thus enhancing the adiabatic quality.

[0107] While the above explanation is given with the use of the films having the aluminum deposit layer and the film having the aluminum metallic foil respectively, aluminum may be replaced by other metals.

[0108] While this embodiment is described on the basis of the first exemplary embodiment it can be constituted in combination with features, which are described in other embodiments. The embodiment may be combined with features, which are described in the following embodiments.

(Twelfth Exemplary Embodiment)

[0109] Fig. 28 is a view showing a transverse section of a refrigerator according to a twelfth exemplary embodiment of the present invention, and Fig. 29 is a view showing, in enlarged scale, a portion in the vicinity of a radiating pipe of the refrigerator. The fundamental construction except the above parts is the same as that according to the first exemplary embodiment or the ninth exemplary embodiment.

[0110] Radiating pipes 101 serving as a condenser, which constitutes a part of a refrigerating cycle, are arranged in contact with side surfaces or a back surface of outer box 12, and fixed to outer box 12 by aluminum tape 102 of good thermal conduction from upper surfaces thereof. Aluminum tape 102 also serves as a sealing material. Vacuum heat insulator 34 is arranged in a manner to cover radiating pipes 101. Aluminum tape 102 is also arranged to extend outside the refrigerator. With such a constitution, heat from radiating pipes 101 is surely shut off by vacuum heat insulator 34 to efficiently reduce an endothermic load into the refrigerator. Further, since aluminum tape 102 is arranged to extend outside the refrigerator, an air present between radiating pipes 101 and outer box 12 can freely move outside the refrigerator. Thereby, irregularities and warpage of surfaces of outer box 12, which are caused by thermal contraction of air, are suppressed, so that beauty in outward appearance is maintained. Further, the work of sticking of radiating pipes 101 can be easily done without caring for a quantity of air between radiating pipes 101 and outer box 12.

[0111] Further, aluminum tape 102 is preferably split midway, or formed with holes. Thereby, an air present between radiating pipes 101 and vacuum heat insulator 34 can freely move outside the refrigerator. Accordingly, irregularities and warpage of surfaces of outer box 12, which are caused by thermal contraction of air, are suppressed, so that beauty in outward appearance is maintained. Further, the work of sticking of radiating pipes 101 can be easily done without caring for a quantity of air between radiating pipes 101 and vacuum heat insulator 34.

[0112] It does not matter if radiating pipes 101 are beforehand assembled into vacuum heat insulator 34 and mounted on outer box 12 when radiating pipes 101 are to be installed. In this case, vacuum heat insulator 34 assembling radiating pipes 101 to a surface thereof in contact with outer box 12 is arranged inside outer box 12. With such a constitution, air gaps between radiating pipes 101 and vacuum heat insulator 34 can be made smaller than those in the case where radiating pipes 101 are fixed to an inside of outer box 12 before radiating pipes 101 are interposed between outer box 12 and vacuum heat insulator 34. Accordingly, irregularities and warpage of surfaces of outer box 12 are suppressed, so that it is possible to maintain beauty in outward appearance. Vacuum heat insulator 34 is enhanced in adiabatic effect, so that it is possible to enhance the effect of energy saving. Since it is possible to beforehand arrange radiating pipes 101 on vacuum heat insulator 34 to assemble the same thereinto, manufacture is facilitated.

[0113] With such a constitution, radiating pipes 101 are interposed between outer box 12 and vacuum heat insulator 34 to be assembled thereto, so that it is possible to surely shut off heat of radiating pipes 101 with vacuum heat insulator 34 to efficiently reduce an endothermic load into the refrigerator.

(Thirteenth Exemplary Embodiment)

[0114] Fig. 30 is a perspective view showing a state before a flat sheet for an outer box of a refrigerator according to a thirteenth exemplary embodiment of the invention is bent. The fundamental construction except the above part is the same as that according to the first exemplary embodiment or the ninth exemplary embodiment.

[0115] Radiating pipes 101 are arranged in contact with surface 107, which will make side surfaces of outer box 12, but radiating pipes 61 are not arranged on surface 106, which will make a roof surface. In other words, radiating pipes 101 are arranged on an inside of outer box 12 keeping from locations, which will correspond to the roof surface of the refrigerator. With such a constitution, heat of radiating pipes 101 is surely shut off by vacuum heat insulator 34, so that an endothermic load into the refrigerator is reduced. Since vacuum heat insulator 34 is superior to rigid urethane foam 13 in adiabatic performance, a quantity of heat absorbed in the refrigerator is reduced, so that it is possible to dispense with the provision of radiating pipes 101 onroof surface 106. Accordingly, vacuumheat insulator 32 can be easily stuck to the roof surface, thereby enabling heightening the energy-saving effect.

[0116] Absence of radiating pipes 101 on roof surface 106 makes radiating pipes 101 simple in configuration, thus enabling achieving an improvement in workability, reduction in manhour, and reduction in material cost. Further, absence of radiating pipes 101 on roof surface 106 makes it possible to have the radiating pipes serving also as ones for refrigerators, which are constructed otherwise.

(Fourteenth Exemplary Embodiment)

[0117] Fig. 31 is an enlarged view showing an essential part of a refrigerator according to a fourteenth exemplary embodiment of the invention. The fundamental construction except the essential part is the same as that according to the first exemplary embodiment or the ninth exemplary embodiment.

[0118] Vacuum heat insulator 34 is arranged in contact with outer box 12, and any margin for sealing of films is not provided on vacuum heat insulator 34 in a direction, in which urethane foam 13 flows. In other words, vacuum heat insulator 34 is arranged between outer box 12 and inner box 11 in a state, in which any margin for sealing of films, on vacuum heat insulator 34 is not positioned in the direction, in which urethane foam 13 flows. With such a constitution, stable flow is enabled without having vacuum heat insulator 34 hindering flow of urethane foam 13.

[0119] Further, urethane foam 13 is in a highly moist state when being poured between outer box 12 and inner box 11, and it does not contact directly with the margin for sealing of films, so that vacuum heat insulator 34 is not subjected to thermal stress and so prevented from being deteriorated.

[0120] Further, the margin for sealing of films is decreased, so that vacuum heat insulator 34 preserves a high gas-barrier quality.

(Fifteenth Exemplary Embodiment)

[0121] Fig. 32 is a cross sectional view showing an essential part of a refrigerator according to a fifteenth exemplary embodiment of the invention. The construction except the above part is the same as that according to the ninth exemplary embodiment.

[0122] Vacuum heat insulator 34A is preferentially arranged in locations, in which miscellaneous things such as defrosting-water pipe 112, wiring (not shown), etc. are present. That is, according to this embodiment, vacuum heat insulator 34A is arranged in locations, in which miscellaneous things (defrosting-water pipe 72, wiring, etc.) being apt to hinder flow of rigid urethane foam 13 are present, between outer box 12 and inner box 11. With such a constitution, vacuum heat insulator 34A effectively restricts an endothermic load in the refrigerator and so the energy-saving effect is heightened. The adiabatic performance is ensured by arranging vacuum heat insulator 34A in locations, in which miscellaneous things being apt to hinder flowability of urethane foam 13 are present.

[0123] Preferably, defrosting-water pipe 112 is preferably installed between vacuum heat insulator 34A and outer box 12. With such a constitution, vacuum heat insulator 34A keeps defrosting water warm to prevent the same from being cooled and frozen under the influence of temperature inside freezing rooms 18A, 19.

(Sixteenth Exemplary Embodiment)

[0124] Fig. 33 is a cross sectional view showing an essential part of a refrigerator according to a sixteenth exemplary embodiment of the invention. The construction except the above part is the same as that according to the first exemplary embodiment or the ninth exemplary embodiment.

[0125] According to this embodiment, protective members 113, which protect end surfaces of outer box 12, also serve as positioning members at the time of sticking of vacuum heat insulator 34. That is, protective members 113 provided on the end surfaces of outer box 12 so as to protect end surfaces of vacuum heat insulator 34 are used to position vacuum heat insulator 34. In this manner, protective members 113 on the end surfaces of outer box 12 and positioning members for vacuum heat insulator 34 are used in common to each other. Thereby, damage to vacuum heat insulator 34 at the time of assembly is prevented. Further, positioning at the time of sticking of vacuum heat insulator 34 is made easy to improve the workability.

[0126] Protective members 113 may be provided on a roof plate to protect end surfaces of vacuum heat insulator 32 and serve as positioning members at the time of assembly.

(Seventeenth Exemplary Embodiment)

[0127] Fig. 34 is a view showing a structure of a vacuum heat insulator applied to a refrigerator according to a seventeenth exemplary embodiment of the invention. Unlike core material 92 in the tenth exemplary embodiment, core material 121 is made of an inorganic fiber aggregate, which is formed by a binding agent to be plate-shaped. A material making the inorganic fiber aggregate is not specifically limitative but formed by using an organic or inorganic binding agent to form an inorganic fiber such as glass wool, ceramic fiber, rock wool, etc., in the form of a plate.

[0128] Gas-barrier film 122 is formed by sealed portions 123 to make a bag. An interior of gas-barrier film 122 is kept gas tight. Amaterial composition of the film is not specifically limitative. The film is composed in the same manner as, for example, deposited layer film 93 and metallic foil layer film 97 in the tenth exemplary embodiment. More specifically, one has a plastic laminate film, which includes an outermost layer of polyethylene terephthalate resin, an intermediate layer of aluminum foil, and an innermost layer of high-density polyethylene resin. The other has, for example, a plastic laminate film, which includes an outermost layer of polyethylene terephthalate resin, an intermediate layer of ethylene-vinyl alcohol copolymer resin having a deposited aluminum layer, and an innermost layer of high-density polyethylene resin. These are formed to make a bag.

[0129] A method of manufacturing a vacuum heat insulator has inserting a core material into gas-barrier film 122 in the form of a bag, vacuumizing an interior of the bag, and sealing an opening by fusing seal 124 to maintain the interior thereof vacuum.

[0130] Figs. 35 and 36 are a side, cross sectional view and a front, cross sectional view, respectively, showing the refrigerator according to this embodiment. The fundamental construction is the same as that according to the ninth exemplary embodiment, and vacuum heat insulators 34 arranged inside the outer box on the sides are extended to a cold storage region in Fig. 36. In place of vacuum heat insulators 34A arranged outside the inner box on the sides, vacuum heat insulators 34B are provided to be arranged in contact with inner box 11 on lower portions of sides of adiabatic box 10A corresponding to freezing room 19. Vacuum heat insulators 34 and vacuum heat insulators 34B are arranged with areas between opposed end surfaces thereof being positioned in the vicinity of an upper end surface of machine room 20. Lower ends of vacuum heat insulators 34 are positioned below upper ends of vacuum heat insulators 34B. Such a constitution serves the adiabatic effect on the side in the same manner as in the ninth exemplary embodiment. That is, positions, in which the lower ends of vacuum heat insulators 34 and the upper ends of the vacuum heat insulators arranged outside the inner box on the side overlap each other, are not limitative. Vacuum heat insulators 34, 34B are provided in a partitioning adiabatic section between machine room 20, in which compressor 21 is accommodated, and an interior of the refrigerator. The temperature inside the refrigerator is -20 °C in freezing room 19 and 40 to 50 °C in machine room 20. That is, vacuum heat insulators 34, 34B efficiently insulate a thick wall portion between machine room 20 and an interior of freezing room 19, between which temperature difference is relatively large. Further, in pouring rigid urethane foam 13 into adiabatic box 10A, it is common that a front opening of adiabatic box 10A is positioned downward. A raw liquid of urethane foam 13 is poured from urethane pouring ports in two locations substantially centrally in a heightwise direction of left and right back surfaces of adiabatic box 10A. Flow of urethane foam 13 thus foamed spreads in a sectorial manner about locations just below the urethane pouring ports in two locations. Urethane foam 13 finally reaches a roof surface and a bottom surface of adiabatic box 10A and constituent surfaces of machine room 20. According to this embodiment, vacuumheat insulator 36 having a high degree of flatness is arranged on the constituent surfaces of machine room 20, which urethane foam 13 finally reaches. Therefore, it is possible to surely ensure spatial dimensions in the vicinity of locations, which urethane foam 13 finally reaches, so that urethane foam 13 is enhanced in filling quality to enable ensuring a predetermined adiabatic performance.

[0131] Adiabatic box 10A is the same as that in the first exemplary embodiment with respect to adiabatic wall thickness and coverage relative to outer surfaces of refrigerator 10, and so an explanation therefor is omitted.

[0132] Vacuum heat insulators 32, 33, 34, 34B, 35, 36, 37, 38, 39, 40, and 41 are formed as described above by covering an inorganic fiber aggregate, which is formed from core material 121 with a binding agent to be plate-shaped, with gas-barrier film 122 and vacuumizing an interior thereof. The vacuum heat insulators together with urethane foam 13 construct adiabatic box 10A.

[0133] The vacuum heat insulator shown in Fig. 34 may be applied to other embodiments.

[0134] Vacuum heat insulators 34B, 35, and 36 may be made by beforehand molding core material 121 by a binding agent to follow a shape of surfaces in contact with inner box 11. By virtue of such molding, spatial layers (voids) are not produced on contact surfaces of inner box 11 and vacuum heat insulators 34B, 35, 36. Therefore, warpage of inner box 11 or the like is prevented, so that it is possible to heighten the quality in outward appearance.

[0135] Preferably, vacuum heat insulators 32, 33, 34, 34B, 35, 36, 37, 38, 39, 40, and 41 have a bend elastic constant of 40 to 64 MPa in a testing method in conformity with Japanese Industrial Standards JIS-K7221. The bend elastic constant is a ratio of a bending stress within a bending proportional limit to a corresponding strain. Since urethane foam 13 has a bend elastic constant of the order of 8 MPa, the vacuum heat insulators preferably have a bend elastic constant five to eight times that of the urethane foam.

[0136] TABLE 1 indicates results of strength tests on adiabatic boxes making use of vacuum heat insulators having different bend elastic constants. The tests are carried out such that displacements of uppermost portions of sides of adiabatic box 10A in a horizontal, longitudinal direction are measured when a food load of about 30 kg is accommodated in cold storage room door 27.

TABLE 1

	SAMPLE A	SAMPLE B	SAMPLE C
SPECIFICATIONS OF ADIABATIC BOX	ONLY RIGID URETHANE FOAM	VACUUM HEAT INSULATOR + RIGID URETHANE FOAM	VACUUM HEAT INSULATOR + RIGID URETHANE FOAM
BEND ELASTIC CONSTANT OF VACUUM HEAT INSULATOR	-	20 MPa	40 MPa
DEFORMATION OF SIDES OF ADIABATIC BOX	3 mm	4 mm	3 mm

[0137] The above results reveal that the strength of adiabatic box 10A is equal to or less than that of only a vacuum heat insulator (A) in the case where rigid urethane foam and a vacuum heat insulator having a bend elastic constant of the order of 40 MPa or less make a dual layer. This is because an adiabatic wall is not of a single structure but of a dual-layered structure to be decreased in bend elastic constant. A vacuum heat insulator having a bend elastic constant of 40 MPa or more is used to provide a dual-layered structure having a larger bend elastic constant than that of only rigid urethane foam. Since rigid urethane foam has a bend elastic constant of 8 MPa, the adiabatic box of dual-layered structure is made equal to or more in strength than that of the single structure by making the bend elastic constant of a vacuum heat insulator five times or more as large as that of the rigid urethane foam.

[0138] An increase of a vacuum heat insulator in bend elastic constant is realized by selecting a binding agent in forming an inorganic fiber aggregate of core material 121 into a plate configuration, or increasing an amount of use of such binding agent. Such measures lead to an increase in cost. Therefore, the bend elastic constant of a vacuum heat insulator has an upper limit of the order of 64 MPa in terms of cost performance. That is, when the bend elastic constant of a vacuum heat insulator is five times or more but eight times or less as large as that of rigid urethane foam, the strength of an adiabatic box of dual-layered structure can be made equal to or more than that of only rigid urethane foam while meeting with cost performance.

[0139] A vacuum heat insulator having such bend elastic constant is manufactured by covering an inorganic fiber aggregate, which is formed from core material 121 with a binding agent to be plate-shaped, with gas-barrier film 122 and vacuumizing an interior thereof. As compared with a vacuum heat insulator having a core material made of only an inorganic fiber aggregate, a vacuum heat insulator is increased in pressure capacity, bending strength, and flatness when an inorganic fiber aggregate is bonded and formed by a binding agent. Accordingly, in case of using such vacuum heat insulator, adiabatic box 10A is increased in strength. Such a vacuum heat insulator can be assembled into adiabatic box 10A with a high degree of flatness maintained, so that it is possible to surely ensure dimensions of a space, in which urethane foam 13 being formed inside adiabatic box 10A flows. Thereby, flowability is increased when urethane foam 13 is poured, urethane foam 13 is increased in filling ratio, and a predetermined adiabatic performance is obtained.

[0140] Since vacuum heat insulators 32, 33, 34, 34B, 35, 36, 37, 38, 39, 40, and 41 are enhanced in flatness, it is possible to eliminate spatial portions defined between them and surfaces, with which they contact directly via adhesives. As a result, the vacuum heat insulators are increased in adhesiveness to the bonded surfaces, so that it is possible to prevent coming-off and fall of vacuum heat insulators at the time of manufacture and assembly, which leads to enhancement in reliability and workability. Further, since the vacuum heat insulators are enhanced in flatness, surfaces of adiabatic box 10A in direct contact with them are also increased in flatness, and refrigerator 10 has a high quality in outward appearance.

[0141] Since the vacuum heat insulators are increased in strength, the vacuum heat insulators are easily taken out at the time of scrapping and disassembling after the use of an associated refrigerator, which leads to an improvement in recycling quality.

[0142] When vacuum heat insulators 32, 33, 34, 34B, 35, 36, 37, 38, 39, 40, and 41 are bonded and fixed to inner box 11, outer box 12 or outer plates of doors, adhesives are preferably coated on whole bond surfaces by means of a roller. As adhesives, hot melt made of, for example, rubber base materials are used.

[0143] TABLE 2 indicates results of adhesive strength tests on vacuum heat insulators and outer box 12 in the case where coating specifications of adhesives are changed. The tests are carried out such that 180-degrees peel adhesion is found in this test for test sheets set to 25 mm in width in conformity with Japanese Industrial Standards JIS-Z0237(8).

TABLE 2

	SAMPLE D	SAMPLE E
COATING SPECIFICATIONS OF ADHESIVES	WHOLE SURFACE COATING	LINEAR COATING OF 10 mm IN WIDTH (BOND-SURFACE AREA RATIO 40 %)
180° PEEL ADHESION (N/25 mm WIDTH)	30N	16N

[0144] Rubber base hot melt is used for adhesives, and stainless, to which polyethylene terephthalate was laminated, is used for test substrate. A coating thickness of adhesives is 30 μm, pressure at the time of bonding is 2 kg, and a roller is caused to reciprocate once. Ambient temperature in the test is 23 °C.

[0145] It is found from results in TABLE 2 that adhesive strength is increased to become substantially twice as large as that of SAMPLE E in the case where adhesives were linearly coated at predetermined intervals in conventional methods.

[0146] By doing in this manner, vacuum heat insulators 32, 33, 34, 34B, 35, 36, 37, 38, 39, 40, and 41 do not come off and fall in the manufacturing process. The vacuum heat insulators are firmly bonded and fixed to inner box 11 or outer box 12 whereby adiabatic box 10A is increased in strength. Owing to whole-surface coating of adhesives, no spaces are generated on bonded surfaces of the respective vacuum heat insulators and inner box 11 or outer box 12, and warpage is not generated on adiabatic box 10A, thus enabling heightening the quality in outward appearance.

[0147] Vacuum heat insulators 32, 33, 34, 38, 39, 40, and 41 are arranged in contact with outer box 12. Since the vacuum heat insulators having a high degree of flatness are arranged on outer box 12, which defines flat surfaces, and adhesives are applied to contact surfaces, no spatial layers (voids) are generated on contact surfaces of outer box 12 and the vacuum heat insulators. Thereby, warpage or the like is prevented from being generated on outer box 12, thus heightening the quality in outward appearance.

[0148] Since vacuum heat insulators 34B, 35, and 36 are arranged in contact with inner box 11, condensing of a foaming agent of urethane foam 13 disposed on a side of outer box 12 is suppressed to lead to an increase of adiabatic walls in adiabatic performance.

[0149] Vacuum heat insulators 33, 35, 34, 34B, and 36 are provided inside those adiabatic walls, which correspond to a freezing temperature zone. Thereby, adiabatic box 10A corresponding to a freezing temperature zone, which is relatively large in temperature difference relative to an outside of the refrigerator, can be efficiently heightened in adiabatic performance.

[0150] In order to heighten the adiabatic performance while ensuring an internal volume of adiabatic box 10A, it is important to ensure maximally a thickness of vacuum heat insulators on those adiabatic wall portions of adiabatic box 10A, which involve large temperature differences, while ensuring spaces, through which urethane foam 13 flows. According to this embodiment, since core material 121 is made of an inorganic fiber aggregate, which is formed by a binding agent to be plate-shaped, vacuum heat insulators 33, 35, 34, 34B, and 36 have a high degree of flatness. Accordingly, thicknesses of vacuum heat insulators 33, 35, 34, 34B, 36 can be ensured maximally on those adiabatic wall portions of freezing rooms 18A, 19, which involve large temperature differences, while ensuring dimensions of spaces,
in which urethane foam 13 flows. Accordingly, it is possible to provide a refrigerator having a high adiabatic performance.

[0151] Vacuum heat insulators 38, 39, 40, and 41 are provided on the outer plates inside those adiabatic walls, which constitute respective doors 27, 28, 29, 30 provided on openings on a front surface of the refrigerator. In this manner, vacuum heat insulators 38, 39, 40, 41 having a high degree of flatness are provided on those outer plates, which constitute respective doors 27, 28, 29, 30, whereby no spatial layers (voids) are generated on contact surfaces of the outer plates of the respective doors and the respective vacuum heat insulators. Therefore, warpage or the like is prevented from being generated on outer box 12, thus heightening the quality in outward appearance.

[0152] According to this embodiment, hydrocarbon, for example, cyclopentane is used as a foaming agent for urethane foam 13. This leads to global environmental protection and prevention of warming as compared with conventional chlorofluorocarbon base foaming agents. Since the vacuum heat insulators are made of a noncombustible inorganic fiber aggregate, safety is high even in case of using a combustible hydrocarbon base foaming agent. The high adiabatic performance of the vacuum heat insulators compensate for degradation in adiabatic performance due to application of hydrocarbon base foaming agents, thus heightening the adiabatic performance of the adiabatic box.

[0153] According to this embodiment, hydrocarbon, for example, isobutane, being a combustible natural refrigerant is used for a refrigerant in a refrigerating cycle composed of compressor 21, condenser 26, refrigerating cooler 22, and freezing cooler 24. Thereby, this leads to global environmental protection and prevention of warming as compared with conventional chlorofluorocarbon base refrigerants. Since vacuum heat insulators are made of a noncombustible inorganic fiber aggregate, safety is high even in case of using hydrocarbon being a combustible refrigerant.

[0154] It is described in the refrigerator according to the present embodiment that the vacuum heat insulators are fixed in contact with inner box 11, outer box 12, or outer plates of the respective doors and urethane foam 13 is foamed in spaces therein. However, the vacuum heat insulators may be arranged intermediate between inner box 11 and outer box 12 and urethane foam 13 may be foamed in the spaces therebetween as in the first exemplary embodiment. In this case, core material 121 of the vacuum heat insulators is made of an inorganic fiber aggregate, which is formed by a binding agent to be plate-shaped, and the vacuumheat insulators have ahighdegree of flatness. Therefore, it is possible to ensure dimensions of spaces between inner box 11 or outer box 12 and the vacuum heat insulators with high accuracy, so that urethane foam 13 can be surely filled. Because of no direct contact with inner box 11 and outer box 12, adiabatic box 10A is not marred in outward appearance. Since the vacuum heat insulators are arranged intermediate between inner box 11 and outer box 12 and surrounded circumferentially by urethane foam 13, fixation of the vacuum heat insulators by means of adhesives or the like is unnecessary.

[0155] Vacuum heat insulators, in which core material 121 is beforehand formed by a binding agent to be L-shaped, may be arranged on corner portions of a roof surface and side surfaces of refrigerator 10. In this case, the coverage of the vacuum heat insulators relative to adiabatic box 10A can be further increased. Adiabatic box 10A can be efficiently increased in strength by arranging vacuum heat insulators of high bending strength on corner portions of adiabatic box 10A.

[0156] It is described in this embodiment that vacuum heat insulators 38, 39, 40, and 41 being arranged inside respective doors 27, 28, 29, 30 disposed on the openings on the front surface of refrigerator 10 contact with outer plates of the respective doors. However, vacuum heat insulators 38, 39, 40, 41 may be arranged in portions of the respective doors intermediate between the inner box and the outer plates and urethane foam 13 may be filled in the spaces in the same manner as in the first exemplary embodiment. In this case, vacuum heat insulators 38, 39, 40, and 41 have a high degree of flatness, dimensions of spaces, into which urethane foam 13 is filled, can be surely ensured, and urethane foam 13 is surely filled. Since the outer plates and vacuum heat insulators 38, 39, 40, 41 do not contact directly with each other, it is possible to further suppress deformation of surfaces of the outer plates of the respective doors.

(Eighteenth Exemplary Embodiment)

[0157] Fig. 37 is a circuit diagram of a refrigerating cycle of a refrigerator according to an eighteenth exemplary embodiment of the present invention. The construction except the refrigerating cycle is the same as that according to the first exemplary embodiment. An explanation will be given below with reference to Figs. 37 and 2.

[0158] Refrigerant discharge port 138A of compressor 138 is connected through condenser 139 to an inlet of three-way switching valve 140, which constitutes a flow-passage switching portion. One of outlets of switching valve 140 is connected through freezing capillary 141 to an inlet of evaporator 136 for the freezing room(referred below to as evaporator 136). An outlet of evaporator 136 is connected through accumulator 142 to an inlet of check valve 143. An outlet of check valve 143 is connected to refrigerant inflow inlet 138B of compressor 138. Another outlet of switching valve 140 is connected through cold storage capillary 144 to an inlet of evaporator 134 for the cold storage room(referred below to as evaporator 134). An outlet of evaporator 134 is connected to the outlet of check valve 143. That is, evaporator 134 and evaporator 136 are connected in parallel according to compressor 138, and the outlet of evaporator 136 is connected through check valve 143 to the outlet of evaporator 134.

[0159] An outline of an action and an effect thereof in the above constitution is illustrated as follows. First, in a state, in which compressor 138 is driven, switching valve 140 switches over a refrigerant flow passage so that a refrigerant discharged from compressor 138 flows to evaporator 134 for the cold storage room. That is, a state indicated by a broken line arrow 150 in Fig. 37 turns up. Subsequently, this state is called a cold storage mode. In the cold storage mode, the refrigerant discharged from compressor 138 undergoes a known phase change and thereafter is fed to evaporator 134 to cool an air around evaporator 134. Evaporator 134 shown in Fig. 37 corresponds to cooler 22 shown in Fig. 2. At this time, an air cooled by evaporator 134 is fed to cold storage room 15 and vegetable room 16 by virtue of the blasting action of refrigerating fan 23 to cool cold storage room 15 and vegetable room 16.

[0160] The refrigerant flow passage is switched over so that the refrigerant discharged from compressor 138 by switching valve 140 in a state, in which compressor 138 is driven, flows to evaporator 136. That is, a state indicated by a solid line arrow 151 in Fig. 37 is brought about. Subsequently, this state is called a freezing mode. In the freezing mode, the refrigerant discharged from compressor 138 undergoes a known phase change and thereafter is fed to evaporator 136 to cool an air around evaporator 136. Evaporator 136 shown in Fig. 37 corresponds to cooler 24 shown in Fig. 2. At this time, the air cooled by evaporator 136 is fed to changeover room 17, ice making room 18, and freezing room 19 by virtue of the blasting action of freezing fan 25.

[0161] In this manner, a cold storage temperature zone space composed of cold storage room 15 and vegetable room 16 and a freezing temperature zone space composed of changeover room 17, ice making room 18, and freezing room 19, respectively, are cooled independently. Therefore, evaporator 14 maintains a cooling temperature of the order of -5 °C and evaporator 16 maintains a cooling temperature of the order of -25 °C whereby temperatures in the rooms to be suited to respective cooling spaces are efficiently provided. Accordingly, the energy-saving effect is heightened. Since the cold storage temperature zone space and the freezing temperature zone space are cooled independently in a time-sharing manner, a quantity of heat, which should be removed at a time, is decreased. Therefore, condenser 139 is decreased in quantity of heat as radiated. As a result, a volume for piping in the circuit diagram of the refrigerating cycle is decreased to some extent. Accordingly, in case of using a hydrocarbon base natural refrigerant for the refrigerant, the danger of ignition at the time of refrigerant leakage is suppressed to some degree.

[0162] Further, in the case where compressor 18 is stopped in a state, in which both the cold storage temperature zone space and the freezing temperature zone space is cooled to preset temperatures, compressor 138 is stopped in a state of the cold storage mode. In the cold storage mode, switching valve 140 acts to put refrigerant discharge port 138A of compressor 138 and the inlet of evaporator 134 in a communicated state, and refrigerant discharge port 138A and the inlet of evaporator 136 are shut off therebetween. When compressor 138 is stopped in this state, there is no inflow into evaporator 136 from a high-pressure side typified by condenser 139. Further, check valve 143 acts to prevent the refrigerant from counterflowing to evaporator 136 from evaporator 134. Accordingly, the refrigerant at low temperature is held in evaporator 136, so that evaporator 136 is prevented from rising in temperature unnecessarily. Thereby, loss in energy in the refrigerating cycle is further decreased, so that the effect of energy saving is enhanced.

[0163] Conventional refrigerators generally use R134a as a refrigerant. On the other hand, the refrigerator according to this embodiment can use R600a isobutane as a hydrocarbon base natural refrigerant in the same manner as in the seventeenth exemplary embodiment.

[0164] With the above constitution, an endothermic quantity of the whole refrigerator is sharply reduced as compared with the case where thermal insulation of refrigerator 10 and doors 27, 28, 29, 30, 31 is achieved only by rigid urethane foam 13. As a result, the effect of energy saving resulted from reduction in endothermic quantity of the box is produced. Further, temperature fluctuation with time in the room under suspension is decreased also in the case where the cold storage temperature zone space and the freezing temperature zone space are alternately cooled by the parallel switchover system. That is, the parallel switchover system can enhance the cooling efficiency and heighten the effect of energy saving as well as heighten the freshness preserving quality of food.

[0165] By using the vacuum heat insulators to decrease the endothermic quantity of the box, a quantity of heat, which should be removed at a time, and a corresponding quantity of released heat are decreased as compared with the case where thermal insulation of the box is achieved only by rigid urethane foam. Therefore, the volume for piping is decreased. With conventional adiabatic boxes with rigid urethane foam, a radiation piping (not shown), which constitutes a part of condenser 139, is embedded in rigid urethane foam with a view to preventing dew condensation on surfaces of the refrigerator. According to the present embodiment, by using vacuum heat insulators for those portions, which possible undergo dew condensation, a radiation piping designed for prevention of dew condensation is made unnecessary. Therefore, the volume for piping is sharply decreased as a whole. As a result, an amount of refrigerant required for cooling is sharply reduced, so that in case of using a combustible hydrocarbon base natural refrigerant, the danger of ignition is exceedingly reduced even if the refrigerant should leak.

[0166] While the effect described above is obtained even in the case where compressor 138 is of constant revolution type, it is preferable to use a compressor of variable revolution type as compressor 138 to constitute a refrigerating cycle. With such a constitution, a difference between a static endothermic load when the box is stabilized by the use of vacuum heat insulators, and a maximum load when doors are opened and closed and food load is charged into rooms can be controlled by the number of revolutions of the compressor. It is necessary in a compressor of constant revolution type to ensure an excessive cylinder volume in conformity with a maximum load, and time, during which the compressor is stopped, is increased when the compressor is stable, so that temperature fluctuation in rooms with time becomes considerable. On the other hand, when a compressor of variable revolution type are applied, such loss in effect of energy saving is decreased and temperature fluctuation in rooms with time is suppressed. Since the cylinder volume is made small, design with a further less amount of refrigerant is made possible. Therefore, even in the case where a combustible hydrocarbon base refrigerant should leak outside the cooling system, the danger involved in the combustible refrigerant is exceedingly reduced.

[0167] Coverage of vacuum heat insulators and design of adiabatic wall thickness of a refrigerator are the same as those in the other embodiments, and so an explanation therefor is omitted.

[0168] Fig. 38 is a view showing a structure of a vacuum heat insulator. The fundamental construction is the same as that according to the tenth exemplary embodiment. In Fig. 38, core material 145 is made of an inorganic fiber aggregate 145 of glass wool or the like. The vacuum heat insulator is formed by inserting core material 145 into a covering, in which metallic foil layer film 146A and deposited layer film 146B are stuck together, vacuumizing an interior of the covering, and sealing an opening. Since materials for and coefficients of thermal conductivity of core material 145 and films 146A, 146B are the same as those according to the tenth exemplary embodiment, an explanation therefor is omitted.

[0169] With such a constitution, there is obtained a vacuum heat insulator having an adiabatic performance about ten times as large as that of rigid urethane foam. Therefore, the effect of reduction in endothermic quantity of the box is sharply heightened in case of using vacuum heat insulators. As a result, the effect of energy saving is sharply enhanced, temperature fluctuation in rooms with time is decreased even in case of using a parallel switchover system, and the freshness preserving quality of food is improved. Owing to further reduction in endothermic quantity, a necessary amount of refrigerant is restricted to be further small, and a possible danger at the time of leakage of a refrigerant is further decreased even when combustible isobutane is used as the refrigerant. The inorganic fiber aggregate used for core material 145 is flame-retardant, so that safety in the case where refrigerator 10 would be ignited is enhanced as compared with a constitution composed only of rigid urethane foam.

[0170] Fig. 39 is a schematic view showing avacuumheat insulator. Thickness 149 of the vacuum heat insulator is 15 mm. That is, the vacuum heat insulator is arranged in a state, in which a surface defined by two sides 147, 148 is oriented in a direction perpendicular to a direction, in which heat being insulated passes. Here, sides 147, 148 preferably have lengths of 200 mm or longer. With such a constitution, the following effect is produced.

[0171] Both gas-barrier films 146A, 146B, which constitute the covering of the vacuum heat insulator, have a metallic film layer, so that a so-called heat bridging phenomenon due to heat transfer occurs. Therefore, when sides 147, 148 defining a covered area of the vacuum heat insulator are too small in length, it is not possible to bring out the primary adiabatic performance of the vacuum heat insulator, so that the adiabatic effect is decreased relative to an amount of vacuum heat insulator as used. On the other hand, sides 147, 148 having lengths of 200 mm or longer make it possible to bring out the primary adiabatic performance of the vacuum heat insulator. That is, it has been confirmed by experiments that heat leakage is suppressed by heat bridge. Based on the above, the primary adiabatic performance of the vacuum heat insulator can be brought out by making lengths of two sides, except one in a thicknesswise direction, among three sides, which define the vacuum heat insulator, 200 mm or longer. As a result, the vacuum heat insulator is made use of in a state of high cost performance, so that the entire refrigerator is effectively reduced in endothermic quantity. As a result, it is possible to further enhance the effect of energy saving, the improved freshness preserving quality of food owing to reduction of temperature fluctuation in rooms with time, and the danger decreasing effect at the time of leakage of a refrigerant produced by lessening of a refrigerant, in the embodiments described above.

[0172] While thickness 149 of the vacuum heat insulator is made 15 mm, an appropriate adiabatic performance is served in the range of around 5 to 20 mm without the possibility of hindering the foaming and filling quality of urethane foam 13.

[0173] The present embodiment is the same as the first exemplary embodiment except the configuration of the refrigerating cycle and dimensions of the vacuumheat insulator. Such a configuration is effective in application to those in the other embodiments.

[0174] While the embodiments of the invention have been described above, a refrigerator, which is good in attractiveness and excellent in adiabatic performance, can be obtained in all the embodiments. The configuration peculiar to the respective embodiments can be embodied in combination with the remaining embodiments if possible, and such combination falls under the category of the invention.

Industrial Applicability

[0175] According to the present invention, a refrigerator having resin foam and a vacuum heat insulator between an outer box and an inner box adopts any one of the following constitutions whereby it is possible to provide a refrigerator having an outward appearance, which is good in attractiveness, and effecting an efficient heat insulation.

(1) An outer surface of an outer box, on which the vacuum heat insulator is arranged, is set to have a center line average roughness (Ra) of 0.1 μm or more. Alternatively, the outer surface of the outer box is set to have a glossiness of 80 or less.
(2) The Vacuum heat insulator being arranged on a door, which constitute a front surface, is stuck to an inner plate of the door.
(3) An intermediate member is provided between the vacuum heat insulator and the outer box to prevent deformation of the outer surface of the outer box.
(4) A radiating pipe is provided between the vacuum heat insulator and the outer box, and an air gap defined by the vacuum heat insulator and the radiating pipe is made to be communicated to outside.
(5) Small hole is provided on the outer box, on the surface of which is provided the vacuum heat insulator.
(6) A machine room is provided in a lower portion, and the vacuum heat insulators are arranged on both side surfaces of an upper portion, a roof surface, a back surface, and a front surface of a refrigerator to contact with

the outer box, and on a bottom surface and both side surfaces of the lower portion of the refrigerator, and surfaces, which define the machine room, to contact with an inner box.

(7) The vacuum heat insulator having a radiating pipe assembled into a surface thereof, which contact with the outer box, is arranged inside the outer box.

Claims

1. A refrigerator comprising:

   an outer box,
   an inner box, and
   resin foam and a vacuum heat insulator between the outer box and the inner box;

   wherein the vacuum heat insulator is arranged in contact with the outer box, and an outer surface of the outer box, on which the vacuum heat insulator is arranged, adopt one of the following configurations,

   A) a center line average roughness (Ra) of 0.1 μm or more, and
   B) a glossiness of 80 or less.

2. A refrigerator comprising:

   an outer box,
   an inner box,
   resin foam and a vacuum heat insulator between the outer box and the inner box, and
   a door defining a front surface, the door having an inner plate;

   wherein the vacuum heat insulator arranged on the door are stuck to the inner plate of the door.

3. The refrigerator according to claim 2, wherein the vacuum heat insulator arranged on the door is stuck to forefront portion of the inner plate of the door.

4. A refrigerator comprising:

   an outer box,
   an inner box,
   resin foam and a vacuum heat insulator between the outer box and the inner box, and
   an intermediate member provided between the vacuum heat insulator and the outer box to prevent deformation of an outer surface of the outer box.

5. The refrigerator according to claim 4, wherein the intermediate member is larger than the vacuum heat insulator.

6. The refrigerator according to claim 4, wherein the intermediate member is made of a soft member softer than the vacuum heat insulator.

7. The refrigerator according to claim 6, wherein the soft member is made of resin foam.

8. The refrigerator according to claim 6, wherein the soft member comprises independent foam.

9. The refrigerator according to claim 6, wherein the soft member has a thickness of at least the flatness of the vacuum heat insulator and at most the thickness of the vacuum heat insulator.

10. The refrigerator according to claim 4, wherein the intermediate member is made of a hard member harder than the vacuum heat insulator.

11. The refrigerator according to claim 4, wherein the intermediate member comprises a hard member harder than the vacuum heat insulator and a soft member softer than the vacuum heat insulator.

12. The refrigerator according to claim 11, wherein the hard member and the soft member in the intermediate member are arranged in this order from a side of the outer box.

13. A refrigerator comprising:

an outer box,
an inner box,
resin foam and a vacuum heat insulator between the outer box and the inner box, and
a radiating pipe provided between the vacuum heat insulator and the outer box;

wherein an air gap defined between the vacuum heat insulator and the radiating pipe is communicated to outside the refrigerator.

14. The refrigerator according to claim 13, a flat surface of the vacuum heat insulator opposed to the radiating pipe is provided with a groove.

15. The refrigerator according to claim 13, further comprising a fixing member to fix thereto the radiating pipe;
wherein the fixing member has one end thereof positioned outside the refrigerator and the other end thereof positioned inside end of the vacuum heat insulator.

16. A refrigerator comprising:

an outer box,
an inner box,
resin foam and a vacuum heat insulator between the outer box and the inner box;

wherein the vacuum heat insulator is arranged on the outer box, and a surface of the outer box on which the vacuum heat insulator are arranged are provided with a small hole.

17. A refrigerator comprising:

an outer box,
an inner box,
resin foam and vacuum heat insulators between the outer box and the inner box, and
a machine room in a lower portion;

wherein the vacuum heat insulators are arranged on both side surfaces of an upper portion, a roof surface, a back surface, and a front surface to contact with the outer box, and on a bottom surface, both side surfaces of the lower portion, and surfaces which define the machine room to contact with an inner box.

18. The refrigerator according to claim 17, wherein whole surfaces of the vacuum heat insulators arranged in contact with the inner box, which contact with the inner box, contact with respective surfaces of the inner box with which the vacuum heat insulator are arranged in contact.

19. The refrigerator according to claim 17, wherein surfaces of the inner box with which the vacuum heat insulators are arranged in contact, has a step in contact with an outer peripheral end surface of each of the vacuum heat insulators arranged in contact with the inner box.

20. The refrigerator according to claim 17, further comprising

a cooler, and
a heat insulator formed at an upper surface thereof with an inclined configuration and having a flat lower surface in close contact with the inner box, the heat insulator being provided below the cooler.

21. The refrigerator according to claim 17, further comprising cooler;
wherein the inner box has an inclined portion disposed below the cooler, and a heat insulator is disposed for filling up a gap defined between the inclined portion and the vacuum heat insulator arranged in contact with the inner box.

22. The refrigerator according to claim 17, wherein the inner box has a back surface provided with an air vent hole for the resin foam.

23. The refrigerator according to claim 17, wherein lower ends of the vacuum heat insulators arranged in contact with the outer box on both upper side surfaces of the refrigerator are positioned to be lower than upper ends of the vacuum heat insulators arranged in contact with the inner box on both lower side surfaces of the refrigerator.

24. The refrigerator according to claim 17, wherein the vacuum heat insulators has a first surface composed of metal deposited layer film and a second surface composed of film including a metallic foil, and a sealed surface at which respective outer peripheral portions of the first surface and the second surface are sealed, is disposed in the same plane as the first surface.

25. The refrigerator according to claim 24, wherein the first surface is arranged in contact with an inside of the outer box.

26. The refrigerator according to claim 24, wherein the first surface is arranged in contact with an outside of the inner box.

27. The refrigerator according to claim 13, further comprising a sealing material for fixing the radiating pipe to an inside of the outer box and is extended to outside the refrigerator.

28. The refrigerator according to claim 27, wherein the sealing material is at least either split or provided with a hole.

29. The refrigerator according to claim 27 , wherein the radiating pipe is arranged on an inside of the outer box keeping from a roof surface of the refrigerator.

30. A refrigerator comprising:

an outer box,
an inner box,
resin foam and a vacuum heat insulator between the outer box and the inner box, and
a radiating pipe assembled into the vacuum heat insulator arranged inside the outer box.

31. The refrigerator according to any one of claims 1, 2, 4, 13, 16, 17 and 30,
wherein both surfaces of the vacuum heat insulator are composed of film having a metallic foil.

32. The refrigerator according to any one of claims 1, 2, 4, 13, 16, 17 and 30,
wherein the vacuum heat insulator has a film sealing margin, the film sealing margin being arranged in a direction except a direction in which the resin foam flows.

33. The refrigerator according to any one of claims 1, 2, 4, 13, 16, 17 and 30,
wherein the vacuum heat insulator has a core material containing an inorganic fiber aggregate, which is formed by a binding agent to be plate-shaped, and a gas-barrier film to cover the core material.

34. The refrigerator according to any one of claims 1, 2, 4, 13, 16, 17 and 30, further comprising an adhesive coated on whole surfaces, at which the vacuum heat insulator and one of the inner box and the outer box contact with each other.

35. The refrigerator according to any one of claims 1, 2, 4, 13, 16, 17 and 30,
wherein a foaming agent for the resin foam contains hydrocarbon.

36. The refrigerator according to any one of claims 1, 2, 4, 13, 16, 17 and 30 further comprising:

at least one of a cold storage room and a freezing room within the inner box,
a cooler to cool at least of one of the cold storage room and the freezing room, and
a refrigerant used for the cooler and composed of hydrocarbon.

37. The refrigerator according to any one of claims 1, 2, 4, 13, 16, 17 and 30, further comprising:

a first evaporator to cool a cold storage room within the inner box,
a second evaporator connected in parallel to the first evaporator to cool a freezing room within the inner box,
a refrigerant flow passage switchover section to switch over a flow passage to one of the first evaporator and the second evaporator, and
a compressor to discharge a refrigerant to the refrigerant flow passage switchover section.

38. The refrigerator according to claim 37, wherein the compressor is variable revolution type.

39. The refrigerator according to any one of claims 1, 2, 4, 13, 16, 17 and 30 further comprising a defrosting-water pipe arranged between the outer box and the inner box,
wherein the vacuum heat insulator is arranged between the defrosting-water pipe and the inner box.

40. The refrigerator according to any one of claims 1, 2, 4, 13, 16, 17 and 30, further comprising a miscellaneous thing to hinder flow of the resin foam between the outer box and the inner box,
wherein the vacuum heat insulator is arranged in locations in which the miscellaneous thing is present.

FIG. 1

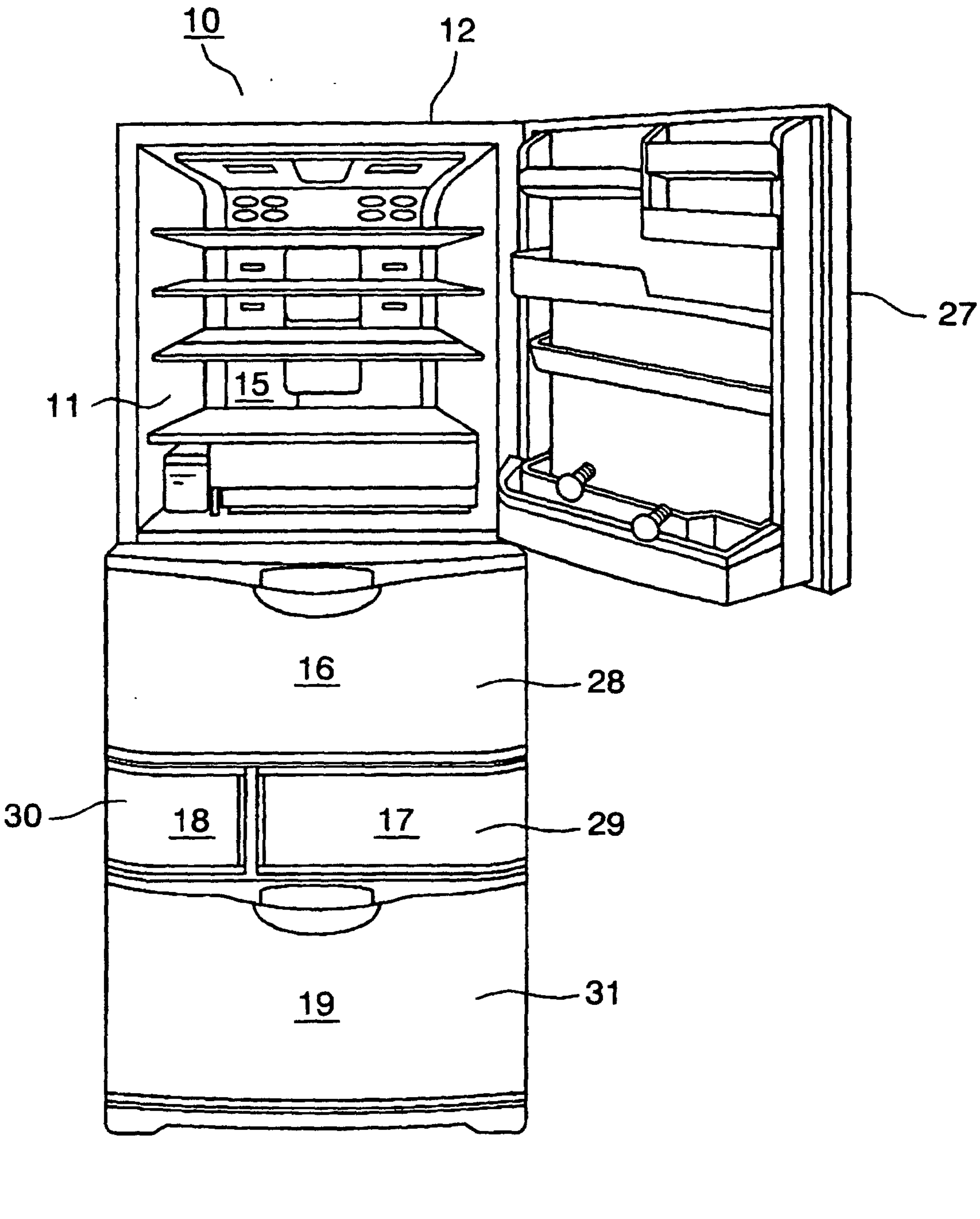

FIG. 2

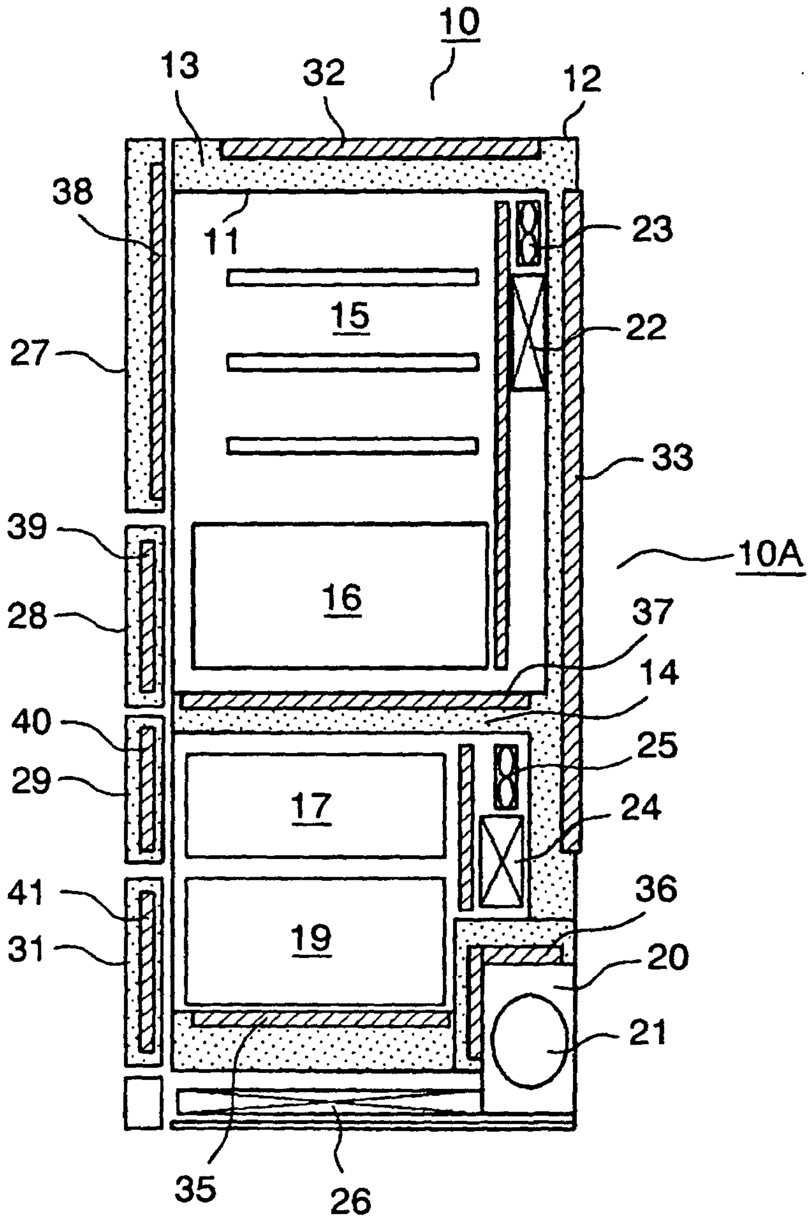
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FIG. 3

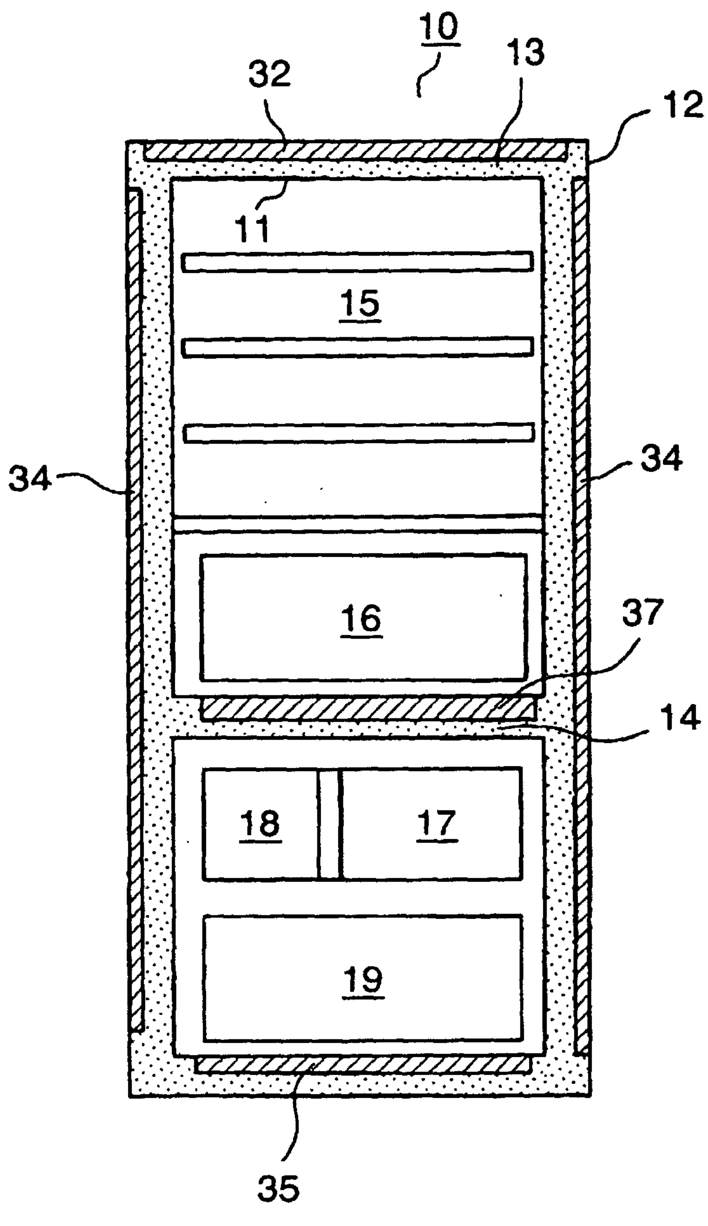

FIG. 4

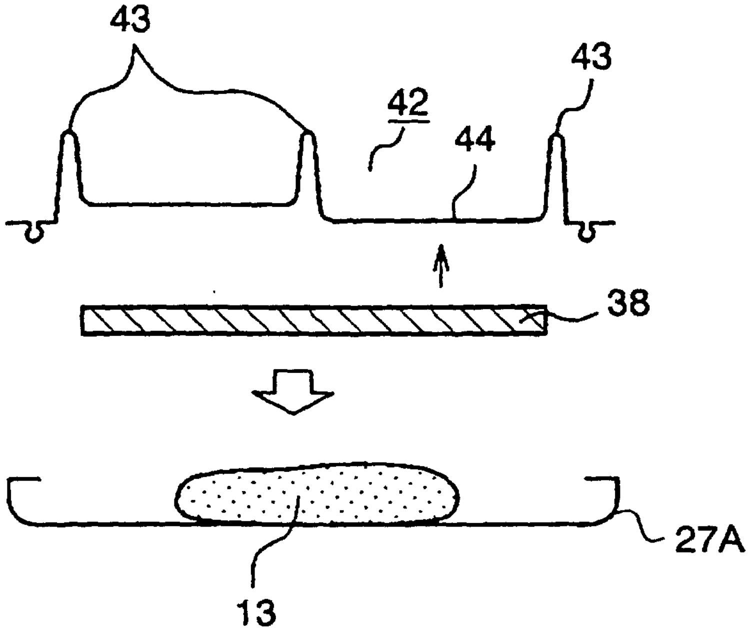

FIG. 5

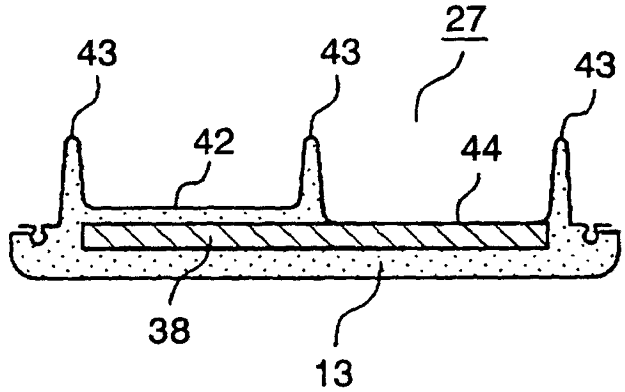

FIG. 6

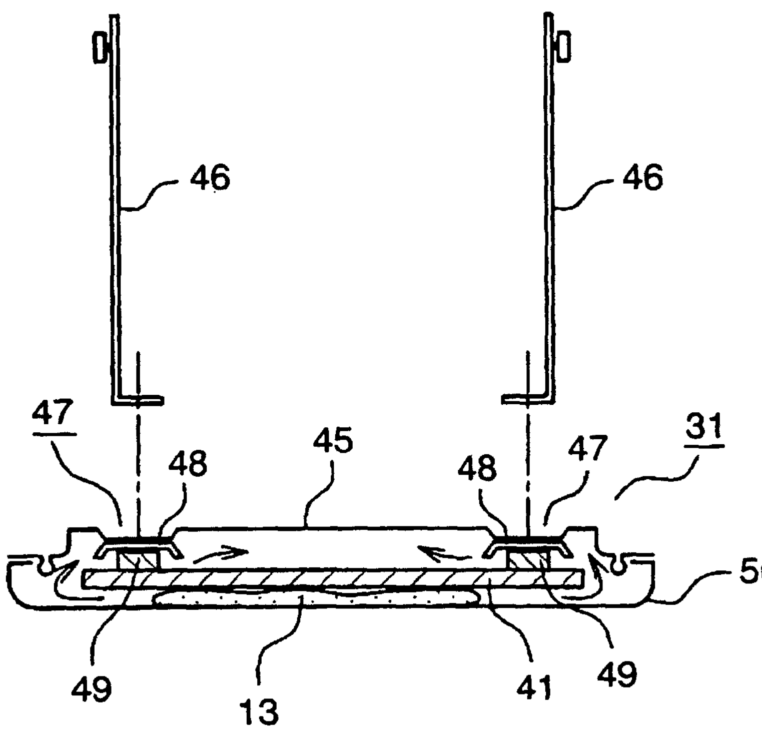

FIG. 7

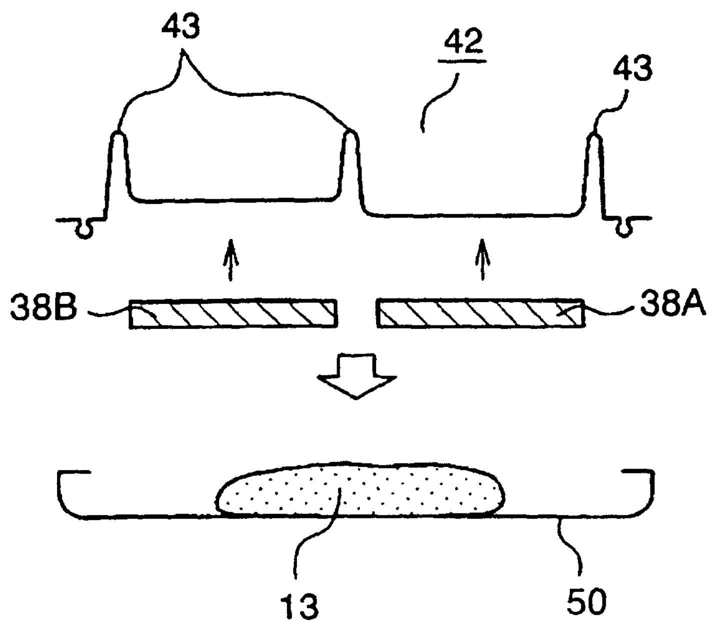

FIG. 8

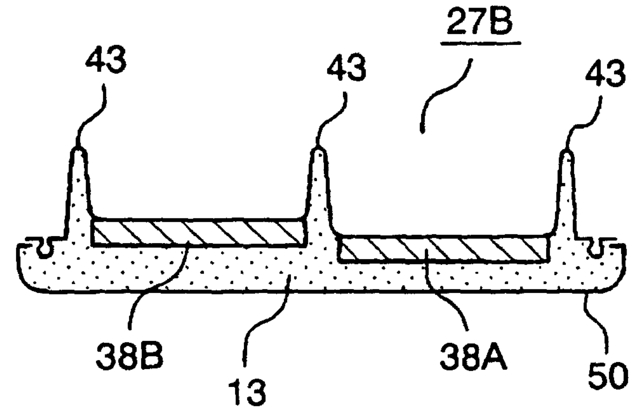

FIG. 9

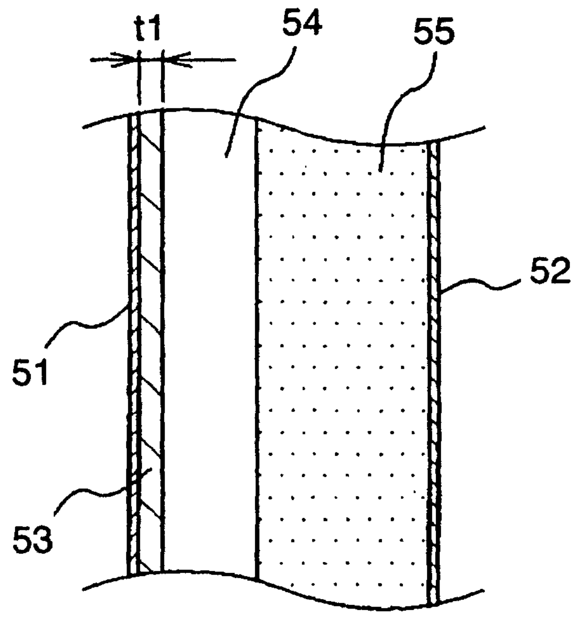

FIG. 10

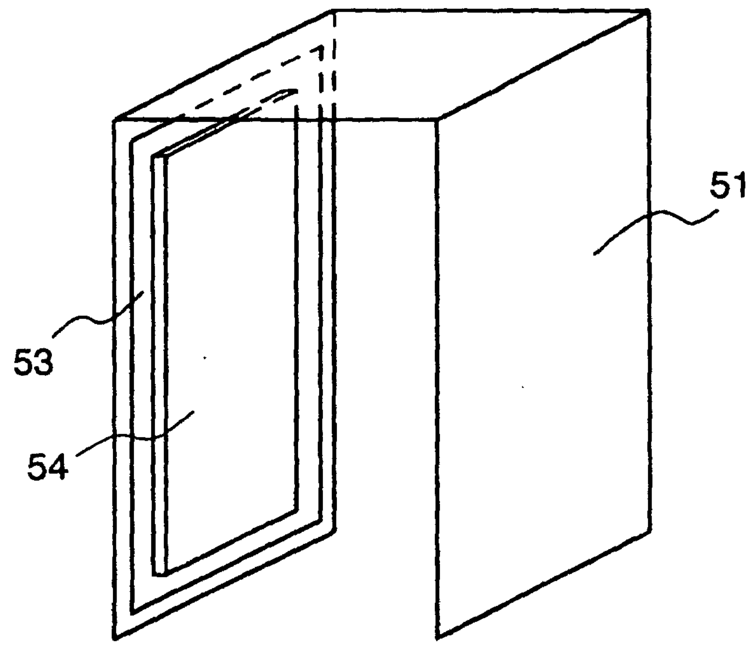

FIG. 11

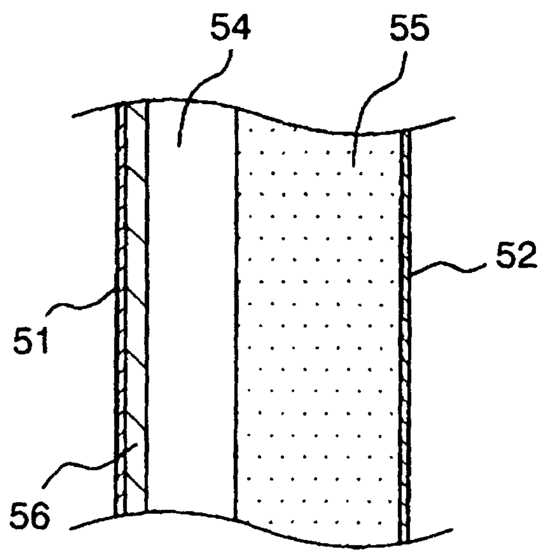

FIG. 12

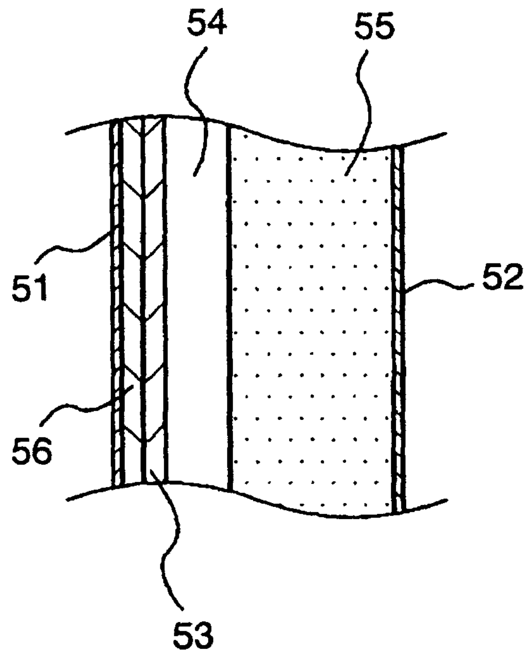

FIG. 13

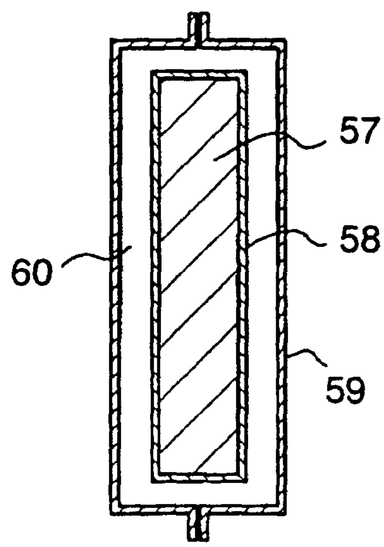

FIG. 14

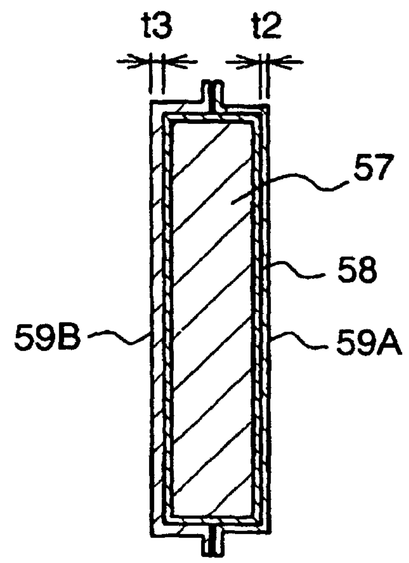

FIG. 15

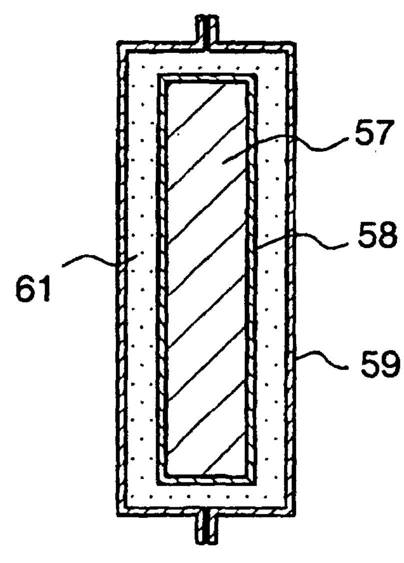

FIG. 16

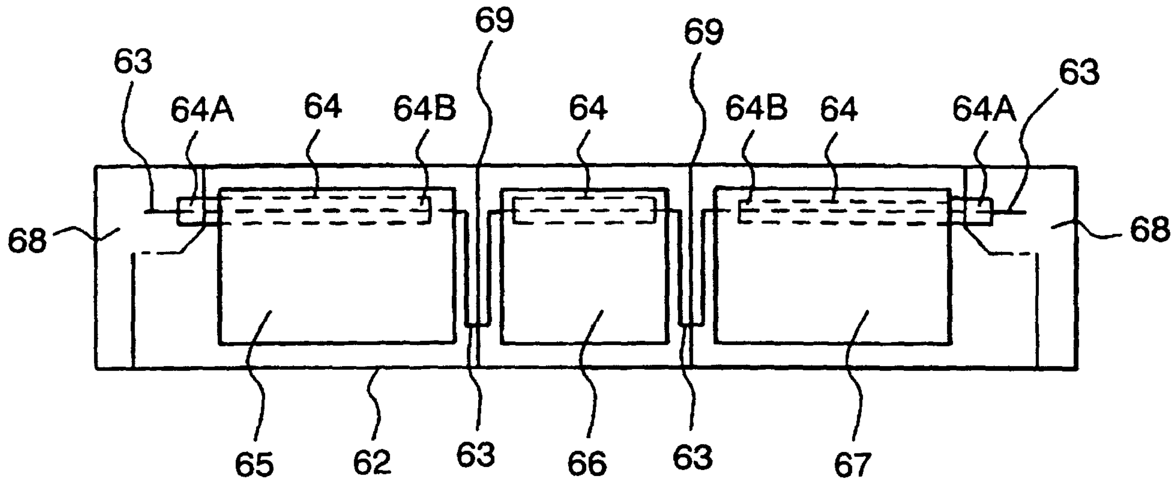
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FIG. 17

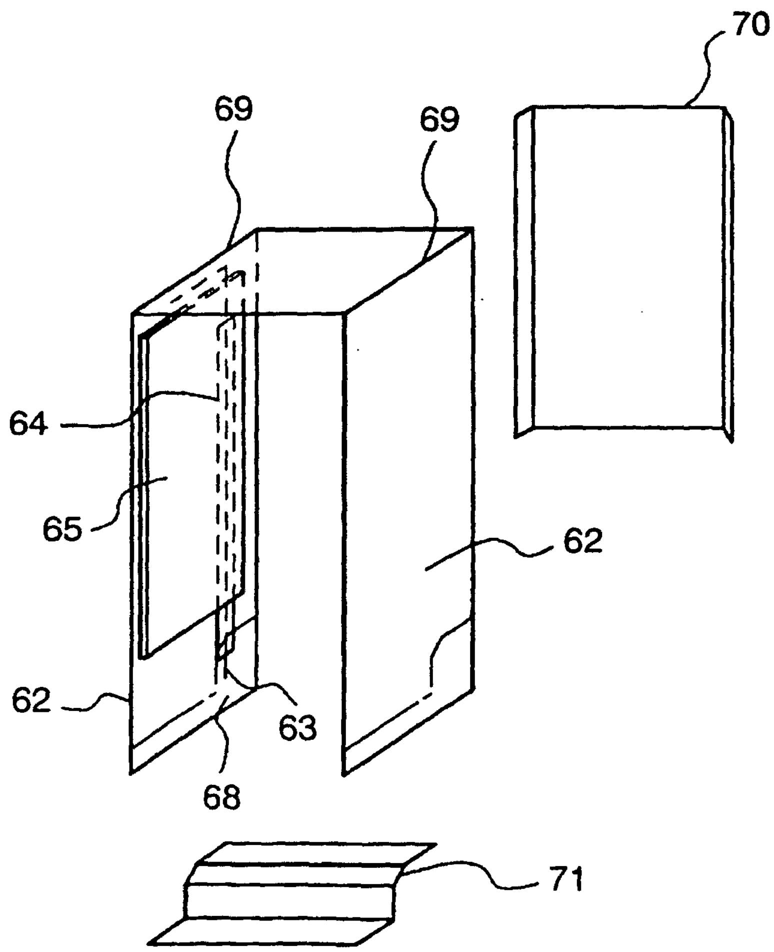
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FIG. 18

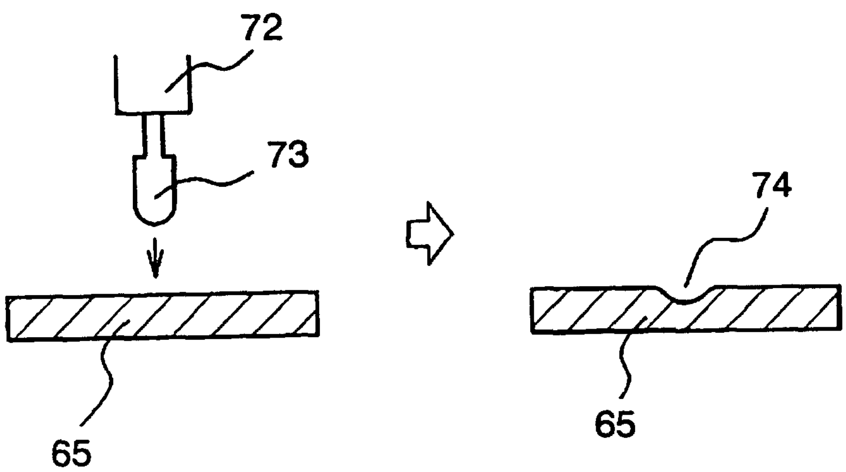

FIG. 19

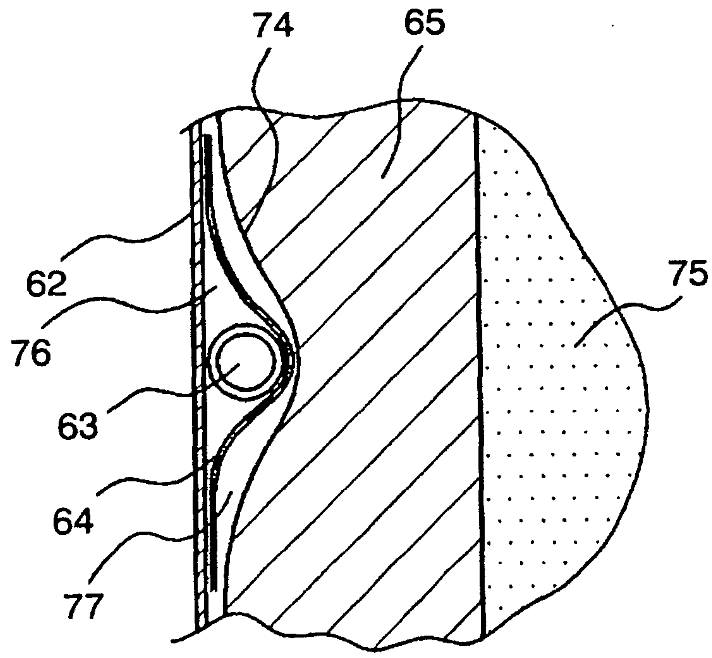

FIG. 20

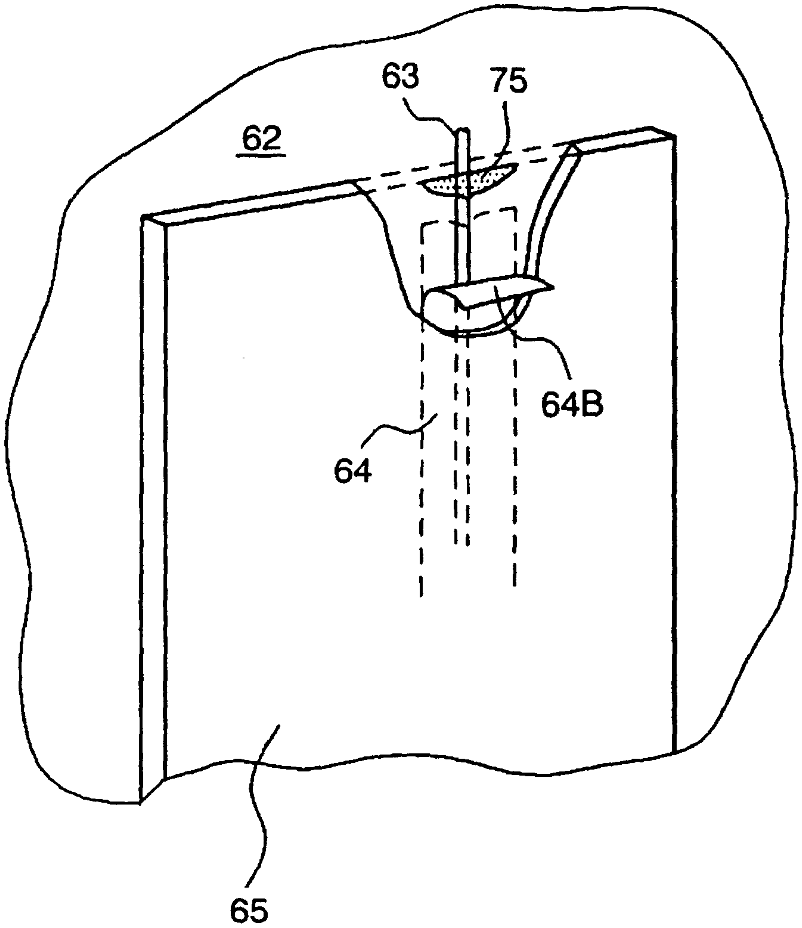

FIG. 21

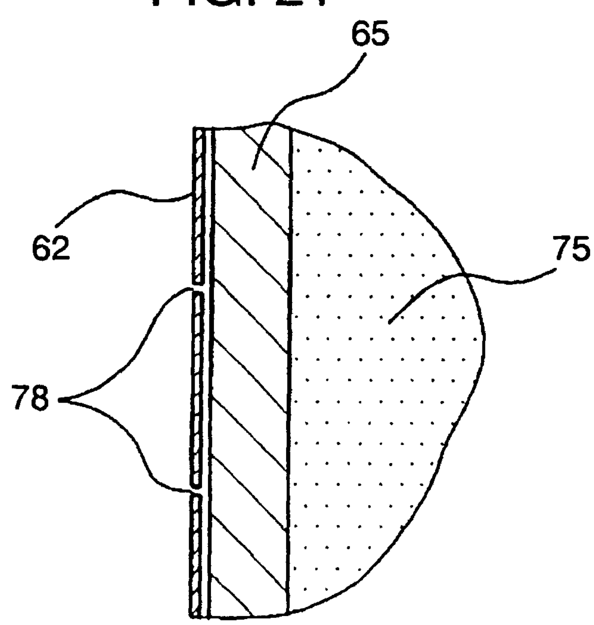

FIG. 22A

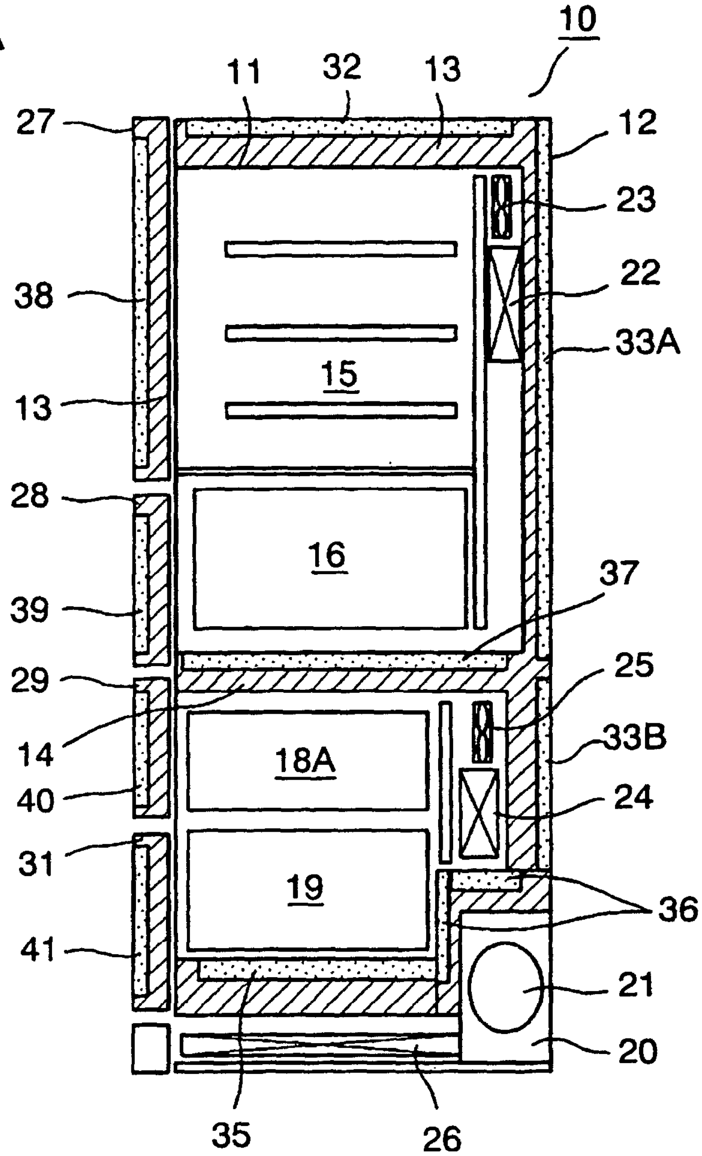

FIG. 22B

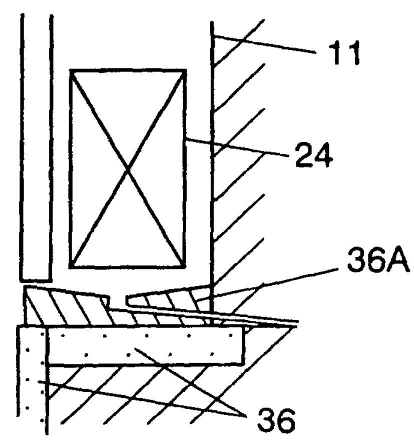

FIG. 23A

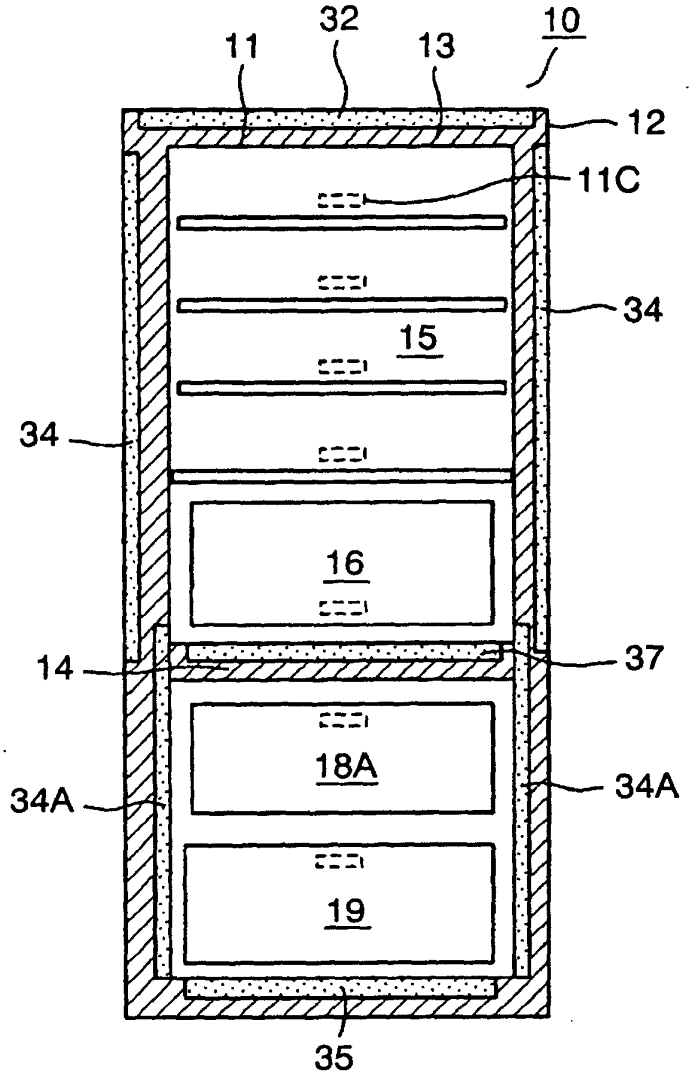

FIG. 23B

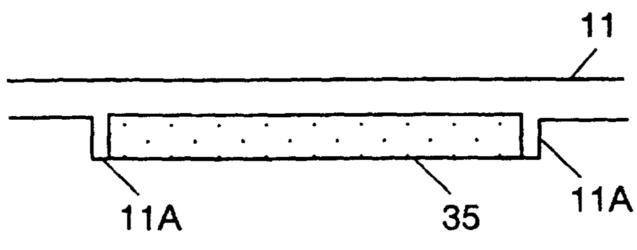

FIG. 23C

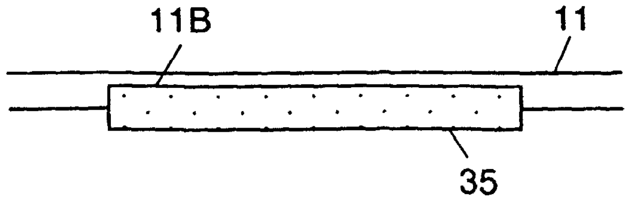

FIG. 24

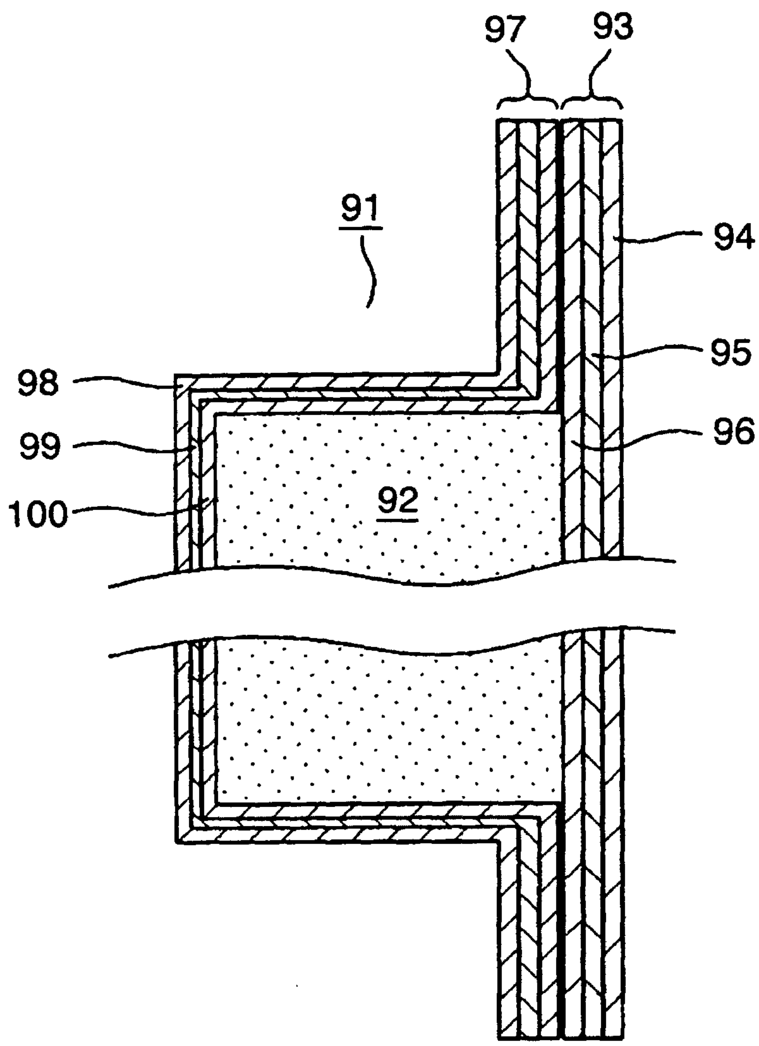

FIG. 25

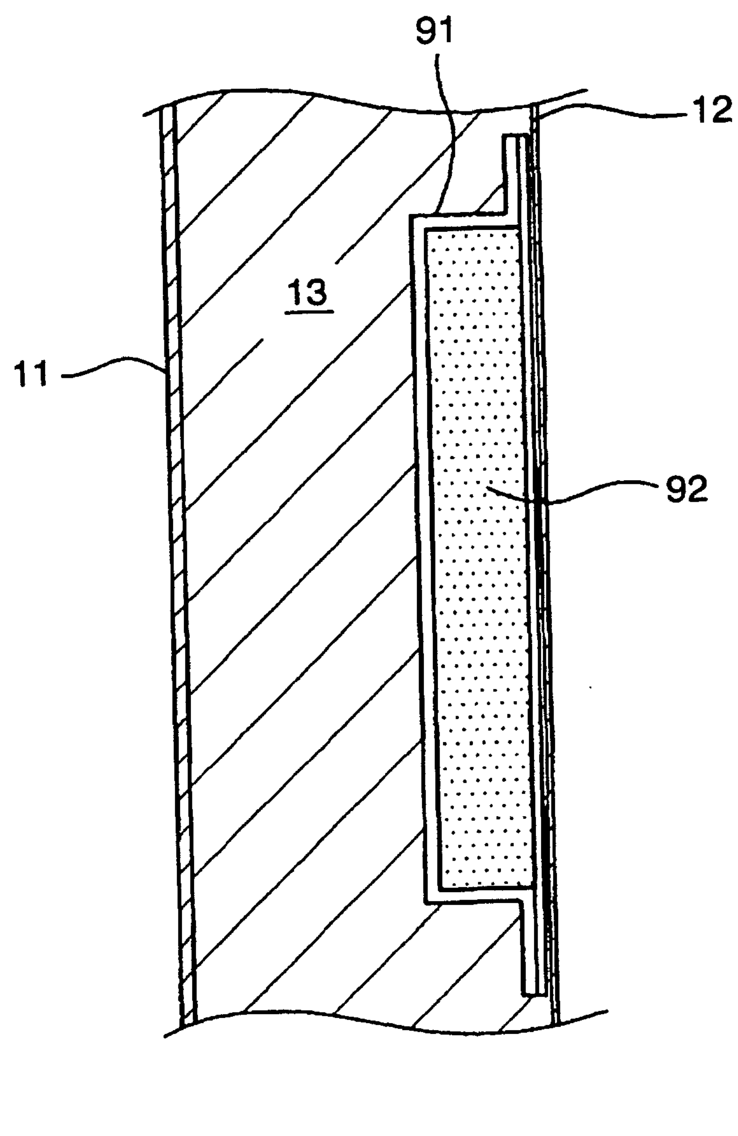

FIG. 26

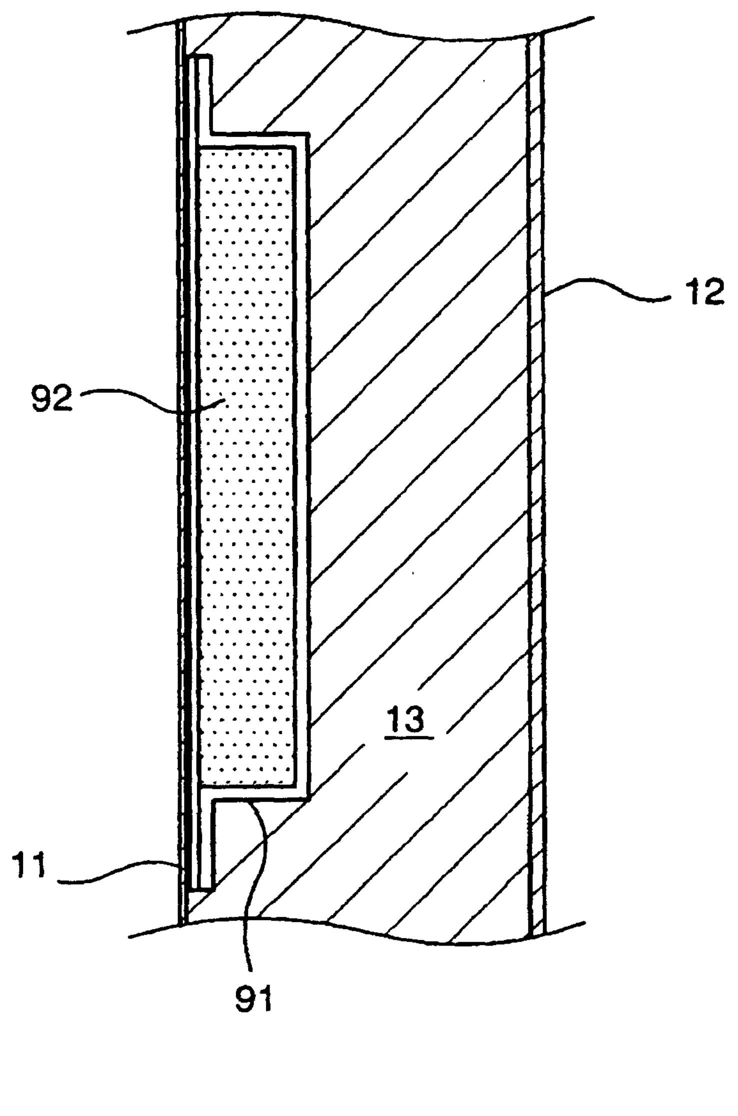

FIG. 27

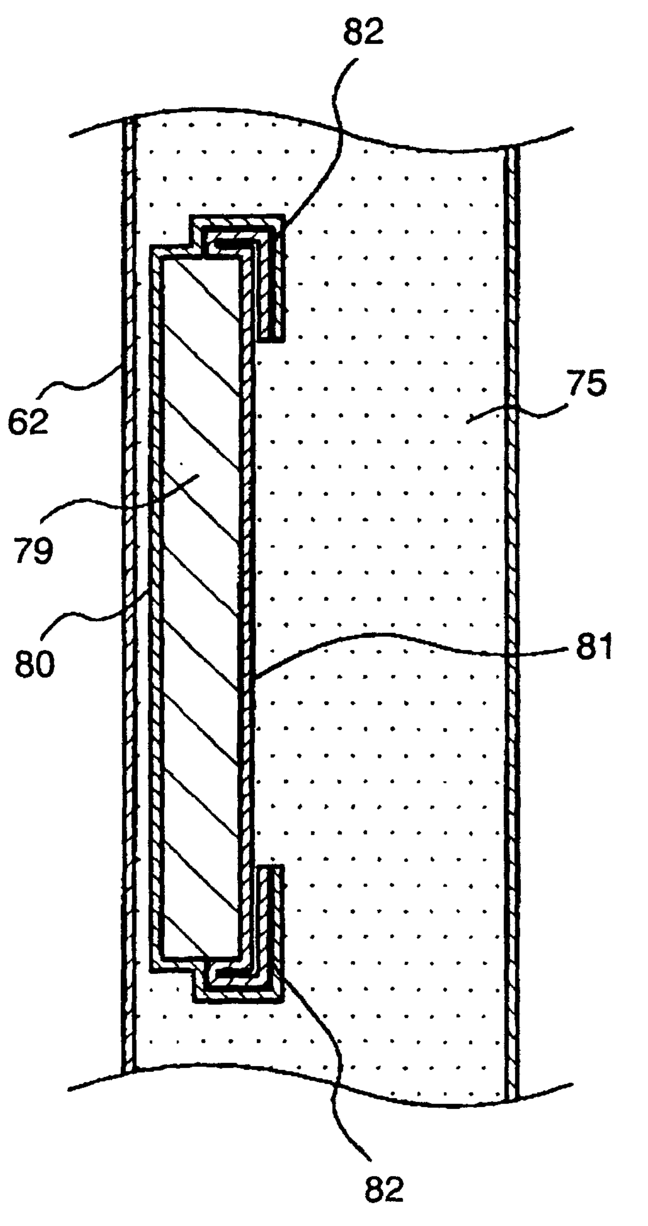

FIG. 28

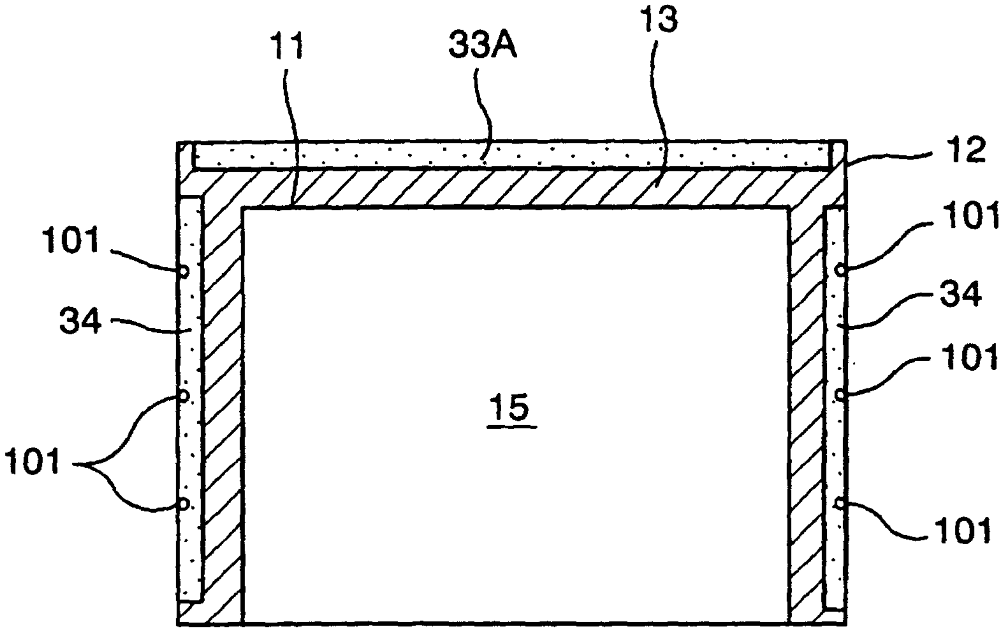

FIG. 29

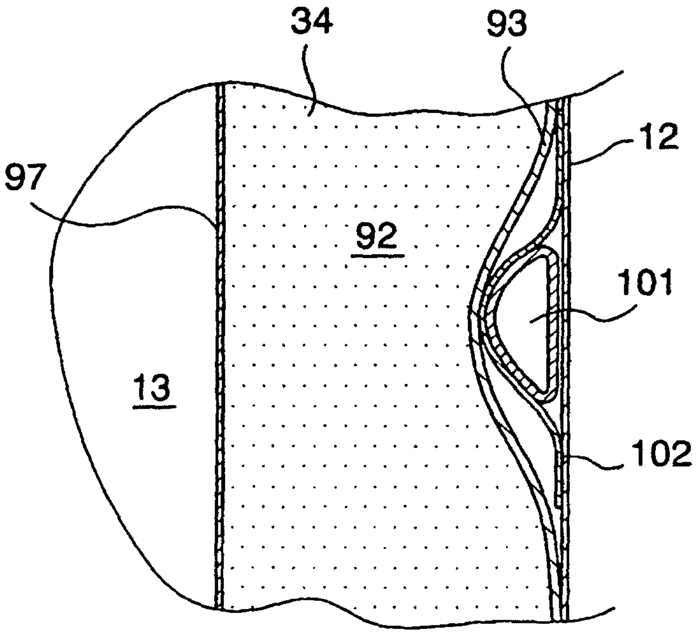

FIG. 30

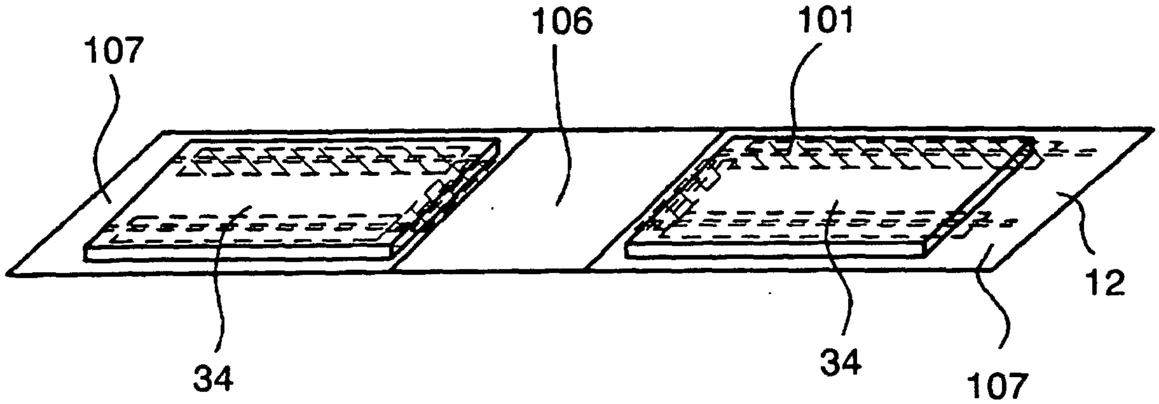
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FIG. 31

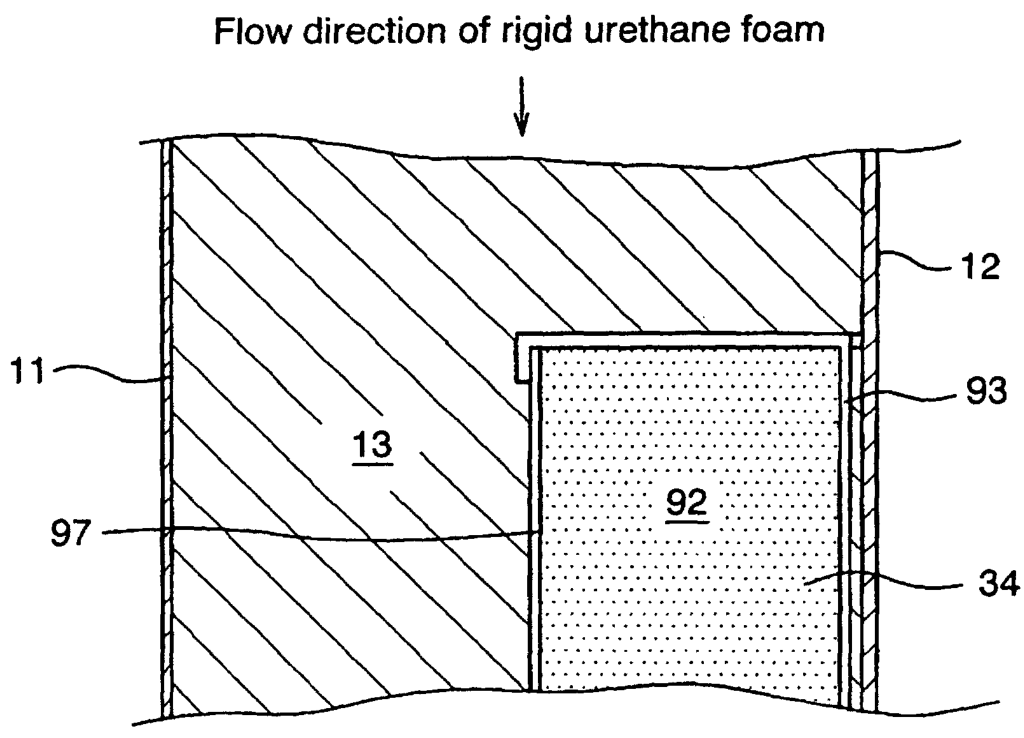
Flow direction of rigid urethane foam
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FIG. 32

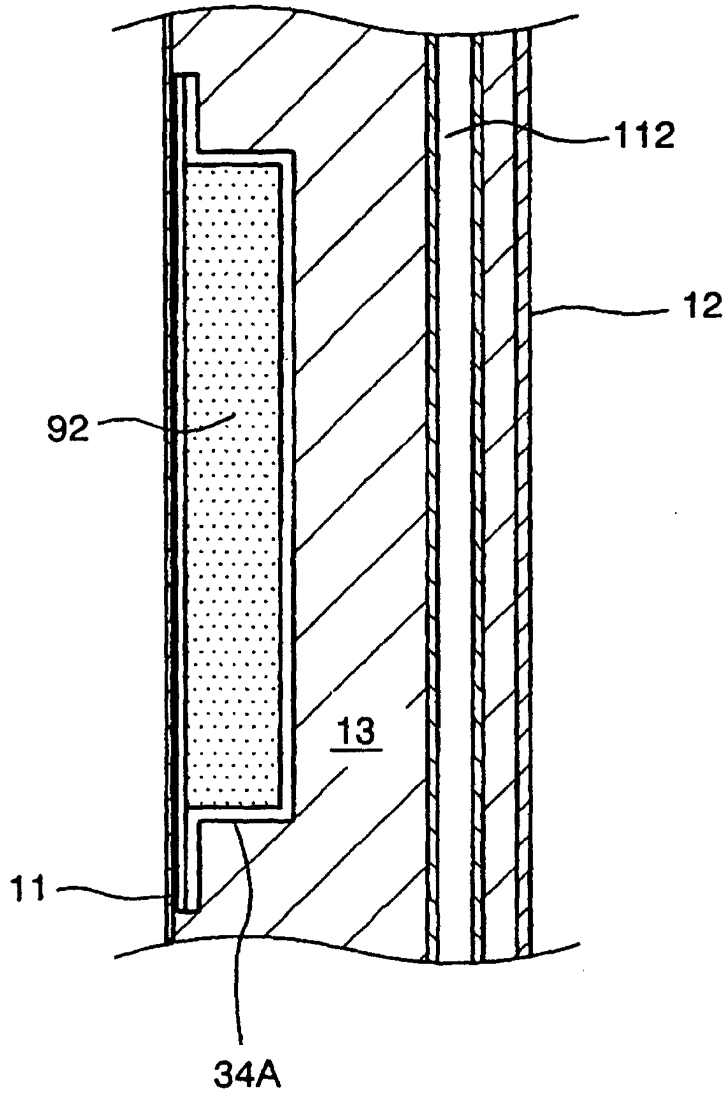

FIG. 33

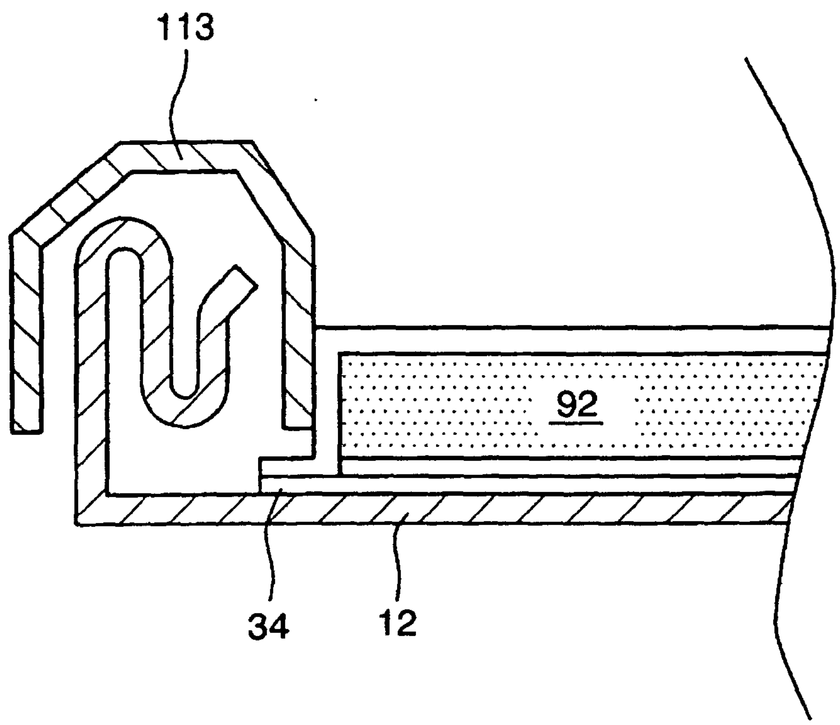

FIG. 34

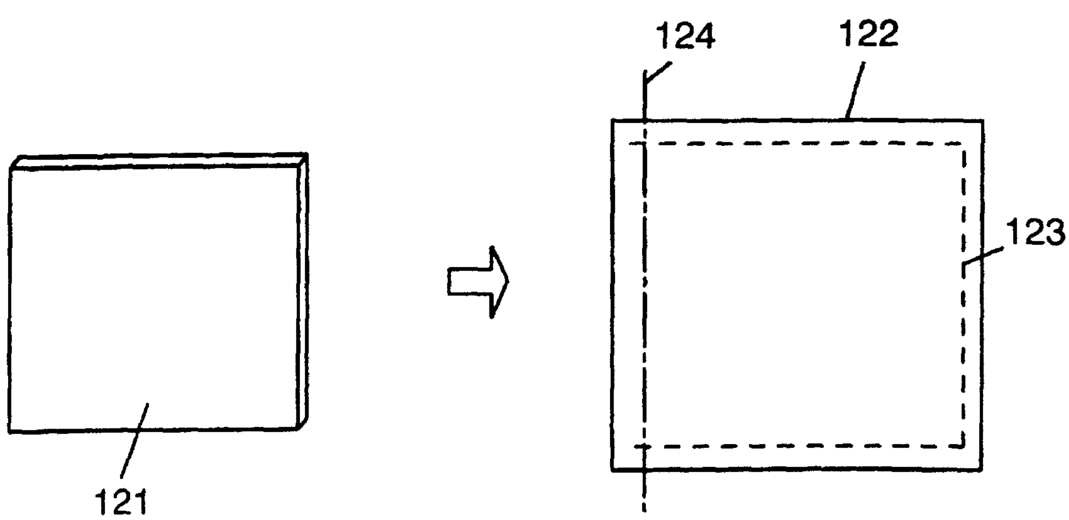

FIG. 35

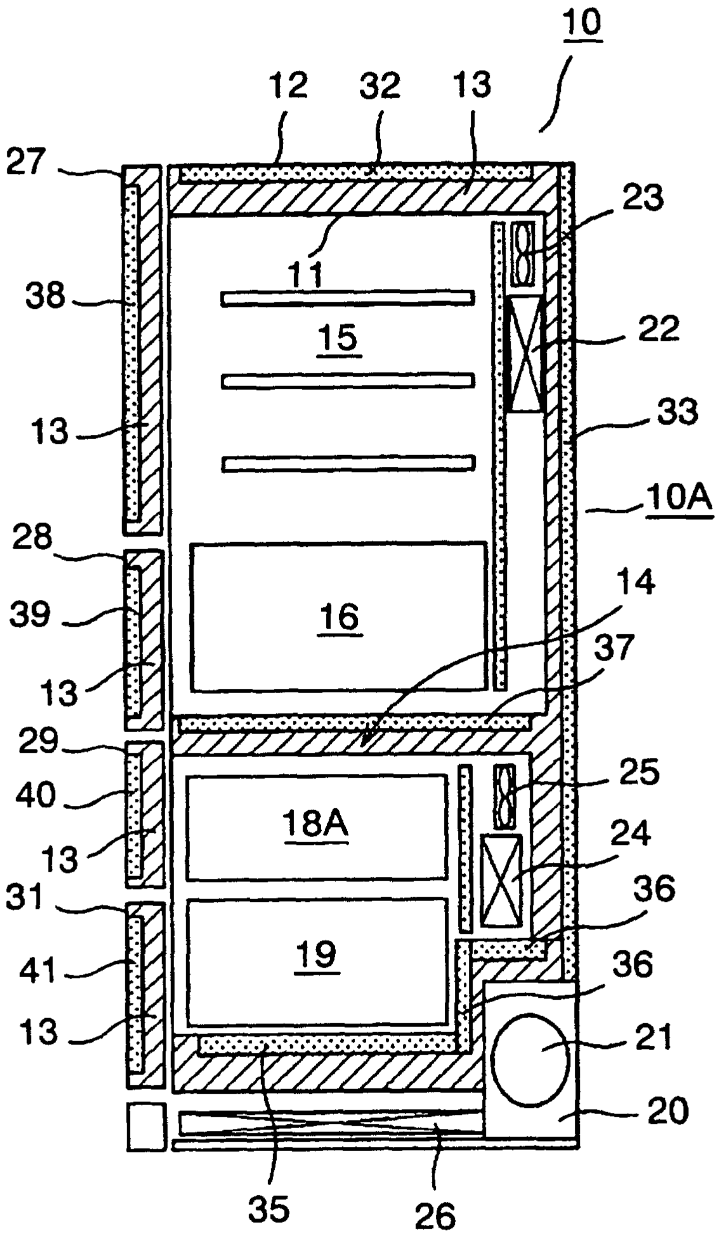
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FIG. 36

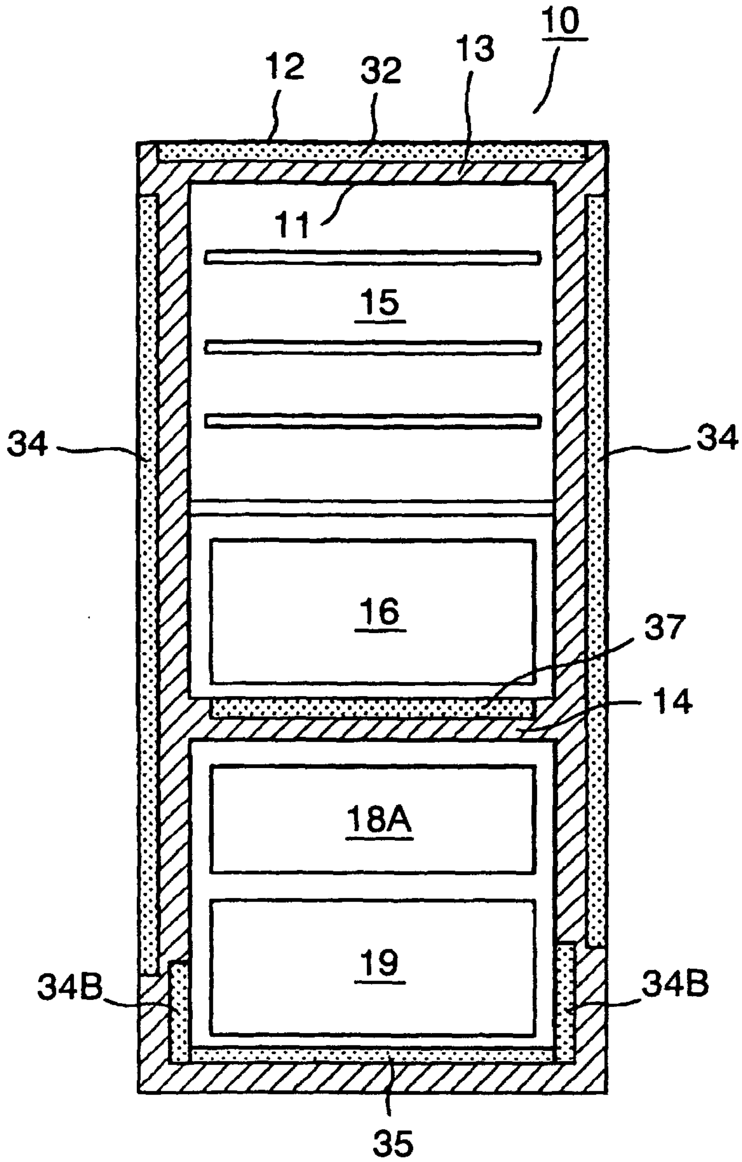

FIG. 37

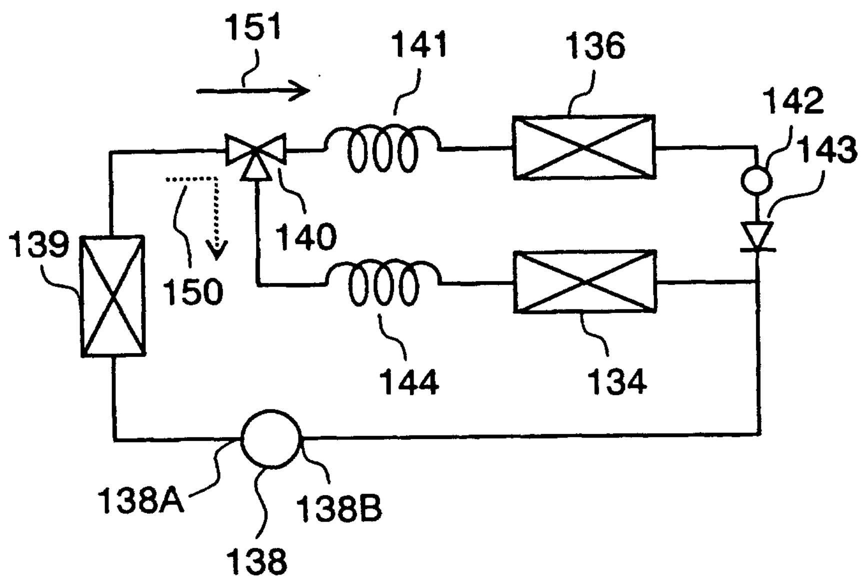
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FIG. 38

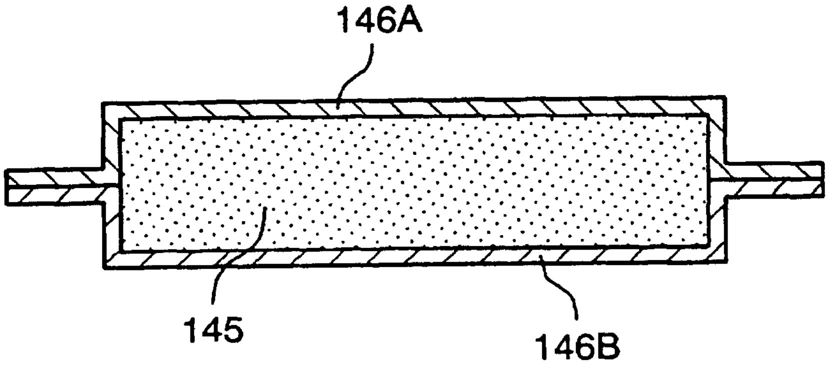
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FIG. 39

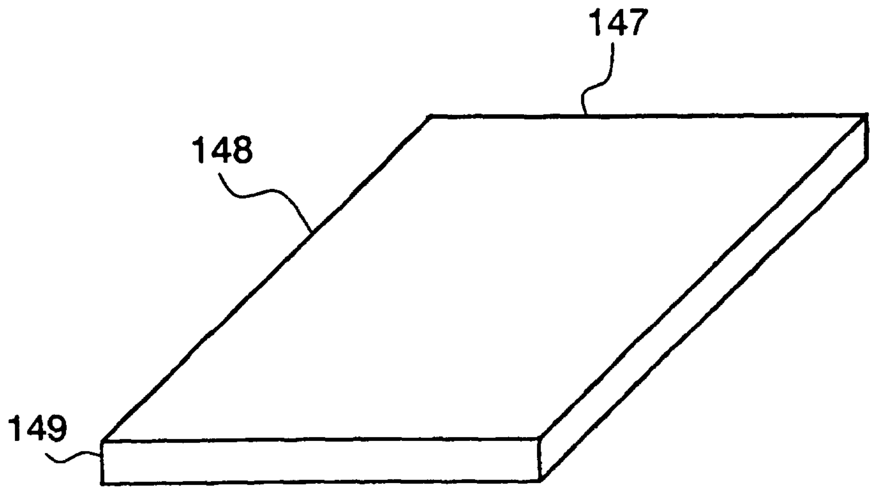


FIG. 40

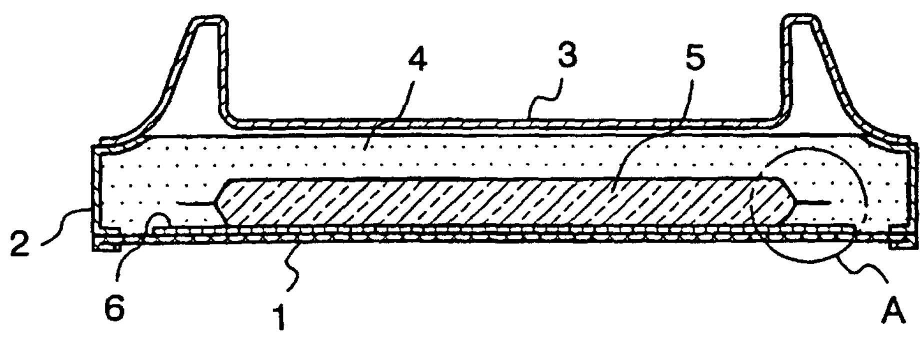


FIG. 41

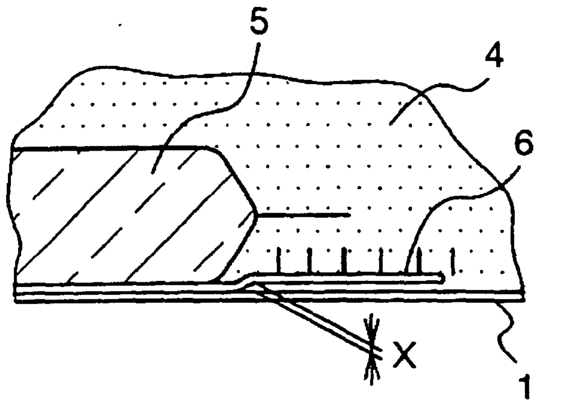
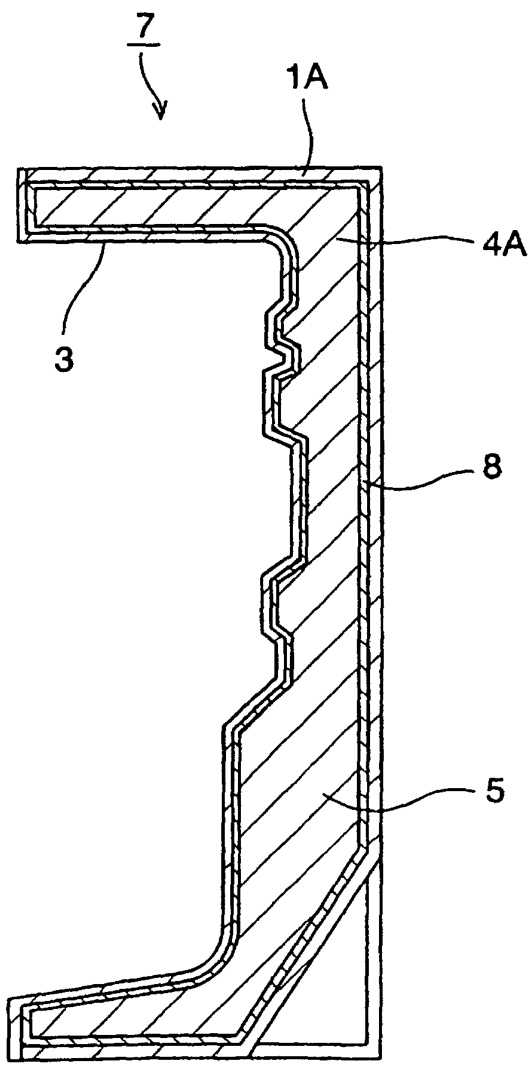


FIG. 42



List of Reference Numerals and Signs in the Drawings

1: outer plate
1A: outer box
2: door frame
3, 3A: inner box
4: foamy heat insulator
4A: filler
5: vacuum heat insulator
6: mould releasing sheet
7: refrigerator body
8: paper material
10: refrigerator
10A: adiabatic box
11, 52: inner box
11A: projection
11B: recess
11C: air vent hole
12, 51: 62: outer box
13, 55, 75: rigid urethane foam
14: adiabatic partition
15: cold storage room
16: vegetable room
17: changeover room
18: ice making room
18A, 19: freezing room
20: machine room
21: compressor
22: refrigerating cooler
23: refrigerating fan
24: freezing cooler
25: freezing fan
26: condenser
27, 27B: cold storage room door
27A: door outer plate
28: vegetable room door
29: changeover room door

30: ice making room door
31: freezing room door
32, 33, 33A, 33B, 34, 34A, 34B, 35, 36, 37, 38A, 38B, 39, 40, 41, 54, 65, 66, 67, 91: vacuum heat insulator
36A: adiabatic member
42, 45: door inner plate
43: projection
44: forefront portion
46: rail
47: fixing portion
48: reinforcement plate
49: spacer
50: door outer plate
53, 61: soft member
56: hard member
57, 92, 121, 145: core material
58: first covering
59: second covering
60: space
63: radiating pipe
64: aluminum tape
64A, 64B: end of aluminum tape
68: machine room constituting portion
69: bend
70: back surface plate
71: bottom plate
72: press machine
73: pressing portion
74: groove
76: first air gap
77: second air gap
78: small hole
80, 93, 146B: deposit layer film
81, 97, 146A: metallic foil layer film
82: sealed portion
94, 98: nylon film

95: aluminum deposited film
96, 100: high-density polyethylene film
99: aluminum foil
101: radiating pipe
102: aluminum tape
106: surface making a roof surface
107: surface making a side surface
112: defrosting-water pipe
113: protective member
122: gas-barrier film
123: sealed portion
124: fusing seal
134: cold storage room evaporator
136: freezing room evaporator
138: compressor
138A: refrigerant discharge port
138B: refrigerant inflow inlet
139: condenser
140: three-way switching valve
141: freezing capillary
142: accumulator
143: check valve
144: cold storage capillary
147, 148: side defining a vacuum heat insulator
149: thicknesswise side of vacuum heat insulator
150, 151: arrow indicating refrigerant flow passage

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/05040

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F25D23/06

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)
Int.Cl[7] F25D23/06

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

Jitsuyo Shinan Koho	1922-1996	Toroku Jitsuyo Shinan Koho	1994-2003
Kokai Jitsuyo Shinan Koho	1971-2003	Jitsuyo Shinan Toroku Koho	1996-2003

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	JP 8-247632 A (Hitachi, Ltd.), 27 September, 1996 (27.09.96), All pages (Family: none)	1-40
Y	JP 2001-47105 A (Nippon Steel Corp.), 20 February, 2001 (20.02.01), All pages (Family: none)	1-40
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 152705/1986(Laid-open No. 57481/1988) (Sharp Corp.), 16 April, 1988 (16.04.88), All pages (Family: none)	1-40

[X] 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 document 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)
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Date of the actual completion of the international search	Date of mailing of the international search report
18 July, 2003 (18.07.03)	05 August, 2003 (05.08.03)
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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 29610/1986(Laid-open No. 141189/1987) (Toshiba Corp.), 05 September, 1987 (05.09.87), All pages (Family: none)	1-40
Y	JP 61-265474 A (Matsushita Refrigeration Co.), 25 November, 1986 (25.11.86), All pages (Family: none)	1-40
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 193440/1981(Laid-open No. 103688/1983) (New Nippon Electric Co., Ltd.), 14 July, 1983 (14.07.83), All pages (Family: none)	1-40
Y	JP 2001-165557 A (Matsushita Refrigeration Co.), 22 June, 2001 (22.06.01), All pages (Family: none)	1-40
Y	JP 8-14733 A (Hitachi, Ltd.), 19 January, 1996 (19.01.96), All pages (Family: none)	1-40
Y	JP 6-42860 A (Matsushita Refrigeration Co.), 18 February, 1994 (18.02.94), All pages (Family: none)	1-40
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 77442/1984(Laid-open No. 188982/1985) (Toshiba Corp.), 14 December, 1985 (14.12.85), All pages (Family: none)	1-40

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