



(51) International Patent Classification:

F25D 23/06 (2006.01) F16L 59/065 (2006.01)

F25D 23/00 (2006.01) F16L 3/12 (2006.01)

F25B 40/00 (2006.01) F16L 3/22 (2006.01)

F25D 19/00 (2006.01)

(21) International Application Number:

PCT/KR2019/007755

(22) International Filing Date:

26 June 2019 (26.06.2019)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

10-2018-0074203 27 June 2018 (27.06.2018) KR

(71) Applicant: LG ELECTRONICS INC. [KR/KR]; 128, Yeoui-daero, Yeongdeungpo-gu, Seoul 07336 (KR).

(72) Inventors: KIM, Daewoong; IP Center, LG Electronics Inc., 51, Gasan digital 1-ro, Geumcheon-gu, Seoul 08592 (KR). JUNG, Wonyeong; IP Center, LG Electronics Inc., 51, Gasan digital 1-ro, Geumcheon-gu, Seoul 08592 (KR). YOUN, Deokhyun; IP Center, LG Electronics Inc., 51, Gasan digital 1-ro, Geumcheon-gu, Seoul 08592 (KR).

(74) Agent: HAW, Yong Noke; 6th Fl., HyunJuk Bldg., 114 Yeoksam-ro, Gangnam-gu, Seoul 06252 (KR).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,

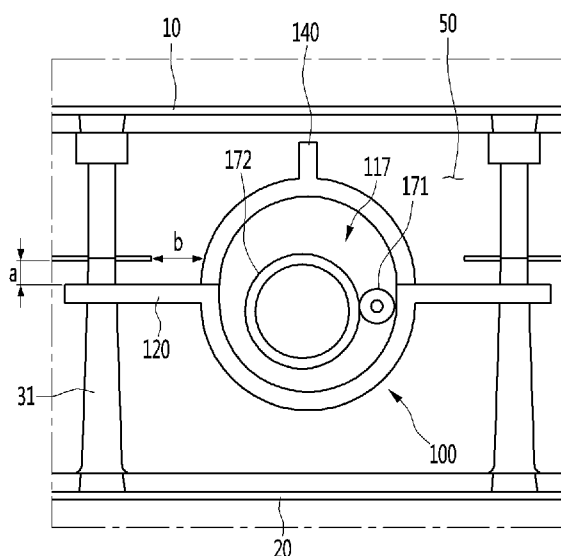
HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: VACUUM ADIABATIC BODY AND REFRIGERATOR



(57) Abstract: Provided is a vacuum adiabatic body. The vacuum adiabatic body include a supporting unit configured to maintain a third space that is a vacuum space and a pipeline disposed in the third space. The pipeline is supported by the supporting unit so that horizontal movement of the pipeline is restricted. Thus, a heat exchange pipeline disposed in the inner space of the vacuum adiabatic body may be accurately supported.

Description

Title of Invention: VACUUM ADIABATIC BODY AND REFRIGERATOR

Technical Field

- [1] The present disclosure relates to a vacuum adiabatic body and a refrigerator.

Background Art

- [2] A vacuum adiabatic body is a product for suppressing heat transfer by vacuumizing the interior of a body thereof. The vacuum adiabatic body may reduce heat transfer by convection and conduction, and hence is applied to heating apparatuses and refrigerating apparatuses. In a typical adiabatic method applied to a refrigerator, although it is differently applied in refrigeration and freezing, a foam urethane adiabatic wall having a thickness of about 30 cm or more is generally provided. However, the internal volume of the refrigerator is therefore reduced.
- [3] In order to increase the internal volume of a refrigerator, there is an attempt to apply a vacuum adiabatic body to the refrigerator.
- [4] First, Korean Patent No. 10-0343719 (Cited Document 1) of the present applicant has been disclosed. According to Reference Document 1, there is disclosed a method in which a vacuum adiabatic panel is prepared and then built in walls of a refrigerator, and the exterior of the vacuum adiabatic panel is finished with a separate molding as Styrofoam. According to the method, additional foaming is not required, and the adiabatic performance of the refrigerator is improved. However, fabrication cost is increased, and a fabrication method is complicated. As another example, a technique of providing walls using a vacuum adiabatic material and additionally providing adiabatic walls using a foam filling material has been disclosed in Korean Patent Publication No. 10-2015-0012712 (Cited Document 2). According to Reference Document 2, fabrication cost is increased, and a fabrication method is complicated.
- [5] To solve this problem, the present applicant had filed Korean Patent Application NO. 10-2013-0049495 (Cited Document 3). This technique provides a vacuum adiabatic body in an empty vacuum state without providing a separate adiabatic material therein. In addition, this technique provides a technique in which a heat exchange pipeline is disposed in the vacuum adiabatic body. The heat exchange pipeline is a pipeline in which two pipelines, i.e., an inlet pipe of an evaporator and an outlet pipe of the evaporator contact each other. The heat exchange pipeline is a pipeline in which a refrigerant flowing through the inside of the two pipelines are heat-exchanged with each other to improve performance of a refrigerating cycle.
- [6] To allow the heat exchange pipelines to be heat-exchanged only therebetween and

reduce a heat loss, the heat exchange pipeline may not contact a plate defining an outer wall of the vacuum adiabatic body. For this, a ring may be inserted into the heat exchange pipeline. The ring may be disposed between the heat exchange pipeline and an inner surface of the plate to space the heat exchange pipeline from the plate.

- [7] Since an outer circumferential surface of the ring has the same shape as that of an outer circumferential surface of the heat exchange pipeline, and the ring has a closed curve shape, it is very difficult to insert the ring into the heat exchange pipeline.
- [8] The ring is made of a solid material and fully contacts the plate to support the plate. Thus, heat of the heat exchange pipeline may be conducted to a case to cause an adiabatic loss.
- [9] The ring has to be inserted into a vacuum space before the vacuum adiabatic body is assembled. Thus, after the vacuum adiabatic body is assembled, it is difficult to additionally insert the guide ring when a contact portion between the heat exchange pipeline and the plate occurs. Since the heat exchange pipeline is made of a copper material having weak rigidity and also is bent inside a spacer, it is more problematic.
- [10] Since the ring is not fixed, the ring may move from a desired position when a worker handles the heat exchange pipeline. If the ring moves, the position of the ring has to be adjusted again after being assembled.

Disclosure of Invention

Technical Problem

- [11] Embodiments provide a vacuum adiabatic body in which a spacing member spacing a heat exchange pipeline from a plate by a predetermined distance is easily coupled to the heat exchange pipeline.
- [12] Embodiments also provide a vacuum adiabatic body in which, when the heat exchange pipeline is supported to be spaced apart from the plate, contact between the spacing member and the plate is minimized to minimize an adiabatic loss due to thermal conductivity.
- [13] Embodiments also provide a vacuum adiabatic body in which a spacing member is installed at a required position, and then, the installed position is permanently fixed.

Solution to Problem

- [14] In one embodiment, a vacuum adiabatic body includes: a supporting unit configured to maintain a third space that is a vacuum space; and a pipeline disposed in the third space, wherein horizontal movement of the pipeline is restricted by the supporting unit. The pipeline through which a refrigerant flows may be well supported in an internal space of the vacuum adiabatic body.
- [15] The supporting unit of the main body-side vacuum adiabatic body, which is applied to a refrigerator according to an embodiment may include: a bar configured to maintain

contraction between plate members, and a support plate configured to support the bar, wherein, in order to restrict movement of the heat exchange pipeline through which the refrigerant flows, a supporting part configured to accommodate the heat exchange pipeline therein and at least one wing extending from the supporting part and supported by the bar may be provided in the supporting unit. The heat exchange pipeline may be stably disposed in the vacuum adiabatic body without contacting and interfering with other components.

[16] The heat resistance unit that resists heat transfer between the plate members defining an outer wall of the vacuum adiabatic body may include a conductive resistance sheet that resists conduction of heat transferred along a wall of the third space and may further include a side frame coupled to the conductive resistance sheet.

[17] The heat resistance unit may include at least one radiation resistance sheet that is provided in a plate shape within the third space or may include a porous material that resists radiation heat transfer between the second plate member and the first plate member within the third space.

Advantageous Effects of Invention

[18] According to the embodiment, since the worker directly install the spacing member at the set position without being inserted from the distal end of the heat exchange pipeline, the assembly workability may be convenient.

[19] According to the embodiment, the number of indirect contact points between the heat exchange pipeline and the plate may be minimized to reduce the adiabatic loss of the vacuum adiabatic body.

[20] According to the embodiment, the spacing member may be permanently fixed to the set position according to the design factors of the vacuum adiabatic body to improve the reliability of the product because the additional process is not required.

[21] According to the embodiment, when the spacing member is additionally required by the unexpected deformation of the heat exchange pipeline made of the material such as copper, the spacing member may be conveniently installed to improve the yield of the good products.

Brief Description of Drawings

[22] FIG. 1 is a perspective view of a refrigerator according to an embodiment.

[23] FIG. 2 is a schematic view illustrating a vacuum adiabatic body used in a main body and a door of the refrigerator.

[24] FIG. 3 is a view illustrating various embodiments of an internal configuration of a vacuum space part.

[25] FIG. 4 is a diagram illustrating results obtained by examining resins.

[26] FIG. 5 illustrates results obtained by performing an experiment on vacuum

maintenance performances of resins.

- [27] FIG. 6 illustrates results obtained by analyzing components of gases discharged from a PPS and a low outgassing PC.
- [28] FIG. 7 illustrates results obtained by measuring maximum deformation temperatures at which resins are damaged by atmospheric pressure in high-temperature exhaustion.
- [29] FIG. 8 is a view showing various embodiments of conductive resistance sheets and peripheral parts thereof.
- [30] FIG. 9 is a partial cutaway view of the vacuum adiabatic body.
- [31] FIG. 10 is a view illustrating a state in which a heat exchange pipeline is disposed in the vacuum space part.
- [32] FIG. 11 is a perspective view of a one-way spacing member that is one kind of spacing members.
- [33] FIG. 12 is a perspective view of a one-way spacing member according to another embodiment.
- [34] FIG. 13 is a perspective view of a one-way spacing member according to further another embodiment.
- [35] FIG. 14 is a front view illustrating a state in which a pair of one-way spacing members are installed.
- [36] FIG. 15 is a partial cutaway view of the vacuum adiabatic body in a state in which the heat exchange pipeline is installed.
- [37] FIG. 16 is a partial cutaway view illustrating another example of the vacuum adiabatic body in the state in which the heat exchange pipeline is installed.
- [38] FIG. 17 is view illustrating a use state of a spacing member according to further another embodiment.
- [39] FIG. 18 is a perspective view of a spacing member according to further another embodiment.
- [40] FIG. 19 is a perspective view of an open-type bidirectional spacing member according to further another embodiment.
- [41] FIG. 20 is a perspective view of an open-type bidirectional spacing member according to further another embodiment.
- [42] FIGS. 21 to 23 are front views illustrating a state in which the open-type bidirectional spacing member of FIGS. 18 to 20 is installed on a bar and the heat exchange pipeline.
- [43] FIG. 24 is a view illustrating a state in which the open-type bidirectional spacing member is installed.
- [44] FIG. 25 is a front view of the open-type spacing member.

Mode for the Invention

- [45] Hereinafter, exemplary embodiments will be described with reference to the accompanying drawings. The invention may, however, be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein, and a person of ordinary skill in the art, who understands the spirit of the present invention, may readily implement other embodiments included within the scope of the same concept by adding, changing, deleting, and adding components; rather, it will be understood that they are also included within the scope of the present invention.
- [46] The drawings shown below may be displayed differently from the actual product, or exaggerated or simple or detailed parts may be deleted, but this is intended to facilitate understanding of the technical idea of the present invention. It should not be construed as limited.
- [47] Also, the number of each of the components illustrated together with the drawings facilitates the understanding of the inventive concept by assigning the same or similar number to the same or similar component in function. Similarly, in the case of performing the same or similar function in function even if the embodiments are different, the same or similar number is assigned to facilitate the understanding of the invention.
- [48] In the following description, the vacuum pressure means any pressure state lower than the atmospheric pressure. In addition, the expression that a vacuum degree of A is higher than that of B means that a vacuum pressure of A is lower than that of B.
- [49] FIG. 1 is a perspective view of a refrigerator according to an embodiment.
- [50] Referring to FIG. 1, the refrigerator 1 includes a main body 2 provided with a cavity 9 capable of storing storage goods and a door 3 provided to open/close the main body 2. The door 3 may be rotatably or slidably movably disposed to open/close the cavity 9. The cavity 9 may provide at least one of a refrigerating compartment and a freezing compartment.
- [51] Parts constituting a freezing cycle in which cold air is supplied into the cavity 9. For example, the parts include a compressor 4 for compressing a refrigerant, a condenser 5 for condensing the compressed refrigerant, an expander 6 for expanding the condensed refrigerant, and an evaporator 7 for evaporating the expanded refrigerant to take heat. As a typical structure, a fan may be installed at a position adjacent to the evaporator 7, and a fluid blown from the fan may pass through the evaporator 7 and then be blown into the cavity 9. A freezing load is controlled by adjusting the blowing amount and blowing direction by the fan, adjusting the amount of a circulated refrigerant, or adjusting the compression rate of the compressor, so that it is possible to control a refrigerating space or a freezing space.
- [52] FIG. 2 is a view schematically showing a vacuum adiabatic body used in the main

body and the door of the refrigerator. In FIG. 2, a main body-side vacuum adiabatic body is illustrated in a state in which top and side walls are removed, and a door-side vacuum adiabatic body is illustrated in a state in which a portion of a front wall is removed. In addition, sections of portions at conductive resistance sheets are provided are schematically illustrated for convenience of understanding.

- [53] Referring to FIG. 2, the vacuum adiabatic body includes a first plate member 10 for providing a wall of a low-temperature space, a second plate member 20 for providing a wall of a high-temperature space, a vacuum space part 50 defined as a gap part between the first and second plate members 10 and 20. Also, the vacuum adiabatic body includes the conductive resistance sheets 60 and 63 for preventing thermal conduction between the first and second plate members 10 and 20. A sealing part 61 for sealing the first and second plate members 10 and 20 is provided such that the vacuum space part 50 is in a sealing state.
- [54] When the vacuum adiabatic body is applied to a refrigerator or a warming apparatus, the first plate member 10 providing a wall of an internal space of the refrigerator may be referred to as an inner case, and the second plate member 20 providing a wall of an outer space of the refrigerator may be referred to as an outer case.
- [55] A machine room 8 in which parts providing a freezing cycle are accommodated is placed at a lower rear side of the main body-side vacuum adiabatic body, and an exhaust port 40 for forming a vacuum state by exhausting air in the vacuum space part 50 is provided at any one side of the vacuum adiabatic body. In addition, a pipeline 64 passing through the vacuum space part 50 may be further installed so as to install a de-frosting water line and electric lines.
- [56] The first plate member 10 may define at least one portion of a wall for a first space provided thereto. The second plate member 20 may define at least one portion of a wall for a second space provided thereto. The first space and the second space may be defined as spaces having different temperatures. Here, the wall for each space may serve as not only a wall directly contacting the space but also a wall not contacting the space. For example, the vacuum adiabatic body of the embodiment may also be applied to a product further having a separate wall contacting each space.
- [57] Factors of heat transfer, which cause loss of the adiabatic effect of the vacuum adiabatic body, are thermal conduction between the first and second plate members 10 and 20, heat radiation between the first and second plate members 10 and 20, and gas conduction of the vacuum space part 50.
- [58] Hereinafter, a heat resistance unit provided to reduce adiabatic loss related to the factors of the heat transfer will be provided. Meanwhile, the vacuum adiabatic body and the refrigerator of the embodiment do not exclude that another adiabatic means is further provided to at least one side of the vacuum adiabatic body. Therefore, an

adiabatic means using foaming or the like may be further provided to another side of the vacuum adiabatic body.

[59] The heat resistance unit may include a conductive resistance sheet that resists conduction of heat transferred along a wall of a third space and may further include a side frame coupled to the conductive resistance sheet. The conductive resistance sheet and the side frame will be clarified by the following description.

[60] The heat resistance unit may include at least one radiation resistance sheet that is provided in a plate shape within the third space or may include a porous material that resists radiation heat transfer between the second plate member and the first plate member within the third space. The radiation resistance sheet and the porous material will be clarified by the following description.

[61] FIG. 3 is a view illustrating various embodiments of an internal configuration of the vacuum space part.

[62] First, referring to FIG. 3A, the vacuum space part 50 may be provided in a third space having a pressure different from that of each of the first and second spaces, preferably, a vacuum state, thereby reducing an adiabatic loss. The third space may be provided at a temperature between the temperature of the first space and the temperature of the second space. Since the third space is provided as a space in the vacuum state, the first and second plate members 10 and 20 receive force contracted in a direction in which they approach each other due to a force corresponding to a pressure difference between the first and second spaces. Therefore, the vacuum space part 50 may be deformed in a direction in which a distance between the plate members is reduced. In this case, the adiabatic loss may be caused due to an increase in amount of heat radiation, caused by the contraction of the vacuum space part 50, and an increase in amount of thermal conduction, caused by contact between the plate members 10 and 20.

[63] The supporting unit 30 may be provided to reduce deformation of the vacuum space part 50. The supporting unit 30 includes a bar 31. The bar 31 may extend in a substantially vertical direction with respect to the plate members to support a distance between the first plate member and the second plate member. A support plate 35 may be additionally provided on at least any one end of the bar 31. The support plate 35 may connect at least two or more bars 31 to each other to extend in a horizontal direction with respect to the first and second plate members 10 and 20. The support plate 35 may be provided in a plate shape or may be provided in a lattice shape so that an area of the support plate contacting the first or second plate member 10 or 20 decreases, thereby reducing heat transfer. The bars 31 and the support plate 35 are fixed to each other at at least one portion, to be inserted together between the first and second plate members 10 and 20. The support plate 35 contacts at least one of the first

and second plate members 10 and 20, thereby preventing deformation of the first and second plate members 10 and 20. In addition, based on the extending direction of the bars 31, a total sectional area of the support plate 35 is provided to be greater than that of the bars 31, so that heat transferred through the bars 31 may be diffused through the support plate 35.

[64] A material of the supporting unit 30 will be described.

[65] The supporting unit 30 is to have a high compressive strength so as to endure the vacuum pressure. Also, the supporting unit 30 is to have a low outgassing rate and a low water absorption rate so as to maintain the vacuum state. Also, the supporting unit 30 is to have a low thermal conductivity so as to reduce the thermal conduction between the plate members. Also, the supporting unit 30 is to secure the compressive strength at a high temperature so as to endure a high-temperature exhaust process. Also, the supporting unit 30 is to have an excellent machinability so as to be subjected to molding. Also, the supporting unit 30 is to have a low cost for molding. Here, the time required to perform the exhaust process takes about a few days. Hence, the time is reduced, thereby considerably improving fabrication cost and productivity. Therefore, the compressive strength is to be secured at the high temperature because an exhaust speed is increased as a temperature at which the exhaust process is performed becomes higher. The inventor has performed various examinations under the above-described conditions.

[66] First, ceramic or glass has a low outgassing rate and a low water absorption rate, but its machinability is remarkably lowered. Hence, the ceramic and glass may not be used as the material of the supporting unit 30. Therefore, resin may be considered as the material of the supporting unit 30.

[67] FIG. 4 is a diagram illustrating results obtained by examining resins.

[68] Referring to FIG. 4, the present inventor has examined various resins, and most of the resins cannot be used because their outgassing rates and water absorption rates are remarkably high. Accordingly, the present inventor has examined resins that approximately satisfy conditions of the outgassing rate and the water absorption rate. As a result, PE is inappropriate to be used due to its high outgassing rate and its low compressive strength. PCTFE is not preferable to be used due to its remarkably high price. PEEK is inappropriate to be used due to its high outgassing rate. Accordingly, it is determined that a resin selected from the group consisting of polycarbonate (PC), glass fiber PC, low outgassing PC, polyphenylene sulfide (PPS), and liquid crystal polymer (LCP) may be used as the material of the supporting unit. However, an outgassing rate of the PC is 0.19, which is at a low level. Hence, as the time required to perform baking in which exhaustion is performed by applying heat is increased to a certain level, the PC may be used as the material of the supporting unit.

- [69] The present inventor has found an optimal material by performing various studies on resins expected to be used inside the vacuum space part. Hereinafter, results of the performed studies will be described with reference to the accompanying drawings.
- [70] FIG. 5 is a view illustrating results obtained by performing an experiment on vacuum maintenance performances of the resins.
- [71] Referring to FIG. 5, there is illustrated a graph showing results obtained by fabricating the supporting unit using the respective resins and then testing vacuum maintenance performances of the resins. First, a supporting unit fabricated using a selected material was cleaned using ethanol, left at a low pressure for 48 hours, exposed to the air for 2.5 hours, and then subjected to an exhaust process at 90 °C for about 50 hours in a state that the supporting unit was put in the vacuum adiabatic body, thereby measuring a vacuum maintenance performance of the supporting unit.
- [72] It may be seen that in the case of the LCP, its initial exhaust performance is best, but its vacuum maintenance performance is bad. It may be expected that this is caused by sensitivity of the LCP to temperature. Also, it is expected through characteristics of the graph that, when a final allowable pressure is 5×10^{-3} Torr, its vacuum performance will be maintained for a time of about 0.5 years. Therefore, the LCP is inappropriate as the material of the supporting unit.
- [73] It may be seen that, in the case of the glass fiber PC (G/F PC), its exhaust speed is fast, but its vacuum maintenance performance is low. It is determined that this will be influenced by an additive. Also, it is expected through the characteristics of the graph that the glass fiber PC will maintain its vacuum performance will be maintained under the same condition for a time of about 8.2 years. Therefore, the LCP is inappropriate as the material of the supporting unit.
- [74] It is expected that, in the case of the low outgassing PC (O/G PC), its vacuum maintenance performance is excellent, and its vacuum performance will be maintained under the same condition for a time of about 34 years, as compared with the above-described two materials. However, it may be seen that the initial exhaust performance of the low outgassing PC is low, and therefore, the fabrication efficiency of the low outgassing PC is lowered.
- [75] It may be seen that, in the case of the PPS, its vacuum maintenance performance is remarkably excellent, and its exhaust performance is also excellent. Therefore, it is most preferably considered that, based on the vacuum maintenance performance, the PPS is used as the material of the supporting unit.
- [76] FIG. 6 illustrates results obtained by analyzing components of gases discharged from the PPS and the low outgassing PC, in which the horizontal axis represents mass numbers of gases and the vertical axis represents concentrations of gases. FIG. 6A illustrates a result obtained by analyzing a gas discharged from the low outgassing PC.

In FIG. 6A, it may be seen that H₂ series (I), H₂O series (II), N₂/CO/CO₂/O₂ series (III), and hydrocarbon series (IV) are equally discharged. FIG. 6B illustrates a result obtained by analyzing a gas discharged from the PPS. In FIG. 6B, it may be seen that H₂ series (I), H₂O series (II), and N₂/CO/CO₂/O₂ series (III) are discharged to a weak extent. FIG. 6C is a result obtained by analyzing a gas discharged from stainless steel. In FIG. 6C, it may be seen that a similar gas to the PPS is discharged from the stainless steel. Consequently, it may be seen that the PPS discharges a similar gas to the stainless steel.

- [77] As the analyzed result, it may be re-confirmed that the PPS is excellent as the material of the supporting unit.
- [78] To further reinforce the strength of the supporting unit, a material added with glass fiber (G/F) of several tens%, preferably, G/F of 40% together with the PPS may be used. To more increase in strength of a PPS+G/F 40% material used in the supporting unit, the PPS+G/F 40% material may be further subjected to a crystallization process (left under an atmosphere of 150°C or more for about 1 hour) as a post-treatment process after injection.
- [79] FIG. 7 illustrates results obtained by measuring maximum deformation temperatures at which resins are damaged by atmospheric pressure in high-temperature exhaustion. At this time, the bars 31 were provided at a diameter of 2 mm at a distance of 30 mm. Referring to FIG. 7, it may be seen that a rupture occurs at 60°C in the case of the PE, a rupture occurs at 90°C in the case of the low outgassing PC, and a rupture occurs at 125°C in the case of the PPS.
- [80] As the analyzed result, it may be seen that the PPS is most preferably used as the resin used inside the vacuum space part. However, the low outgassing PC may be used in terms of fabrication cost.
- [81] A radiation resistance sheet 32 for reducing heat radiation between the first and second plate members 10 and 20 through the vacuum space part 50 will be described. The first and second plate members 10 and 20 may be made of a stainless material capable of preventing corrosion and providing a sufficient strength. The stainless material has a relatively high emissivity of 0.16, and hence a large amount of radiation heat may be transferred. In addition, the supporting unit 30 made of the resin has a lower emissivity than the plate members, and is not entirely provided to inner surfaces of the first and second plate members 10 and 20. Hence, the supporting unit 30 does not have great influence on radiation heat. Therefore, the radiation resistance sheet 32 may be provided in a plate shape over a majority of the area of the vacuum space part 50 so as to concentrate on reduction of radiation heat transferred between the first and second plate members 10 and 20. A product having a low emissivity may be preferably used as the material of the radiation resistance sheet 32. In an embodiment, an

aluminum foil having an emissivity of 0.02 may be used as the radiation resistance sheet 32. Also, since the transfer of radiation heat may not be sufficiently blocked using one radiation resistance sheet, at least two radiation resistance sheets 32 may be provided at a certain distance so as not to contact each other. Also, at least one radiation resistance sheet may be provided in a state in which it contacts the inner surface of the first or second plate member 10 or 20.

[82] Referring back to FIG. 3B, the distance between the plate members is maintained by the supporting unit 30, and a porous material 33 may be filled in the vacuum space part 50. The porous material 33 may have a higher emissivity than the stainless material of the first and second plate members 10 and 20. However, since the porous material 33 is filled in the vacuum space part 50, the porous material 33 has a high efficiency for resisting the radiation heat transfer.

[83] In the present embodiment, the vacuum adiabatic body may be manufactured without the radiation resistance sheet 32.

[84] Referring to FIG. 3C, the supporting unit 30 for maintaining the vacuum space part 50 may not be provided. A porous material 333 may be provided to be surrounded by a film 34 instead of the supporting unit 30. Here, the porous material 33 may be provided in a state of being compressed so that the gap of the vacuum space part is maintained. The film 34 made of, for example, a PE material may be provided in a state in which a hole is punched in the film 34.

[85] In the present embodiment, the vacuum adiabatic body may be manufactured without the supporting unit 30. That is to say, the porous material 33 may perform the function of the radiation resistance sheet 32 and the function of the supporting unit 30 together.

[86] FIG. 8 is a view showing various embodiments of conductive resistance sheets and peripheral parts thereof. Structures of the conductive resistance sheets are briefly illustrated in FIG. 2, but will be understood in detail with reference to the drawings.

[87] First, a conductive resistance sheet proposed in FIG. 8A may be preferably applied to the main body-side vacuum adiabatic body. Specifically, the first and second plate members 10 and 20 are to be sealed so as to vacuumize the interior of the vacuum adiabatic body. In this case, since the two plate members have different temperatures from each other, heat transfer may occur between the two plate members. A conductive resistance sheet 60 is provided to prevent thermal conduction between two different kinds of plate members.

[88] The conductive resistance sheet 60 may be provided with the sealing part 61 at which both ends of the conductive resistance sheet 60 are sealed to defining at least one portion of the wall for the third space and maintain the vacuum state. The conductive resistance sheet 60 may be provided as a thin foil in unit of micrometer so as to reduce the amount of heat conducted along the wall for the third space. The sealing part 61

may be provided as a welding part. That is, the conductive resistance sheet 60 and the plate members 10 and 20 may be fused to each other. In order to cause a fusing action between the conductive resistance sheet 60 and the plate members 10 and 20, the conductive resistance sheet 60 and the plate members 10 and 20 may be made of the same material, and a stainless material may be used as the material. The sealing part 61 is not limited to the welding part, and may be provided through a process such as cocking. The conductive resistance sheet 60 may be provided in a curved shape. Thus, a thermal conduction distance of the conductive resistance sheet 60 is provided longer than the linear distance of each plate member, so that the amount of thermal conduction may be further reduced.

[89] A change in temperature occurs along the conductive resistance sheet 60. Therefore, in order to block heat transfer to the exterior of the conductive resistance sheet 60, a shielding part 62 may be provided at the exterior of the conductive resistance sheet 60 such that an adiabatic action occurs. In other words, in the refrigerator, the second plate member 20 has a high temperature and the first plate member 10 has a low temperature. In addition, thermal conduction from high temperature to low temperature occurs in the conductive resistance sheet 60, and hence the temperature of the conductive resistance sheet 60 is suddenly changed. Therefore, when the conductive resistance sheet 60 is opened to the exterior thereof, heat transfer through the opened place may seriously occur. In order to reduce heat loss, the shielding part 62 is provided at the exterior of the conductive resistance sheet 60. For example, when the conductive resistance sheet 60 is exposed to any one of the low-temperature space and the high-temperature space, the conductive resistance sheet 60 does not serve as a conductive resistor as well as the exposed portion thereof, which is not preferable.

[90] The shielding part 62 may be provided as a porous material contacting an outer surface of the conductive resistance sheet 60. The shielding part 62 may be provided as an adiabatic structure, e.g., a separate gasket, which is placed at the exterior of the conductive resistance sheet 60. The shielding part 62 may be provided as a portion of the vacuum adiabatic body, which is provided at a position facing a corresponding conductive resistance sheet 60 when the main body-side vacuum adiabatic body is closed with respect to the door-side vacuum adiabatic body. In order to reduce heat loss even when the main body and the door are opened, the shielding part 62 may be preferably provided as a porous material or a separate adiabatic structure.

[91] A conductive resistance sheet proposed in FIG. 8B may be preferably applied to the door-side vacuum adiabatic body. In FIG. 8B, portions different from those of FIG. 8A are described in detail, and the same description is applied to portions identical to those of FIG. 8A. A side frame 70 is further provided at an outside of the conductive resistance sheet 60. A part for sealing between the door and the main body, an exhaust

port necessary for an exhaust process, a getter port for vacuum maintenance, and the like may be placed on the side frame 70. This is because the mounting of parts is convenient in the main body-side vacuum adiabatic body, but the mounting positions of parts are limited in the door-side vacuum adiabatic body.

[92] In the door-side vacuum adiabatic body, it is difficult to place the conductive resistance sheet 60 at a front end portion of the vacuum space part, i.e., a corner side portion of the vacuum space part. This is because, unlike the main body, a corner edge portion of the door is exposed to the exterior. More specifically, if the conductive resistance sheet 60 is placed at the front end portion of the vacuum space part, the corner edge portion of the door is exposed to the exterior, and hence there is a disadvantage in that a separate adiabatic part should be configured so as to thermally insulate the conductive resistance sheet 60.

[93] A conductive resistance sheet proposed in FIG. 8C may be preferably installed in the pipeline passing through the vacuum space part. In FIG. 8C, portions different from those of FIGS. 8A and 8b are described in detail, and the same description is applied to portions identical to those of FIGS. 8A and 8B. A conductive resistance sheet having the same shape as that of FIG. 8A, preferably, a wrinkled conductive resistance sheet 63 may be provided at a peripheral portion of the pipeline 64. Accordingly, a heat transfer path may be lengthened, and deformation caused by a pressure difference may be prevented. In addition, a separate shielding part may be provided to improve the adiabatic performance of the conductive resistance sheet.

[94] A heat transfer path between the first and second plate members 10 and 20 will be described with reference back to FIG. 8A. Heat passing through the vacuum adiabatic body may be divided into surface conduction heat ① conducted along a surface of the vacuum adiabatic body, more specifically, the conductive resistance sheet 60, supporter conduction heat ② conducted along the supporting unit 30 provided inside the vacuum adiabatic body, gas conduction heat ③ conducted through an internal gas in the vacuum space part, and radiation transfer heat ④ transferred through the vacuum space part.

[95] The transfer heat may be changed depending on various design dimensions. For example, the supporting unit may be changed such that the first and second plate members 10 and 20 may endure a vacuum pressure without being deformed, the vacuum pressure may be changed, the distance between the plate members may be changed, and the length of the conductive resistance sheet may be changed. The transfer heat may be changed depending on a difference in temperature between the spaces (the first and second spaces) respectively provided by the plate members. In the embodiment, a preferred configuration of the vacuum adiabatic body has been found by considering that its total heat transfer amount is smaller than that of

a typical adiabatic structure formed by foaming polyurethane. In a typical refrigerator including the adiabatic structure formed by foaming the polyurethane, an effective heat transfer coefficient may be proposed as 19.6 mW/mK.

[96] By performing a relative analysis on heat transfer amounts of the vacuum adiabatic body of the embodiment, a heat transfer amount by the gas conduction heat ③ may become the smallest. For example, the heat transfer amount by the gas conduction heat ③ may be controlled to be equal to or smaller than 4% of the total heat transfer amount. A heat transfer amount by solid conduction heat defined as a sum of the surface conduction heat ① and the supporter conduction heat ② is the largest. For example, the heat transfer amount by the solid conduction heat may reach 75% of the total heat transfer amount. A heat transfer amount by the radiation transfer heat ④ is smaller than the heat transfer amount by the solid conduction heat but larger than the heat transfer amount of the gas conduction heat. For example, the heat transfer amount by the radiation transfer heat ④ may occupy about 20% of the total heat transfer amount.

[97] According to such a heat transfer distribution, effective heat transfer coefficients (eK: effective K) (W/mK) of the surface conduction heat ①, the supporter conduction heat ②, the gas conduction heat ③, and the radiation transfer heat ④ may have an order of Math Equation 1.

[98] [Equation 1]

[99] $eK_{\text{solid conduction heat}} > eK_{\text{radiation transfer heat}} > eK_{\text{gas conduction heat}}$

[100] Here, the effective heat transfer coefficient (eK) is a value that may be measured using a shape and temperature differences of a target product. The effective heat transfer coefficient (eK) is a value that may be obtained by measuring a total heat transfer amount and a temperature at least one portion at which heat is transferred. For example, a calorific value (W) is measured using a heating source that may be quantitatively measured in the refrigerator, a temperature distribution (K) of the door is measured using heats respectively transferred through a main body and an edge of the door of the refrigerator, and a path through which heat is transferred is calculated as a conversion value (m), thereby evaluating an effective heat transfer coefficient.

[101] The effective heat transfer coefficient (eK) of the entire vacuum adiabatic body is a value given by $k=QL/A\Delta T$. Here, Q denotes a calorific value (W) and may be obtained using a calorific value of a heater. A denotes a sectional area (m²) of the vacuum adiabatic body, L denotes a thickness (m) of the vacuum adiabatic body, and ΔT denotes a temperature difference.

[102] For the surface conduction heat, a conductive calorific value may be obtained through a temperature difference (ΔT) between an entrance and an exit of the conductive resistance sheet 60 or 63, a sectional area (A) of the conductive resistance

sheet, a length (L) of the conductive resistance sheet, and a thermal conductivity (k) of the conductive resistance sheet (the thermal conductivity of the conductive resistance sheet is a material property of a material and may be obtained in advance). For the supporter conduction heat, a conductive calorific value may be obtained through a temperature difference (ΔT) between an entrance and an exit of the supporting unit 30, a sectional area (A) of the supporting unit, a length (L) of the supporting unit, and a thermal conductivity (k) of the supporting unit. Here, the thermal conductivity of the supporting unit is a material property of a material and may be obtained in advance. The sum of the gas conduction heat ③, and the radiation transfer heat ④ may be obtained by subtracting the surface conduction heat and the supporter conduction heat from the heat transfer amount of the entire vacuum adiabatic body. A ratio of the gas conduction heat ③, and the radiation transfer heat ④ may be obtained by evaluating radiation transfer heat when no gas conduction heat exists by remarkably lowering a vacuum degree of the vacuum space part 50.

[103] When a porous material is provided inside the vacuum space part 50, porous material conduction heat ⑤ may be a sum of the supporter conduction heat ② and the radiation transfer heat ④. The porous material conduction heat may be changed depending on various variables including a kind, an amount, and the like of the porous material.

[104] According to an embodiment, a temperature difference ΔT_1 between a geometric center formed by adjacent bars 31 and a point at which each of the bars 31 is located may be preferably provided to be less than 0.5°C. Also, a temperature difference ΔT_2 between the geometric center formed by the adjacent bars 31 and an edge portion of the vacuum adiabatic body may be preferably provided to be less than 0.5°C. In the second plate member 20, a temperature difference between an average temperature of the second plate and a temperature at a point at which a heat transfer path passing through the conductive resistance sheet 60 or 63 meets the second plate may be the largest. For example, when the second space is a region hotter than the first space, the temperature at the point at which the heat transfer path passing through the conductive resistance sheet meets the second plate member becomes lowest. Similarly, when the second space is a region colder than the first space, the temperature at the point at which the heat transfer path passing through the conductive resistance sheet meets the second plate member becomes highest.

[105] This means that the amount of heat transferred through other points except the surface conduction heat passing through the conductive resistance sheet should be controlled, and the entire heat transfer amount satisfying the vacuum adiabatic body may be achieved only when the surface conduction heat occupies the largest heat transfer amount. To this end, a temperature variation of the conductive resistance sheet may be controlled to be larger than that of the plate member.

- [106] Physical characteristics of the parts constituting the vacuum adiabatic body will be described. In the vacuum adiabatic body, a force by vacuum pressure is applied to all of the parts. Therefore, a material having a strength (N/m^2) of a certain level may be preferably used.
- [107] Under such circumstances, the plate members 10 and 20 and the side frame 70 may be preferably made of a material having a sufficient strength with which they are not damaged by even vacuum pressure. For example, when the number of bars 31 is decreased so as to limit the support conduction heat, deformation of the plate member occurs due to the vacuum pressure, which may bad influence on the external appearance of refrigerator. The radiation resistance sheet 32 may be preferably made of a material that has a low emissivity and may be easily subjected to thin film processing. Also, the radiation resistance sheet 32 is to ensure a strength enough not to be deformed by an external impact. The supporting unit 30 is provided with a strength enough to support the force by the vacuum pressure and endure an external impact, and is to have machinability. The conductive resistance sheet 60 may be preferably made of a material that has a thin plate shape and may endure the vacuum pressure.
- [108] In an embodiment, the plate member, the side frame, and the conductive resistance sheet may be made of stainless materials having the same strength. The radiation resistance sheet may be made of aluminum having a weaker strength than the stainless materials. The supporting unit may be made of resin having a weaker strength than the aluminum.
- [109] Unlike the strength from the point of view of materials, analysis from the point of view of stiffness is required. The stiffness (N/m) is a property that would not be easily deformed. Although the same material is used, its stiffness may be changed depending on its shape. The conductive resistance sheets 60 or 63 may be made of a material having a strength, but the stiffness of the material is preferably low so as to increase heat resistance and minimize radiation heat as the conductive resistance sheet is uniformly spread without any roughness when the vacuum pressure is applied. The radiation resistance sheet 32 requires a stiffness of a certain level so as not to contact another part due to deformation. Particularly, an edge portion of the radiation resistance sheet may generate conduction heat due to drooping caused by the self-load of the radiation resistance sheet. Therefore, a stiffness of a certain level is required. The supporting unit 30 requires a stiffness enough to endure a compressive stress from the plate member and an external impact.
- [110] In an embodiment, the plate member and the side frame may preferably have the highest stiffness so as to prevent deformation caused by the vacuum pressure. The supporting unit, particularly, the bar may preferably have the second highest stiffness. The radiation resistance sheet may preferably have a stiffness that is lower than that of

the supporting unit but higher than that of the conductive resistance sheet. Lastly, the conductive resistance sheet may be preferably made of a material that is easily deformed by the vacuum pressure and has the lowest stiffness.

[111] Even when the porous material 33 is filled in the vacuum space part 50, the conductive resistance sheet may preferably have the lowest stiffness, and the plate member and the side frame may preferably have the highest stiffness.

[112] The vacuum space part may resist to heat transfer by only the supporting unit 30. Here, a porous material 33 may be filled with the supporting unit inside the vacuum space part 50 to resist to the heat transfer. The heat transfer to the porous material may resist without applying the supporting unit.

[113] In the above description, as a material suitable for the supporting unit, a resin of PPS has been proposed. The bar 31 is provided on the support plate 35 at gaps of 2 cm to 3 cm, and the bar 31 has a height of 1 cm to 2 cm. These resins often have poor fluidity of the resin during the molding. In many cases, the molded article does not have the designed value. Particularly, the shape of a molded product such as a bar having a short length is often not provided properly due to non-uniform injection of resin into a part far from the liquid injection port of the liquid.

[114] This may cause damage of the supporting unit or defective vacuum adiabatic body later.

[115] The supporting unit 30 is a substantially two-dimensional structure, but its area is considerably large. Therefore, if a defect occurs in one of the portions, it is difficult to discard the entire structure. This limitation becomes even more pronounced as refrigerators and warming apparatus are becoming larger in size to meet the needs of consumers.

[116] The heat exchange pipeline may be disposed in the internal space of the vacuum adiabatic body, i.e., the vacuum space part 50. The heat exchange pipeline may be provided by allowing an inlet pipe 171 through which the refrigerant is introduced into an evaporator disposed in the refrigerator to contact an outlet pipe 172 through which the refrigerant is discharged from the evaporator. Two pipelines that are the inlet pipe 171 and the outlet pipe 172 may be bonded to each other through welding. The refrigerant flowing through the inlet pipe and the outlet pipe may be heat-exchanged with each other to improve efficiency of a refrigeration cycle.

[117] An operation and configuration in a state in which the heat exchange pipeline is disposed in the vacuum space part will be described below.

[118] First, an embodiment in which a porous material 33 is filled into the third space as illustrated in FIGS. 3B and 3C will be described. In this case, the heat exchange pipeline 117 may be inserted into the third space, and then, the porous material may be filled into the third space. Here, the porous material may be filled into a region within the

third space except for the heat exchange pipeline 117 to improve adiabatic performance. Particularly, in the case of FIG. 3C, the porous material may serve to surround a position of the heat exchange pipeline 117 and also maintain a gap of the third space as the supporting unit.

[119] Alternatively, when the porous material is processed into an object having a predetermined shape at the outside, the porous material and the heat exchange pipeline may be provided first as a single body. Thereafter, the single body of the porous material and the heat exchange pipeline may be inserted into the third space.

[120] In the case of FIG. 3B, the vacuum space part may perform a function of fixing the position of the heat exchange pipeline and a function of the supporting unit, as well as, the supporting unit including the bar may be separately provided.

[121] Hereinafter, as illustrated in FIGS. 3A and 3B, an operation and configuration of the heat exchange pipeline in the vacuum space part will be described as an embodiment that is preferably applied to when the supporting unit including the bar is provided.

[122] FIG. 9 is a partial cutaway view of the vacuum adiabatic body, and FIG. 10 is a view illustrating a state in which the heat exchange pipeline is disposed in the vacuum space part.

[123] Referring to FIGS. 9 and 10, the supporting unit 30 is disposed between the plate members 10 and 20. The supporting unit 30 includes a support panel 35 contacting the plate members and at least two or more bars 31, preferably, a plurality of bars 31 maintaining a gap between the plate members 10 and 20.

[124] Each of the bars 31 may have a lower portion greater than an upper portion thereof in the drawing. As a result, high molding processability may be secured.

[125] It is preferable that the heat exchange pipeline 117 avoids contact with other members in the vacuum space part 50 as much as possible. When a pipeline made of a metal, for example, copper contacts the other member, heat exchange efficiency may be deteriorated due to thermal conduction, and thus, the adiabatic performance may not be realized. Particularly, the bonding between the metals of the plate member and the heat exchange pipeline may cause a sharp heat loss.

[126] The heat exchange pipeline 117 may be disposed so as not to contact any member at a gap between the bars 31 in the horizontal direction in a space between the plate members 10 and 20 in the vertical direction. Thus, the occurrence of the heat loss due to the contact between the heat exchange pipeline 117 and the other member may be prevented.

[127] The heat exchange pipeline 117 may be made of a material having relatively low rigidity, for example, copper. Thus, the heat exchange pipeline 117 may be weak against an external impact or force. When the heat exchange pipeline 117 is bent, any unintentional force in one direction may lead to deformation of the pipeline to cause

contact with the internal component of the vacuum space part 50. This limitation may also be caused by an external impact. Thus, the heat exchange pipeline 117 may be supported by the other guide member.

- [128] To guide the heat exchange pipeline 117 so as to be spaced apart from other members, a spacing member is provided in the vacuum space part 50. The spacing member may be provided on a bent portion at the entire position of the heat exchange pipeline 117. The bent portion may correspond to each of areas A and B of FIG. 9.
- [129] Hereinafter, the spacing member will be described.
- [130] FIG. 11 is a perspective view of a one-way spacing member that is one kind of spacing members.
- [131] Referring to FIG. 11, the one-way spacing member 100 includes a supporting part 110 that is smoothly recessed in one direction to accommodate the heat exchange pipeline to restrict movement of the heat exchange pipeline 117 in one direction and wings 120 and 121 extending from both end portions of the supporting part 110. Insertion holes 130 and 131 into which the bar 31 is inserted may be provided in the wings 120 and 121, respectively.
- [132] The supporting part 110 may have a smoothly bent cross-sectional shape. As a result, the downward movement of the heat exchange pipeline 117 may be restricted by the supporting part 110. In addition, high moldability may be secured.
- [133] The supporting part 110 may restrict the movement of the heat exchange pipeline 117 within a predetermined level range in which the heat exchange pipeline 117 moves in left and right directions. Although this case is not frequently applied in the arrangement state of the heat exchange pipeline, the movement of the heat exchange pipeline in upward and downward directions with respect to the drawings may have a great influence on the heat loss. Thus, it is understood that, since each of the upward and downward directions is defined as one direction, and the left and right directions are directions in which the movement of the heat exchange pipeline 117 does not have a great influence on the heat loss, the movement of the heat exchange pipeline is restricted in all directions by the spacing members.
- [134] The wings 120 and 121 may allow the installed position of the supporting part 110 to be supported with respect to the bar 31. For this, the wings 120 and 121 may extend up to a position at which the bar 31 is placed. That is to say, force supporting the heat exchange pipeline 117 may be provided by the bar 31. Alternatively, it may be understood that the supporting force is provided via the supporting part 110 and the wings 120 and 121.
- [135] The bar 31 may be inserted into the insertion holes 130 and 131, and the vertical movement of the one-way spacing member may be stopped at a portion at which an inner diameter of each of the insertion holes 130 and 131 match an outer diameter of

the bar 31. The bar 31 may have a cross-sectional diameter that gradually increases. Thus, the wings 120 and 121 may be supported between the largest cross-sectional diameter A1 the smallest cross-sectional diameter A2.

- [136] The one-way spacing member of FIG. 11 according to an embodiment may restrict the movement of the heat exchange pipeline 117 to a lower side in the drawings (here, the lower side is defined toward a thick side in the diameter of the bar), i.e., the downward movement of the heat exchange pipeline 117.
- [137] FIG. 12 is a perspective view of a one-way spacing member according to another embodiment. The spacing member according to this embodiment is substantially the same as that according to the foregoing embodiment except that a supporting protrusion is provided. Thus, the same description as that of FIG. 11 may be equally applied to description of FIG. 12.
- [138] Referring to FIG. 12, a supporting protrusion 140 is further provided at the lowest position of a supporting part 110. The supporting protrusion 140 may be used for restricting the excessive movement of the supporting part 110. The supporting protrusion 140 protrudes from the supporting part 10 by a predetermined height. When the heat exchange pipeline 117 pushes the supporting part 110, the supporting part 110 may contact the support plate 35 to restrict the movement of the heat exchange pipeline 117. However, the supporting protrusion 140 may do not always contact the support plate 35 and thus act as a factor that causes a conductive heat loss. When the supporting protrusion 140 is designed, the supporting protrusion 140 may have a shape and length so as not to contact peripheral other members such as the support plate 35 when the spacing member is mounted. Alternatively, if excessively pushed when the heat exchange pipeline 117 is installed, although the supporting protrusion 140 contacts the support plate 35, the space member may be restored by restoring force thereof to prevent the supporting protrusion 140 from contacting the support plate 35.
- [139] Unlike that the supporting protrusion 140 is provided, a predetermined support structure may be processed on an outer circumferential surface of the bar 31, or a separate hook member may be provided to further give a hooking operation between the wings 120 and 121 and the bar 31. However, for convenience of description, it may be more convenient to provide the supporting protrusion 140 on a single member. This may be applied to all following embodiments.
- [140] The one-way spacing member may be made of a resin that is the same material as the supporting unit 30. For example, when the supporting unit is made of a PPS+G/F 40% material to reinforce strength, the crystallization process may not be applied to the one-way spacing member 100. This object is to obtain an effect of absorbing a predetermined amount of external force applied from the heat exchange pipeline 117 and restoring force after deformation. The deformation restoring force may be more clearly

understood in case of an open-type one-way spacing member that will be described below.

- [141] The material of the spacing member may be equally applied to all the following spacing members without further explanation.
- [142] An operation of the one-way spacing member 100 will be described with reference to FIGS. 14 and 15.
- [143] FIG. 14 is a front view illustrating a state in which a pair of one-way spacing members are installed, and FIG. 15 is a partial cutaway view of the vacuum adiabatic body in a state in which the heat exchange pipeline is installed.
- [144] In a state in which the pair of one-way spacing members are installed, one one-way spacing member may restrict movement of the heat exchange pipeline in one direction, and the other one-way spacing member may restrict movement of the heat exchange pipeline in the other direction.
- [145] In more detail, a first one-way spacing member, which is disposed at a front side in FIGS. 14 and 15, may restrict downward movement of the heat exchange pipeline 117, and a second one-way spacing member, which is disposed at a rear side, may restrict upward movement of the heat exchange pipeline 117. The first one-way spacing member may be a member in which the supporting protrusion 140 is not provided and restrict the movement of the heat exchange pipeline 117 by an actual supporting operation between the insertion holes 130 and 131 and the bar 31. The second one-way spacing member may be a member in which the supporting protrusion 140 is provided. Thus, when pushed by the heat exchange pipeline 117, the supporting protrusion 140 contacts and support the support plate 35, the second one-way spacing member may restrict additional thermal conduction.
- [146] As illustrated in FIG. 15, the one-way spacing member 100 may not support the heat exchange pipeline 117 in all upward and downward directions at one position. That is to say, the downward movement of the heat exchange pipeline 117 may be restricted at one position, and the upward movement of the heat exchange pipeline 117 may be restricted at the other position that is spaced apart from the one position.
- [147] When the heat exchange pipeline 117 is shaken in the horizontal direction, the supporting part 110 provided in the band shape may guide the heat exchange pipeline 117 to prevent the heat exchange pipeline 117 and the bar 31 from contacting each other. This may be realized because the bar 31 and the one-way spacing member 100 are fixed in position with respect to each other.
- [148] Since the one-way spacing member 100 is made of a non-metal material by using a resin as a base material, it is difficult to manufacturing a one-way spacing member having a thin plate shape. Thus, it is difficult to install the one-way spacing member 100 together with a radiation resistance sheet 32 in a space between the supporting

units. In consideration to the above-described structure, the insertion holes 130 and 131 are provided to surround the bar 31.

[149] The radiation resistance sheet 32 may be further installed in the vacuum space part 50. The radiation resistance sheet 32 may be provided with a cutoff part that is cut so as not to contact the one-way spacing member.

[150] In more detail, the one-way spacing member 100 may be supported by the bar 31 but move in at least one direction along the bar 31. As a result, when the radiation resistance sheet 32 and the one-way spacing member 100 are installed to overlap each other, the radiation resistance sheet 32 may be damaged by the one-way spacing member 100. Thus, the radiation resistance sheet 32 may be cut in a portion of a space in which the one-way spacing member 100 is installed.

[151] The description of the cutoff part of the radiation resistance sheet 32 may be equally applied to following other spacing members without further explanation. The radiation resistance sheet may not be applied to the vacuum adiabatic body having a low adiabatic load.

[152] FIG. 16 is a partial cutaway view illustrating another example of the vacuum adiabatic body in the state in which the heat exchange pipeline is installed.

[153] Referring to FIG. 16, a portion of the vacuum adiabatic body in which the supporting protrusion 140 is provided in each of the upward and downward directions of the heat exchange pipeline 117. According to this embodiment, since the single spacing member is provided, convenience of work may be expected. Even though the one-way spacing member 100 is fixed in position by the relationship between the inner diameter of each of the insertion holes 130 and 131 and the outer diameter of the bar 31, the installation position of the heat exchange pipeline 117 may be more firmly fixed by the supporting protrusion 140.

[154] FIG. 13 is a perspective view of a one-way spacing member according to further another embodiment.

[155] Referring to FIG. 13, this embodiment is different from the foregoing embodiment in that a supporting protrusion 150 is not installed at the lowermost point of a supporting part 110 but installed on wings 120 and 121.

[156] In case of the embodiment of FIG. 13, movement of the supporting part 110 may be restricted to stably maintain an installation position of a heat exchange pipeline 117. Although the supporting protrusion 150 is provided on one side in the drawings, this embodiment is not limited thereto. For example, the supporting protrusion may be provided on each of both wings 120 and 121.

[157] Various methods of installing the one-way spacing member on the vacuum adiabatic body will be described.

[158] A first method is as follows. First, the one-way spacing member, the supporting unit,

and the heat exchange pipeline may be assembled to manufacture an assembly. In a state in which a first plate member and a second plate member are separately temporarily assembled, the assembly is inserted into a gap between the plate members. Thereafter, a third space may be sealed from external other spaces, and then, a gas within the third space may be exhausted.

- [159] A second method is as follows. First, the one-way spacing member, the supporting unit, and the heat exchange pipeline may be assembled to manufacture an assembly. The assembly is seated on one plate member, and the other plate member is coupled to the one plate member. Then, the third space is sealed from the external outer spaces. Then, the gas within the third space may be exhausted.
- [160] All the first method and the second method may be methods for manufacturing the assembly and performed as follows. First, the lower one-way spacing member may be mounted on a supporting unit, and the heat exchange pipeline may be seated on the lower one-way spacing member. Then, the upper one-way spacing member may be seated on the supporting unit.
- [161] FIG. 17 is view illustrating a use state of a spacing member according to further another embodiment. A spacing member according to this embodiment may be a close-type bidirectional spacing member. The close-type bidirectional spacing member may be different from the one-way spacing member in that the single spacing member restricts the bidirectional movement of the heat exchange pipeline. However, since other explanations are the same as those of FIG. 14, the explanations may be equally applied.
- [162] Referring to FIG. 17, the close-type bidirectional spacing member 160 includes a supporting part 110 having a smoothly bent shape, of which a cross-section has a closed curve shape, and supporting a heat exchange pipeline 117, wings 120 and 121 extending in both directions of the supporting part 110, and a supporting protrusion 140 extending in a vertical direction.
- [163] The heat exchange pipeline 117 may be provided on the close-type bidirectional spacing member 160 to pass through the supporting part 110, and then, the close-type bidirectional spacing member 160 may be supported on the bar 31. This is done because the supporting part 110 is provided in close-type, i.e., cross-section having the closed curve shape.
- [164] The supporting protrusion 140 according to this embodiment may not be provided downward by a hooking operation between the insertion holes and the bar. However, the supporting protrusion 140 may be provided in all the upward and downward directions to easily manage maintenance through compatibility of the same member.
- [165] In the case of this embodiment, there is discomfort in that the heat exchange pipeline 117 and the close-type bidirectional spacing member 160 have to be previously

coupled to each other (that is, the required number of supporting parts 110 of the heat exchange pipeline 117 has to be previously inserted into the heat exchange pipeline 117). However, since the bar and the spacing member are mutually fixed to each other to prevent the spacing member installed at one end from being shaken, the post-work may be convenient. Like the further another embodiment, there is an advantage in which the heat exchange pipeline is supported by the spacing member so that the relative positions between the bar 31 and the plate members 10 and 20 are accurately fixed.

- [166] In the close-type bidirectional spacing member 160, there is an inconvenience that the heat exchange pipeline 117 has to be inserted into the supporting part 110. Further another embodiment for solving this inconvenience will be disclosed below.
- [167] Various methods of installing the close-type bidirectional spacing member on the vacuum adiabatic body will be described.
- [168] A first method is as follows. First, the close-type bidirectional spacing member, the supporting unit, and the heat exchange pipeline may be assembled to manufacture an assembly. In a state in which a first plate member and a second plate member are separately temporarily assembled, the assembly is inserted into a gap between the plate members. Thereafter, a third space may be sealed from external other spaces, and then, a gas within the third space may be exhausted.
- [169] A second method is as follows. First, the close-type bidirectional spacing member, the supporting unit, and the heat exchange pipeline may be assembled to manufacture an assembly. The assembly is seated on one plate member, and the other plate member is coupled to the one plate member. Then, the third space is sealed from the external outer spaces. Then, the gas within the third space may be exhausted.
- [170] All the first method and the second method may be methods for manufacturing the assembly and performed as follows. First, the lower close-type bidirectional spacing member is inserted into the heat exchange pipeline. The close-type bidirectional spacing member may move to a proper position so as to be seated on the supporting member.
- [171] FIG. 18 is a perspective view of a spacing member according to further another embodiment. A spacing member according to this embodiment may be an open-type bidirectional spacing member. The open-type bidirectional spacing member may also restrict bidirectional movement of a heat exchange pipeline through the single spacing member. However, open-type bidirectional spacing member is different from the close-type bidirectional spacing member in that a predetermined gap of a supporting part is opened. Other descriptions are the same as those of the other embodiments in addition to the embodiment of FIG. 17, and thus, the description will be applied at it is.
- [172] Referring to FIG. 18, the open-type bidirectional spacing member 200 includes a

supporting part 210, wings 220 and 221, an insertion hole 230, and a supporting protrusion 231 like the forgoing embodiments.

[173] Although the supporting part 210 is opened upward with respect to the drawings, the opened portion of the supporting part 210 is narrow unlike the one-way spacing member 100. Due to the above-described shape, the heat exchange pipeline 117 may not freely pass through the opened portion. That is to say, the opened portion may be expanded when the heat exchange pipeline 117 is inserted into the supporting part 210 and then contracted again after the heat exchange pipeline 117 is inserted into the supporting part 210. Thus, the heat exchange pipeline 117 already inserted into the supporting part 210 may be fixed so as not to be separated.

[174] The supporting part 210 may have a circular shape of which open side is opened. Here, both end portions of the supporting part 210 and a gap between both the end portions may provide a recessed groove 212 in the opened portion so that the heat exchange pipeline 117 is inserted into the supporting part 210. The recess groove 212 may be expanded within a predetermined range. Since the recess groove 212 has the expandable structure and is a component that is elastically deformable, the recess groove 212 may be called an elastically deformable frame. The spacing member may be made of a resin and thus be elastically deformable with a predetermined range.

[175] The open-type bidirectional spacing member 200 may be in a state of being installed at the bar 31 or not. Here, the recess groove 212 may be spread so that the heat exchange pipeline 117 is inserted into the supporting part 210. Alternatively, since the recess groove 212 is contracted by elastic restoring force after the heat exchange pipeline 117 is inserted, the heat exchange pipeline 117 may not be separated without external force, and an installation position of the heat exchange pipeline 117 may be fixed inside the supporting part 210.

[176] FIG. 19 is a perspective view of an open-type bidirectional spacing member according to further another embodiment. The open-type bidirectional spacing member may be substantially the same as that of FIG. 18 except for a supporting protrusion. The description of FIG. 18 will be applied as it is without any specific explanation.

[177] Referring to FIG. 19, a supporting part 210, wings 220 and 221, and an insertion hole 230 may be equally provided like the open-type bidirectional spacing member of FIG. 18. However, supporting protrusions 240 and 241 may not be provided on the supporting part 210 but provided on the wings 220 and 221.

[178] The supporting protrusions 240 and 241 may have one side extending upward from the wing and the other side extending downward from the wing. According to this configuration, the movement of the supporting part 210 and the movement of the heat exchange pipeline 117 may be stopped by the supporting protrusions 240 and 241 either upward or downward.

- [179] Each of the supporting protrusions 240 and 241 may have one side extending upward from the wing and the other side extending downward from the wing to reduce thermal conductivity generated between the plate members 10 and 20 through the spacing member. That is to say, a thermal conduction path through the contact is extended from an end portion of the one side supporting protrusion 240 to an end portion of the other side supporting protrusion 240. Thus, the thermal conduction path includes the supporting part 210. Therefore, thermal conduction between the plate members 10 and 20 may be more reduced.
- [180] FIG. 20 is a perspective view of an open-type bidirectional spacing member according to further another embodiment. The open-type bidirectional spacing member may be substantially the same as that of FIGS. 18 and 19 except for a supporting protrusion. The description of FIGS. 18 and 19 will be applied as it is without any specific explanation.
- [181] Referring to FIG. 20, a supporting part 210, wings 220 and 221, and an insertion hole 230 may be equally provided like the open-type bidirectional spacing member according to the foregoing embodiment. However, supporting protrusions 251, 252, and 253 may be disposed one by one on a lower end portion of the supporting part 210 and a pair of wings 220 and 221.
- [182] The supporting protrusions 240 and 241 may have both sides extending upward from the wings. According to this configuration, the movement of the supporting part 210 and the movement of the heat exchange pipeline 117 may be stopped by the supporting protrusions 251, 252, and 253 either upward or downward.
- [183] The open-type bidirectional spacing member according to this embodiment may be applied to a case in which force for allowing the spacing member to support the heat exchange pipeline is large because movement of the heat exchange pipeline 117 is large.
- [184] The spacing member may be advantageous in that the installation of the radiation resistance sheet is convenient according to its type. In detail, it is possible to realize a configuration in which both upward and downward movement along the bar 31 is restricted by the action of the supporting protrusion of the bidirectional spacing member. In this case, the spacing member and the radiation resistance sheet may be coupled to each other to improve workability. Here, thermal conductivity may be easy through the radiation resistance sheet and the spacing member.
- [185] FIGS. 21 to 23 are front views illustrating a state in which the open-type bidirectional spacing member of FIGS. 18 to 20 is installed on the bar and the heat exchange pipeline.
- [186] Referring to FIG. 21, the downward movement of the open-type bidirectional spacing member may be restricted due to the contact with the wing and the bar. The

upward movement of the open-type bidirectional spacing member may be restricted by the supporting protrusion 231.

[187] Referring to FIG. 22, all of the downward movement and the upward movement of the open-type bidirectional spacing member may be restricted by the supporting protrusion 240. In this case, the contact with the wing and the bar may be unnecessary, and each of the insertion holes 230 and 231 may have a diameter greater than that of the bar to reduce the thermal conduction due to the contact between the spacing member and the bar.

[188] Referring to FIG. 23, the downward movement of the open-type bidirectional spacing member may be restricted by the supporting protrusions 252 and 253 disposed on the supporting part 210. The upward movement of the open-type bidirectional spacing member may be restricted by the supporting protrusions 252 and 253 disposed on the wing.

[189] Also, in this case, the contact with the wing and the bar may be unnecessary, and each of the insertion holes 230 and 231 may have a diameter greater than that of the bar to reduce the thermal conduction due to the contact between the spacing member and the bar.

[190] FIG. 24 is a view illustrating a state in which the open-type bidirectional spacing member is installed.

[191] Referring to FIG. 24, the open-type bidirectional spacing member may have a width w_2 greater than that w_1 of each of lattice frames constituting the support plate 35. Thus, even though the spacing member moves by the heat exchange pipeline 117, there is no fear that the supporting of the supporting protrusion 231 by the support plate 35 is twisted. Alternatively, only the width of the supporting protrusion 231 may more increase.

[192] The insertion hole 230 may have a width w_4 greater than a diameter w_3 of the bar 31. For example, the insertion hole 230 may have a width w_4 that is about 1.2 times to about 2.0 time the diameter w_3 of the bar 31. Thus, the contact between the wing and the bar may be prevented to more reduce the thermal conduction. In addition, when the recess groove 212 is expanded so that the heat exchange pipeline is inserted in the state in which the open-type bidirectional spacing member is supported by the bar, the recess groove 212 may function as a tolerance that is capable of accepting the deformation of the wing.

[193] The description of this drawing may be applied to all open-type bidirectional spacing members as well.

[194] FIG. 25 is a front view of the open-type spacing member.

[195] Referring to FIG. 25, the wings 220 and 221 may be provided above a geometrical center C of the supporting part 210. Thus, the recess groove 212 may be expanded to

realize an effect in which the support part 210 sufficiently provides an elastically deformable section. That is to say, all the lower supporting parts on which the wing provided may serve as springs. The description of this drawing may be applied to all open-type bidirectional spacing members as well.

[196] Various methods of installing the open-type bidirectional spacing member on the vacuum adiabatic body will be described.

[197] A first method is as follows. First, the open-type bidirectional spacing member, the supporting unit, and the heat exchange pipeline may be assembled to manufacture an assembly. In a state in which a first plate member and a second plate member are separately temporarily assembled, the assembly is inserted into a gap between the plate members. Thereafter, a third space may be sealed from external other spaces, and then, a gas within the third space may be exhausted.

[198] A second method is as follows. First, the open-type bidirectional spacing member, the supporting unit, and the heat exchange pipeline may be assembled to manufacture an assembly. The assembly is seated on one plate member, and the other plate member is coupled to the one plate member. Then, the third space is sealed from the external outer spaces. Then, the gas within the third space may be exhausted.

[199] All the first method and the second method may be methods for manufacturing the assembly and performed as follows. First, the heat exchange pipeline is inserted into the open-type bidirectional spacing member. The open-type bidirectional spacing member may move to a proper position so as to be seated on the supporting member. As alternative method, the open-type bidirectional spacing member is seated on the supporting unit. The recess groove of the open-type bidirectional spacing member may be spread so that the heat exchange pipeline is inserted into the supporting part.

[200] A third method is as follows. First, in a state in which the heat exchange pipeline is provided in one plate member, the heat exchange pipeline may be inserted into the supporting part of the open-type bidirectional spacing member. Here, the open-type bidirectional spacing member may be in the state of being coupled to the supporting unit or be coupled to the supporting unit later. Thereafter, the other plate member may be coupled to the one plate member, and the third space may be sealed from external other spaces. Then, the gas within the third space may be exhausted.

[201] All the spacing members disclosed in this embodiment may be fixed by the supporting unit 30 without moving. For example, the bar 31 may be inserted into the insertion hole 231 provided in the spacing member, and the spacing member including the wing 120 in which the insertion hole is defined may be fixed by the supporting unit including the bar 31. Here, the spacing member may slightly move by a gap between the components.

[202] The heat exchange pipeline 117 may be disposed within the spacing member. The

heat exchange pipeline 117 may be disposed within the supporting part 110 of the spacing member and thus be fixed in position.

[203] First fixing of the spacing member due to the supporting unit 30 and second fixing of the heat exchange pipeline due to the spacing member may be realized at the same time. According to the first fixing and the second fixing, the heat exchange pipeline 117 may be fixed by the supporting unit 30. In detail, when the heat exchange pipeline 117 is placed in the direction in which the vacuum adiabatic body extends, the vertical and horizontal movement of the heat exchange pipeline 117 may be restricted by the supporting unit.

[204] The heat exchange pipeline 117 may be prevented from vertically moving to reduce the adiabatic loss that occurs due to the contact between the heat exchange pipeline 117 and the plate member. The horizontal movement of the heat exchange pipeline 117 may be restricted to prevent the components disposed within the third space from colliding with the heat exchange pipeline 117 when an impact is applied to the vacuum adiabatic body, thereby protecting the components within the third space.

[205] The horizontal movement of the heat exchange pipeline 117 may be restricted to prevent the heat exchange pipeline 117 from contacting and approaching the supporting unit, i.e., the bar 31 while the vacuum adiabatic body is manufactured. Thus, the inlet pipe and the outlet pipe, which constitute the heat exchange pipeline 117, may be promoted in heat transfer therebetween, and the heat transfer between the inlet and outlet pipes and the supporting unit may be prevented to reduce the adiabatic loss. In addition, an impact applied to the supporting unit, i.e., the bar 31 due to the horizontal movement of the heat exchange pipeline 117 may be prevented to improve reliability of the vacuum adiabatic body.

Industrial Applicability

[206] The present disclosure may provide the structure that is capable of reliably supporting the heat exchange pipeline as the method for more improving the adiabatic efficiency of the vacuum adiabatic body that is applied to the refrigeration cycle. Therefore, the convenient workability and the reliability of the product may be secured, and the production yield of the product may be improved.

Claims

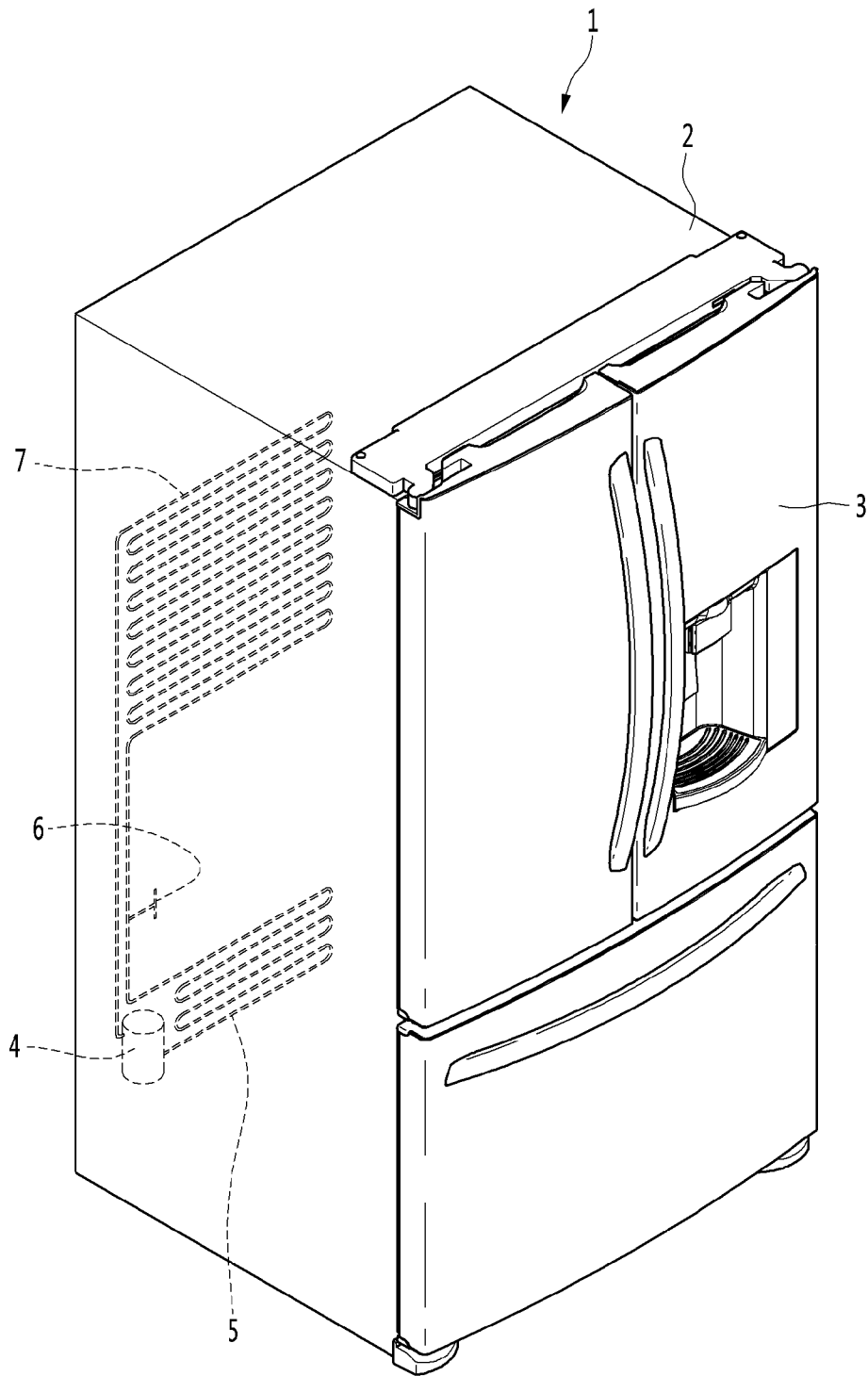
- [Claim 1] A vacuum adiabatic body comprising:
a first plate member configured to define at least a portion of a wall for a first space;
a second plate member configured to define at least a portion of a wall for a second space having a temperature different from that of the first space;
a sealing part configured to seal the first plate member and the second plate member so as to provide a third space that has a temperature between the temperature of the first space and the temperature of the second space and is a vacuum space;
a supporting unit configured to maintain the third space;
a heat resistance unit configured to reduce a heat transfer amount between the first plate member and the second plate member;
an exhaust port configured to discharge a gas within the third space;
and
a pipeline placed in the third space,
wherein movement of the pipeline in a horizontal direction is restricted by the supporting unit.
- [Claim 2] The vacuum adiabatic body according to claim 1, further comprising at least one spacing member that is made of a non-metallic material and interposed between the pipeline and the supporting unit.
- [Claim 3] The vacuum adiabatic body according to claim 2, wherein the supporting unit comprises a bar configured to maintain a gap between the first plate and the second plate, and
the spacing member comprises:
a supporting part configured to accommodate the pipeline so as to restrict the movement of the pipeline; and
at least one wing extending from the supporting part so as to be hung and supported by the bar.
- [Claim 4] The vacuum adiabatic body according to claim 3, wherein the supporting part surrounds only a portion of the pipeline.
- [Claim 5] The vacuum adiabatic body according to claim 3, wherein at least two wings are provided with respect to one supporting part.
- [Claim 6] The vacuum adiabatic body according to claim 3, wherein an insertion hole into which the bar is inserted is provided in the wing, and the insertion hole has an inner diameter greater than an outer diameter

- of the bar to surround the bar.
- [Claim 7] The vacuum adiabatic body according to claim 6, wherein an inner surface of the insertion hole is spaced a predetermined distance from an outer surface of the bar to prevent the supporting part from interfering when the supporting part is deformed.
- [Claim 8] The vacuum adiabatic body according to claim 3, wherein the spacing member is a one-way spacing member in which the supporting part is largely opened relative to the pipeline so as to permit free movement in any one direction of upward and downward directions of the pipeline.
- [Claim 9] The vacuum adiabatic body according to claim 3, wherein the spacing member is a bidirectional spacing member that does not permit free movement in all directions of the pipeline.
- [Claim 10] The vacuum adiabatic body according to claim 9, wherein the bidirectional spacing member has a recessed groove in which one side of the supporting part is relatively slightly opened when compared to the pipeline, and
the supporting part is an open-type bidirectional spacing member that is made of a deformable resin material.
- [Claim 11] The vacuum adiabatic body according to claim 9, wherein the wing is disposed at an upper side when viewed from a center of the supporting part as a position that is adjacent to an end of the recessed groove.
- [Claim 12] The vacuum adiabatic body according to claim 9, wherein an inner surface of the insertion hole is spaced a predetermined distance from an outer surface of the bar to prevent the supporting part from interfering when the supporting part is deformed.
- [Claim 13] The vacuum adiabatic body according to claim 9, wherein the bidirectional spacing member is a closed bidirectional spacing member provided in a closed curve shape in which the supporting part is sealed.
- [Claim 14] The vacuum adiabatic body according to any one of claims 2 to 13, wherein at least one supporting protrusion extending to at least one plate member of the first plate member or the second plate member is disposed on at least one of the wing or the supporting part.
- [Claim 15] The vacuum adiabatic body according to claim 2, wherein the supporting unit further comprises a lattice-shaped support plate that contacts at least one plate member of the first plate member or the second plate member, and
the spacing member has a width greater than that of a lattice frame of the support plate.

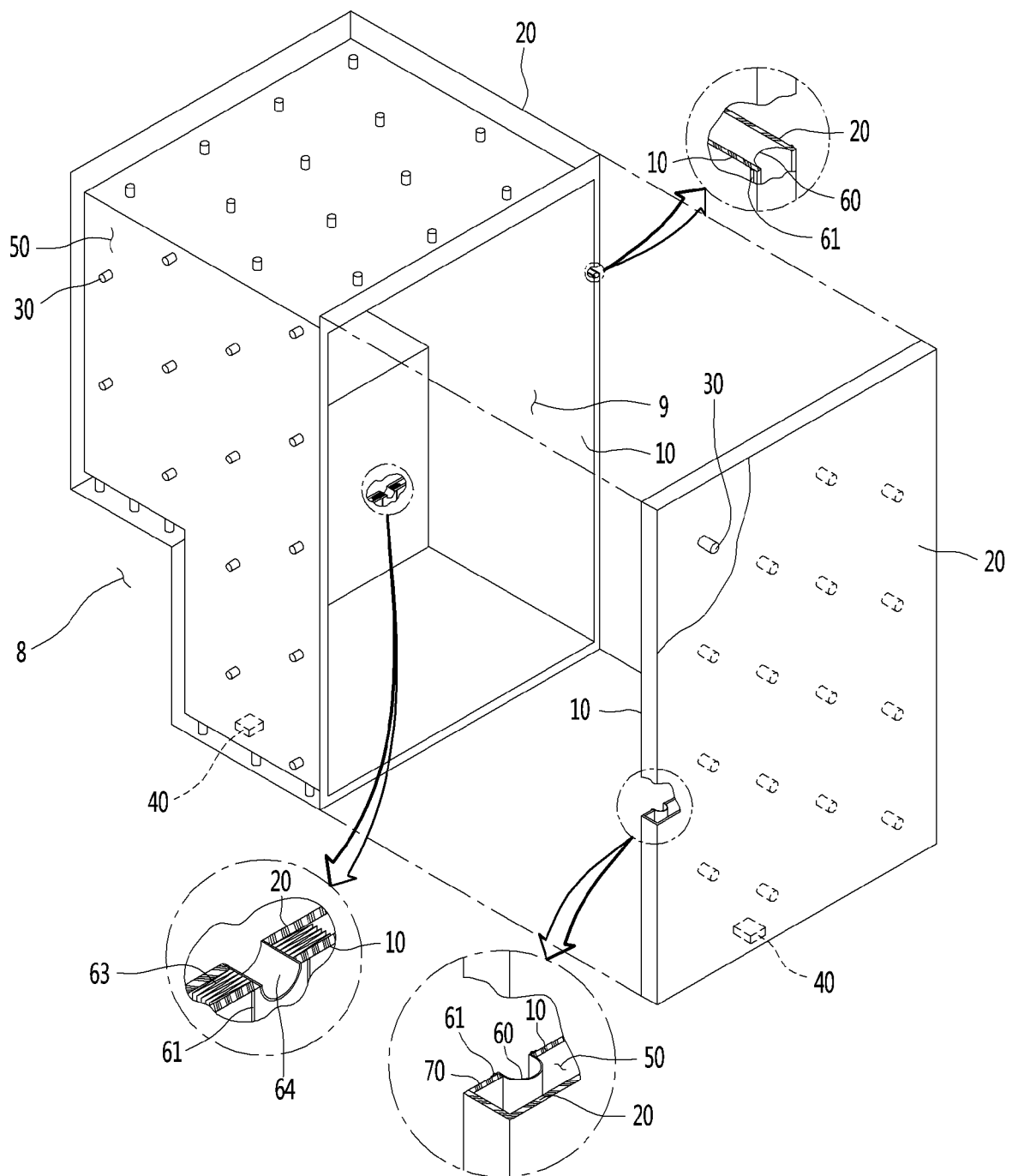
- [Claim 16] The vacuum adiabatic body according to claim 2, wherein a radiation resistance sheet configured to reduce radiation heat transfer between the plate members is disposed in the third space, and the radiation resistance sheet is cut so as not to contact the spacing member.
- [Claim 17] A refrigerator comprising:
a main body configured to provide an internal space in which storage goods are stored; and
a door provided so that the internal space is openable with respect to an external space,
wherein, in order to supply a refrigerant into a cavity, the refrigerator further comprises:
a compressor configured to compress the refrigerant;
a condenser configured to condense the compressed refrigerant;
an expansion device configured to expand the condensed refrigerant;
an evaporator configured to evaporate the expanded refrigerant to dissipate heat; and
a heat exchange pipeline in which a refrigerant outlet pipe, through which the refrigerant is discharged from the evaporator, and a refrigerant inlet pipe, through which the refrigerant is introduced into the evaporator, are heat-exchanged with each other, and
the main body comprises a vacuum adiabatic body,
wherein the vacuum adiabatic body comprises:
a first plate member configured to define at least a portion of a wall for the internal space;
a second plate member configured to define at least a portion of a wall for the external space;
a sealing part configured to seal the first plate member and the second plate member so as to provide a vacuum space part that has a temperature between the temperature of the internal space and the temperature of the external space and is a vacuum space;
a supporting unit configured to maintain the vacuum space part;
at least one spacing member configured to space the heat exchange pipeline from the other member within the vacuum space part and support the heat exchange pipeline;
a heat resistance unit configured to reduce a heat transfer amount between the first plate member and the second plate member; and
an exhaust port configured to discharge a gas within the vacuum space

- part,
wherein movement of the pipeline is restricted by the supporting unit.
- [Claim 18] The refrigerator according to claim 17, wherein the supporting unit comprises a porous material.
- [Claim 19] The refrigerator according to claim 17, wherein the supporting unit comprises a bar configured to maintain contraction between the plate members, and
the spacing member comprises:
a supporting part configured to accommodate the pipeline so as to restrict the movement of the pipeline; and
at least one wing extending from the supporting part, the at least one wing being supported by the bar.
- [Claim 20] A vacuum adiabatic body comprising:
a first plate member configured to define at least a portion of a wall for a first space;
a second plate member configured to define at least a portion of a wall for a second space having a temperature different from that of the first space;
a sealing part configured to seal the first plate member and the second plate member so as to provide a third space that has a temperature between the temperature of the first space and the temperature of the second space and is a vacuum space;
a supporting unit configured to maintain the third space;
a heat resistance unit configured to reduce a heat transfer amount between the first plate member and the second plate member;
an exhaust port configured to discharge a gas within the third space;
two pipelines placed in the third space; and
a spacing member configured to restrict movement of the pipeline in a horizontal direction,
wherein the spacing member is supported on the supporting unit, and
the horizontal direction comprises an extension direction of any one of the plate members.

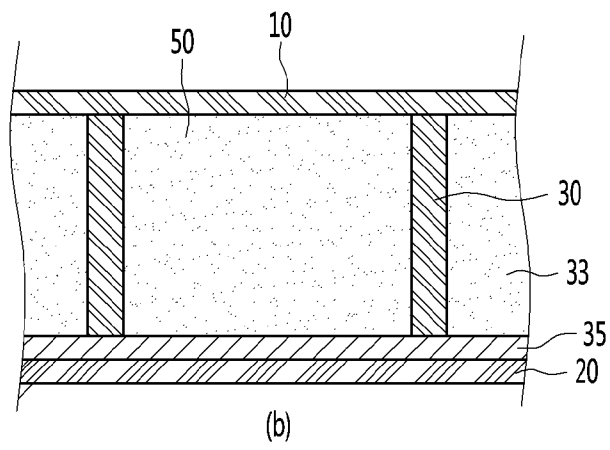
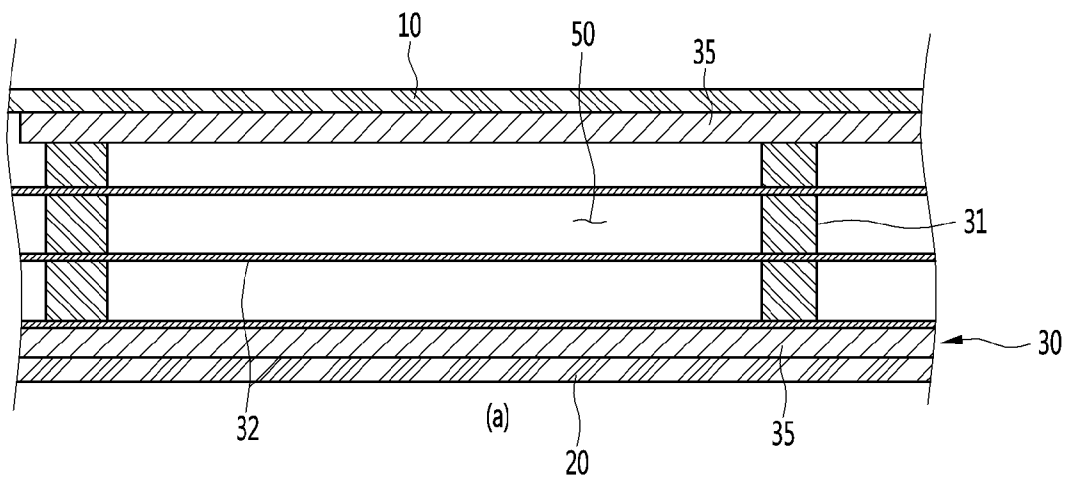
[Fig. 1]



[Fig. 2]



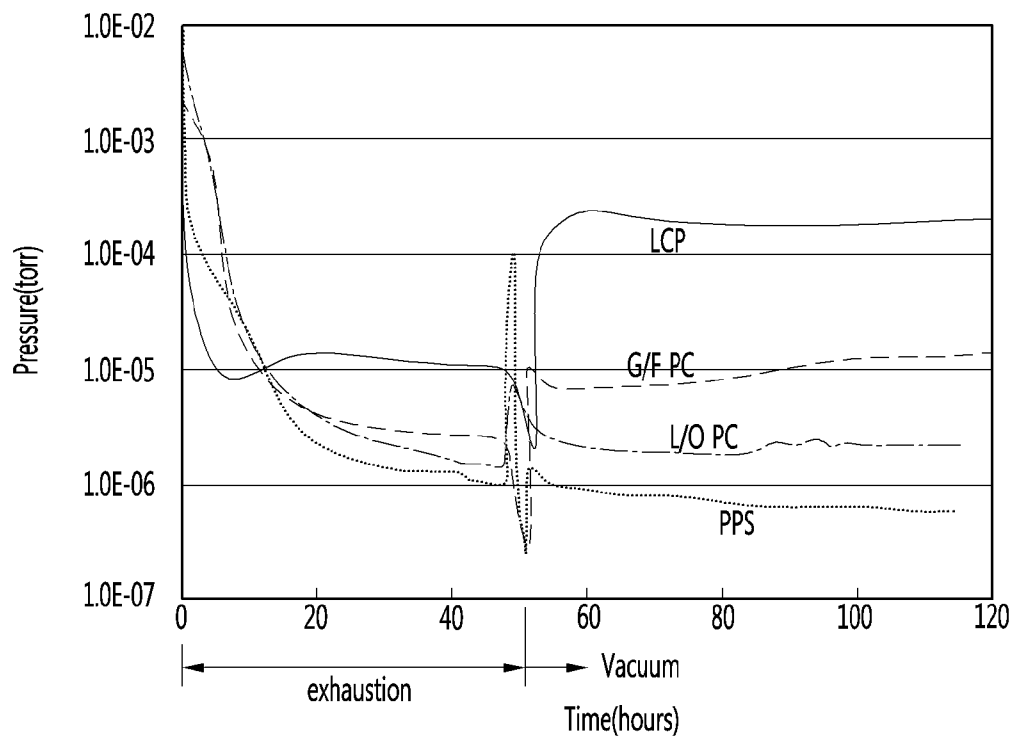
[Fig. 3]



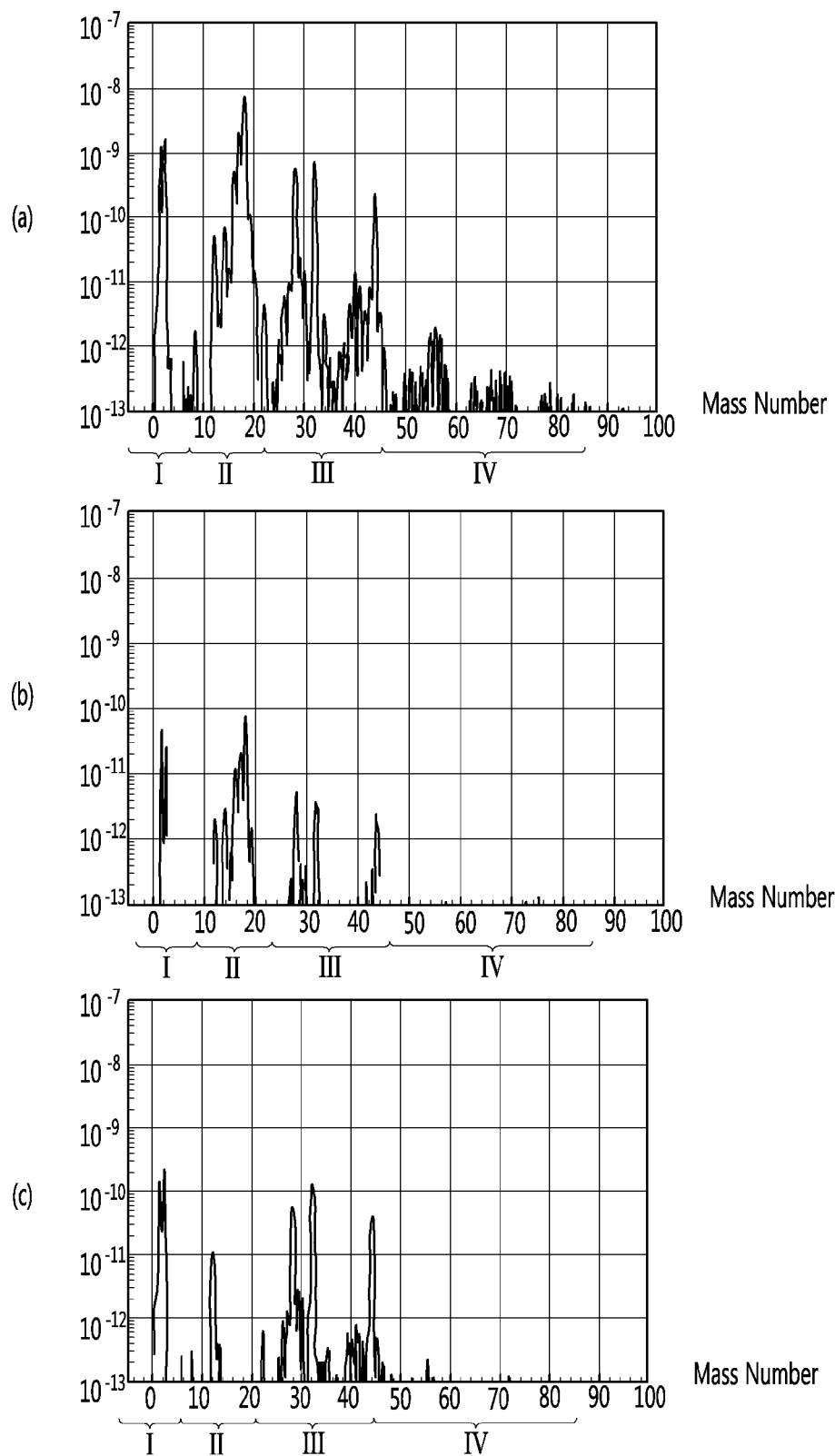
[Fig. 4]

Group		General plastic					Engineering plastic			
Material		(HD)PE *G-Plastic Reference	PC	Glass fiber PC (30% Glass-F)	*Low outgassing PC		PCTFE	PPS	LCP	PEEK
	Out-gassing rate	TML(%)	0.58	0.19	0.14	No Data	0.01	0.06	0.06	0.26
Compressive Strength	MPa	31.7	82.8	124.1	*80.6		37.9	107.0	* 151.1	137.9
Thermal Conductivity	W/m-k	<0.40	0.18	0.18	0.18		0.20	0.3	0.36 (G/F 50%)	0.25
Strength /Cond.	MPa-m-k/W	79	460	689	448		189	357	420	552
Heat Deflection Temp at 264 psi	℃	80	132	146	125		126	121	105 ~ 260	160
Max Operating Temperature	℃	82	121	132	No Data		132	218	No Data	249
*Cost(per 1kg)		Low	\$3.1	\$6.2(G/F20%)	\$6.7		High	\$30	\$40	\$150

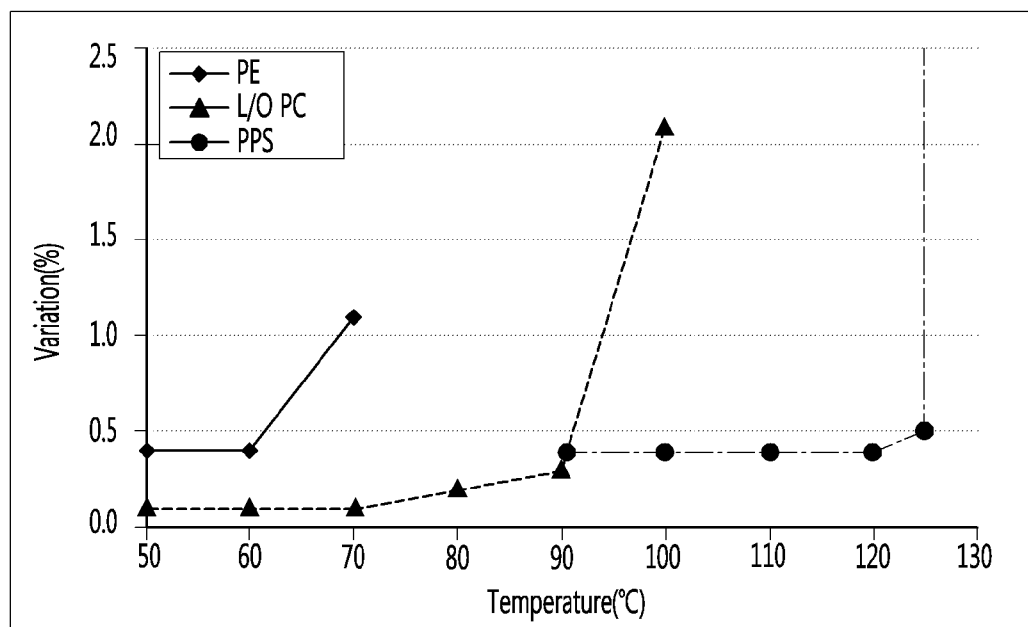
[Fig. 5]



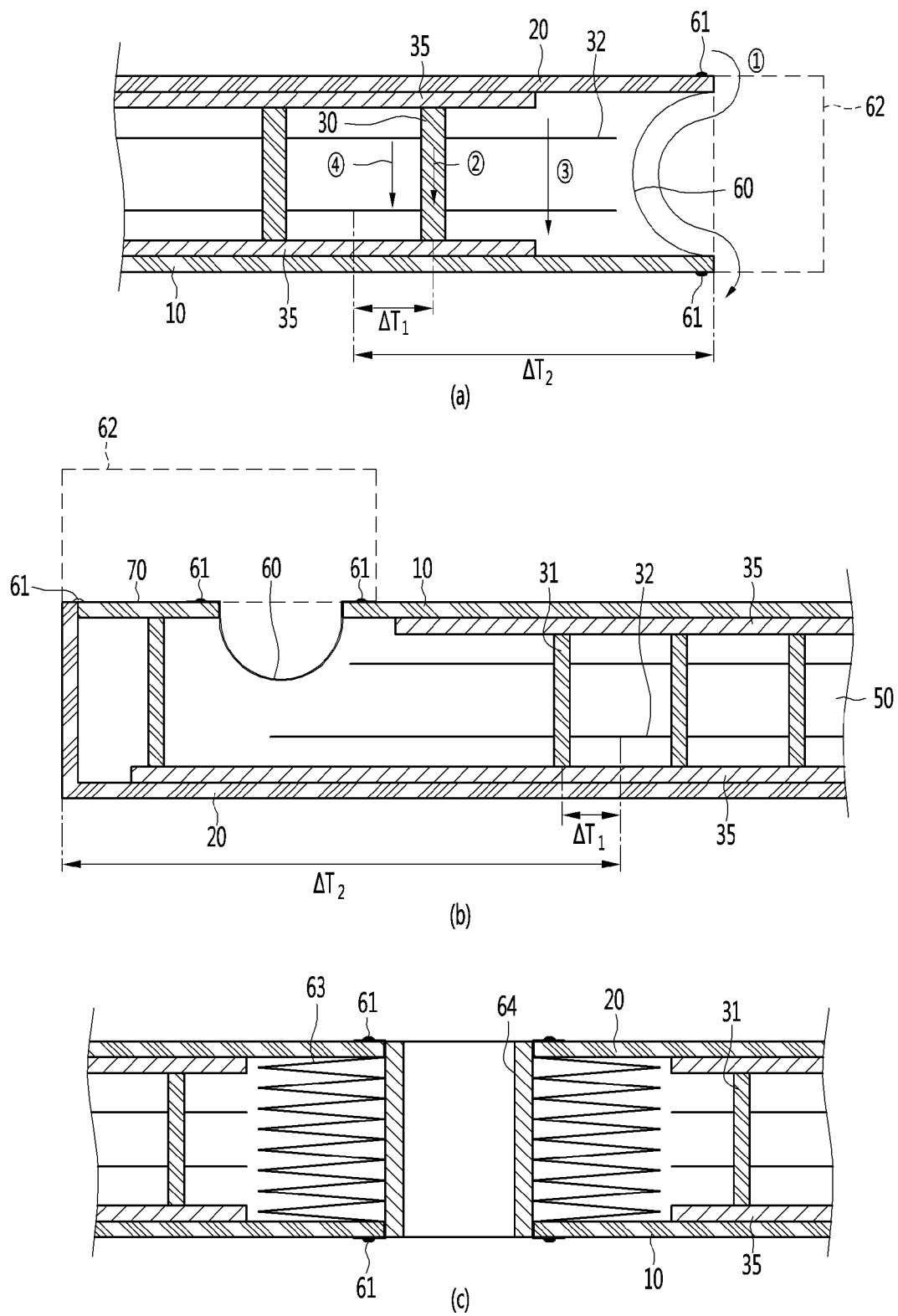
[Fig. 6]



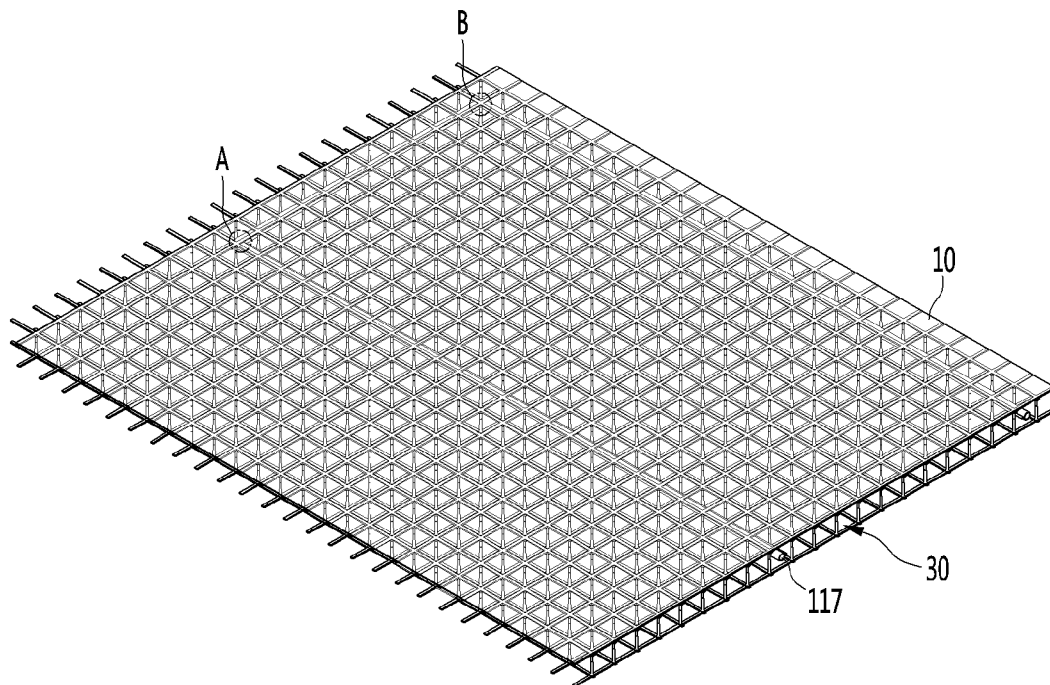
[Fig. 7]



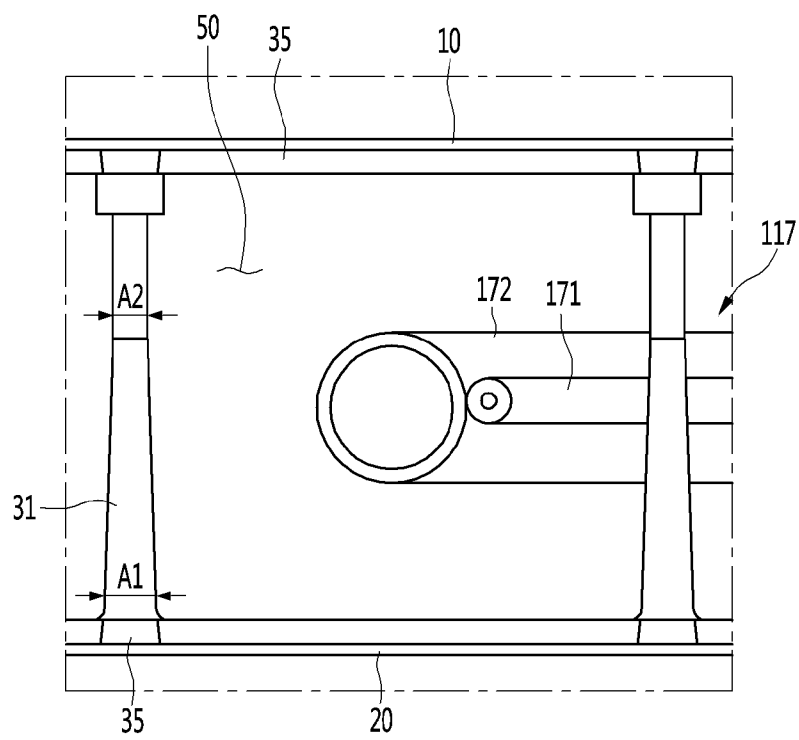
[Fig. 8]



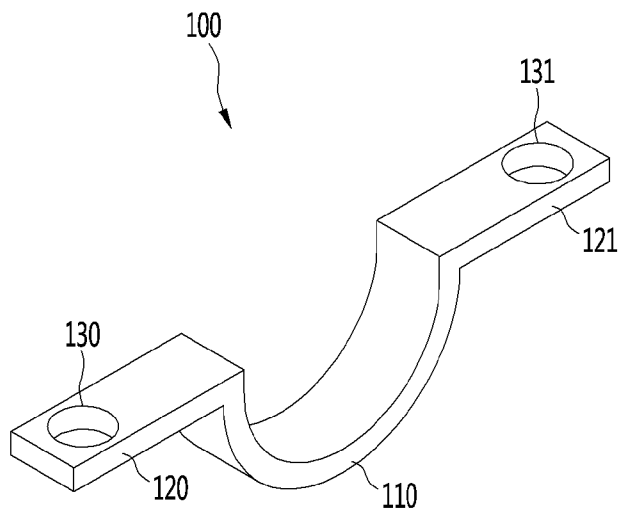
[Fig. 9]



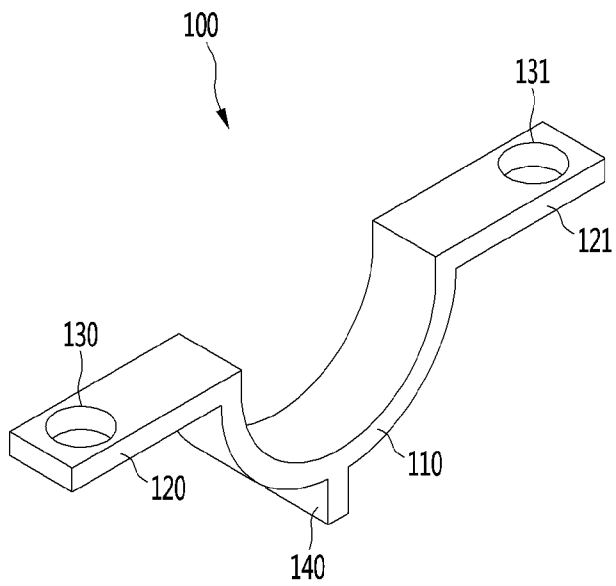
[Fig. 10]



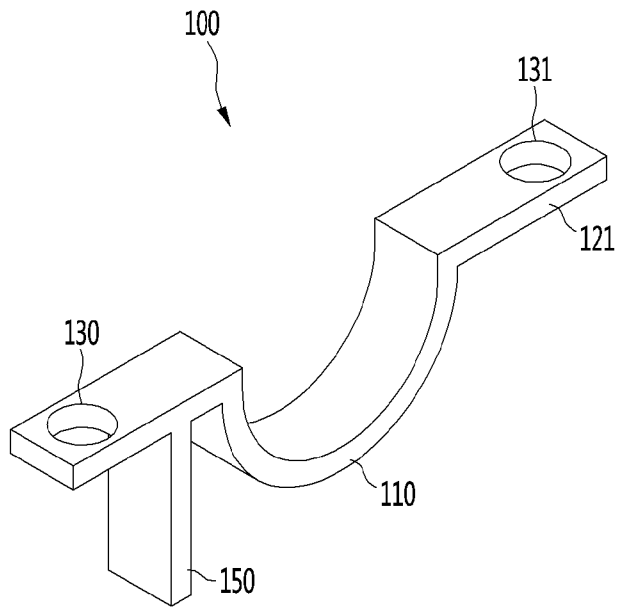
[Fig. 11]



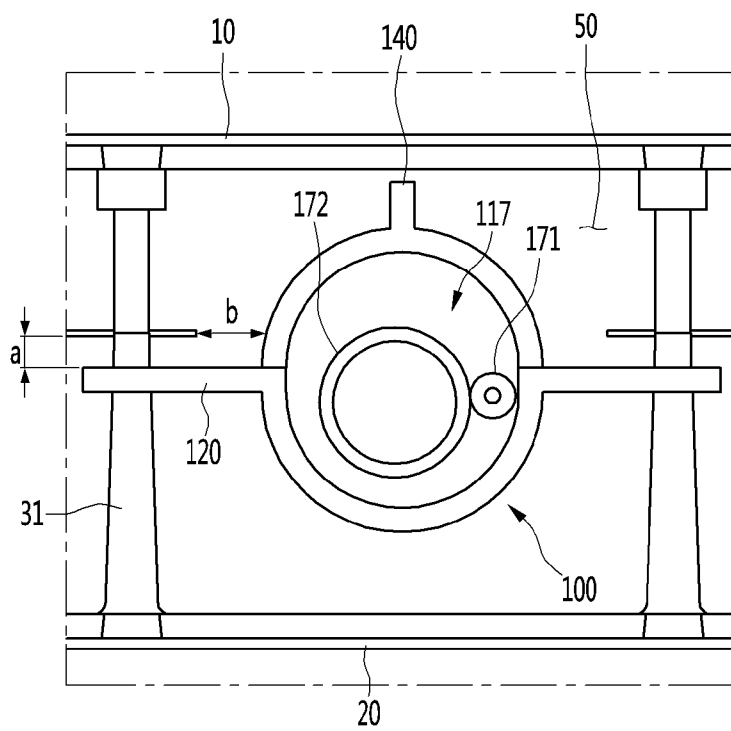
[Fig. 12]



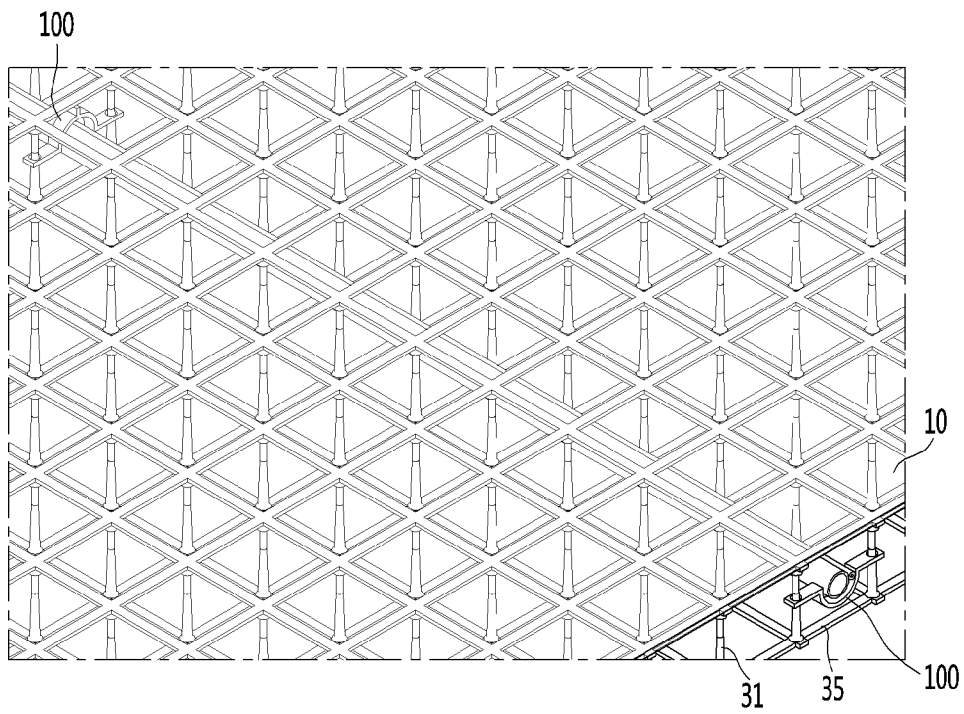
[Fig. 13]



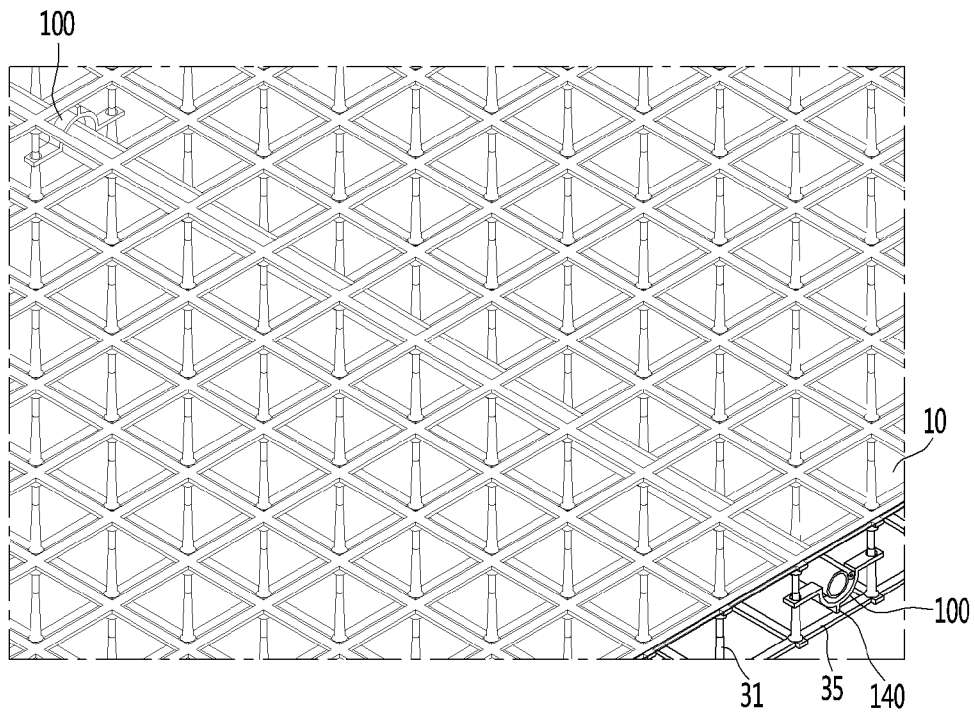
[Fig. 14]



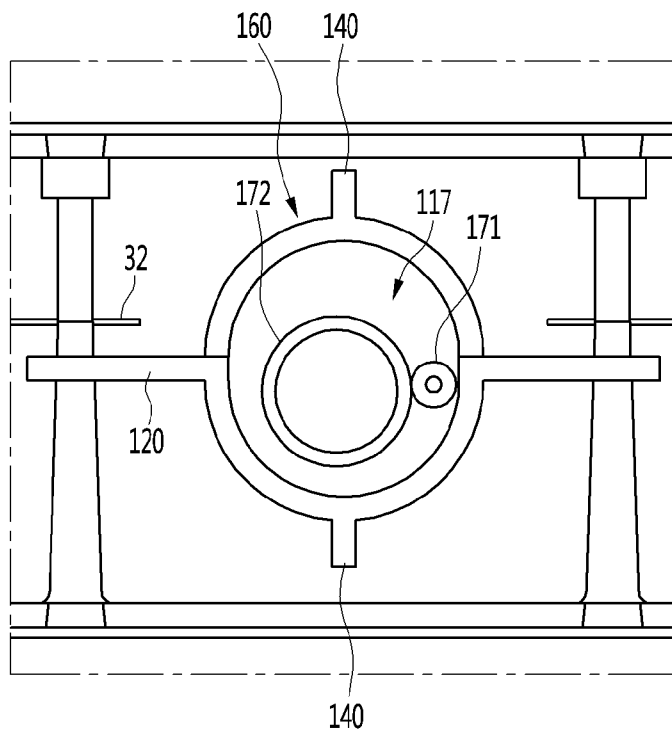
[Fig. 15]



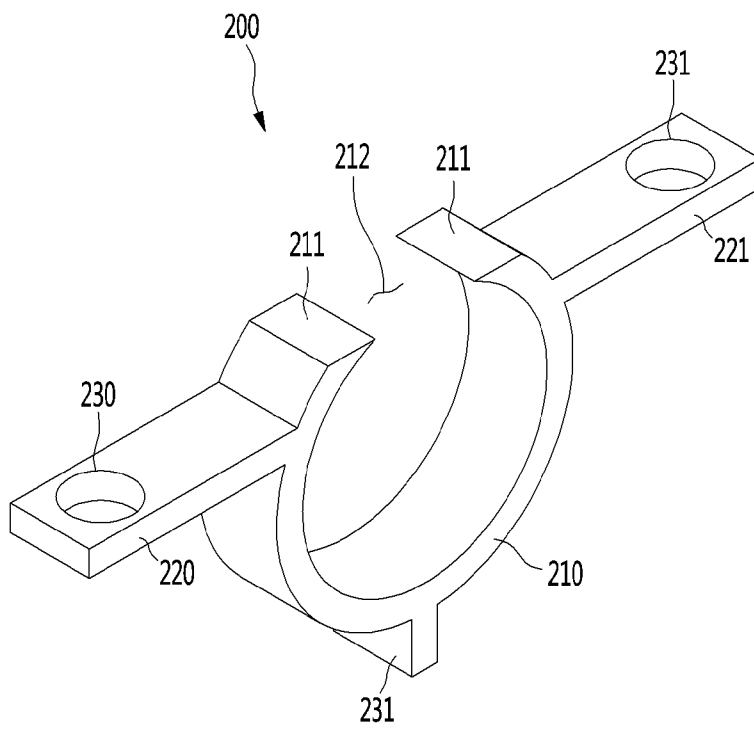
[Fig. 16]



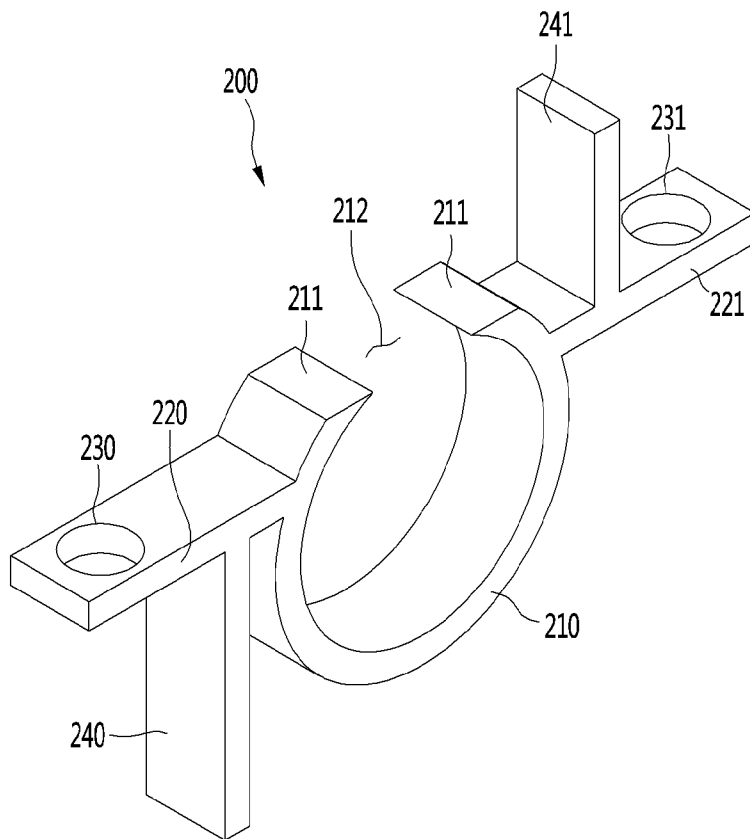
[Fig. 17]



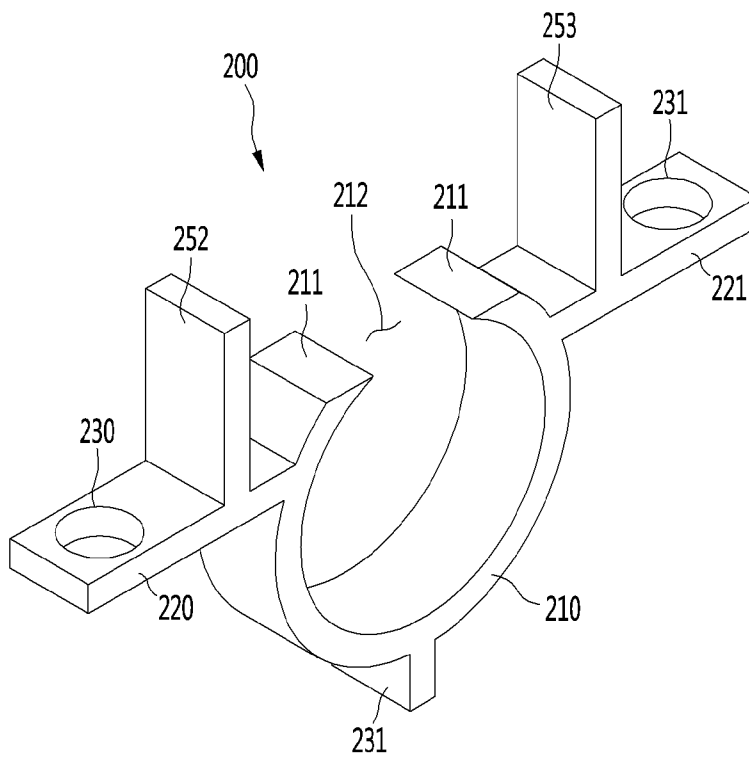
[Fig. 18]



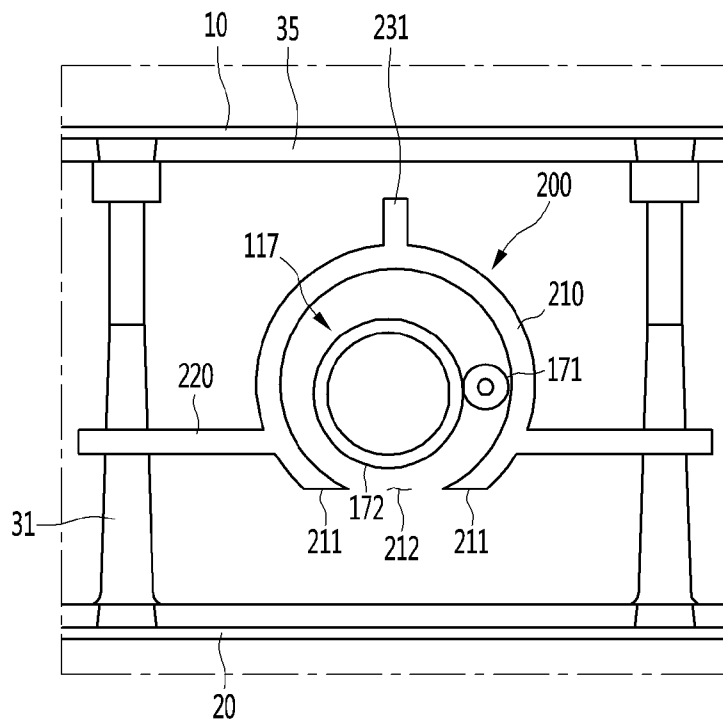
[Fig. 19]



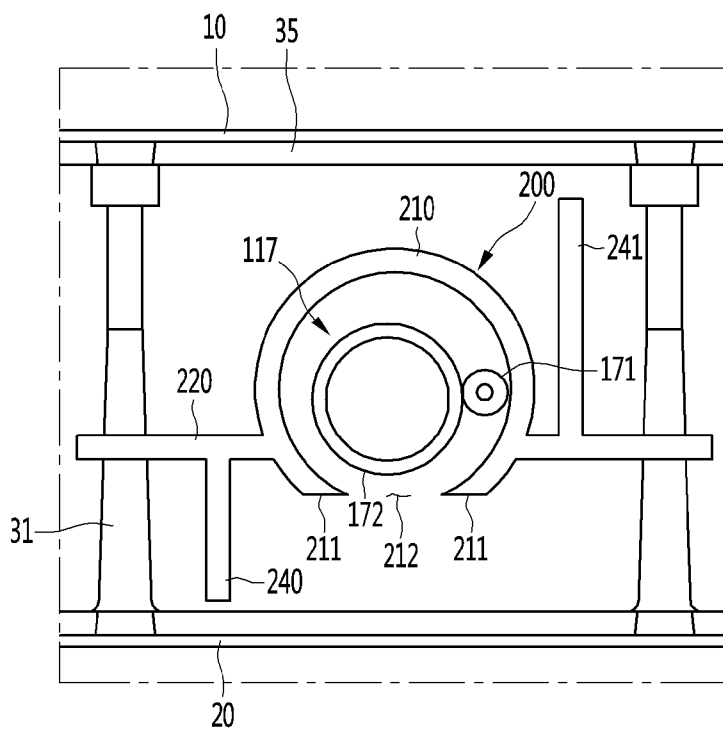
[Fig. 20]



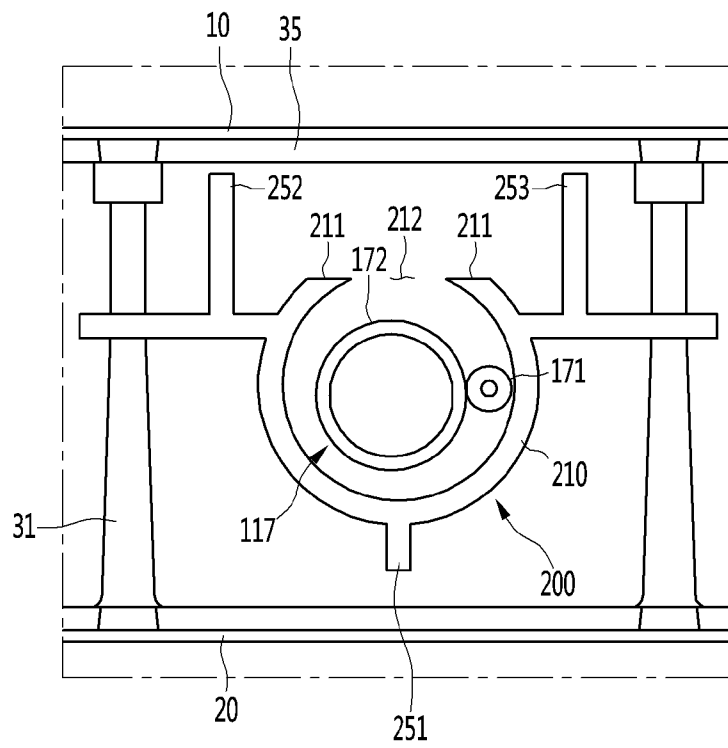
[Fig. 21]



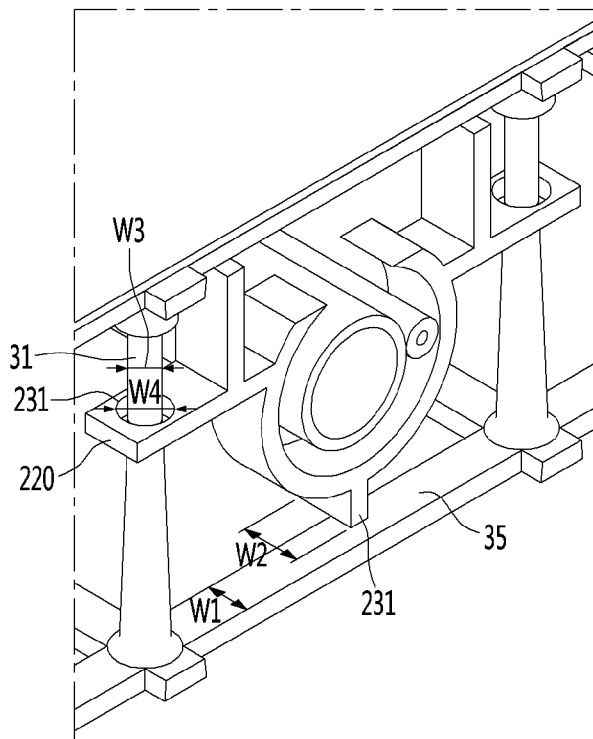
[Fig. 22]



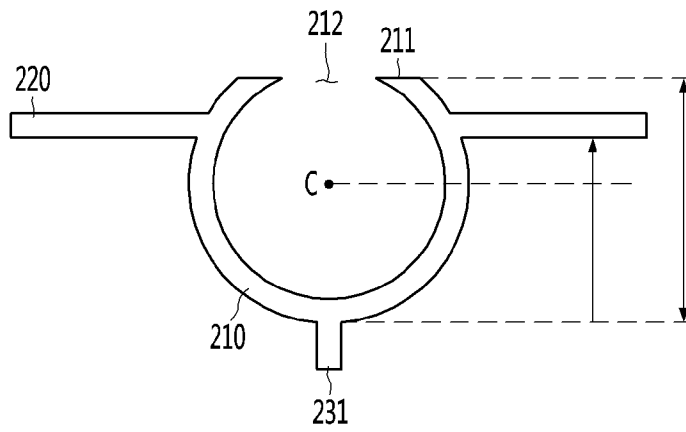
[Fig. 23]



[Fig. 24]



[Fig. 25]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2019/007755**A. CLASSIFICATION OF SUBJECT MATTER****F25D 23/06(2006.01)i, F25D 23/00(2006.01)i, F25B 40/00(2006.01)i, F25D 19/00(2006.01)i, F16L 59/065(2006.01)i, F16L 3/12(2006.01)i, F16L 3/22(2006.01)i**

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)

F25D 23/06; F25B 40/00; F25B 41/00; F25D 19/00; F25D 21/04; F25D 23/00; F25D 23/02; F16L 59/065; F16L 3/12; F16L 3/22

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: refrigerator, vacuum, seal, pipeline, restrict, bar, wing, bidirectional, spacing member, recessed groove

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2017-023095 A1 (LG ELECTRONICS INC.) 09 February 2017 See paragraphs [0031]–[0041] and figures 1–4.	1–20
Y	KR 10-2006-0062056 A (DAEWOO ELECTRONICS CORP.) 12 June 2006 See paragraphs [0015]–[0017] and figures 4–5.	1–20
Y	US 2016-0290690 A1 (LG ELECTRONICS INC.) 06 October 2016 See abstract, paragraph [0121], and figure 4.	17–19
A	JP 2017-089945 A (SHARP CORP.) 25 May 2017 See claim 1 and figure 5.	1–20
A	JP 10-170128 A (FUJI ELECTRIC CO., LTD.) 26 June 1998 See claim 1 and figure 1.	1–20



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

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

16 October 2019 (16.10.2019)

Date of mailing of the international search report

17 October 2019 (17.10.2019)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea



Facsimile No. +82-42-481-8578

Authorized officer

LEE, Chang Ho

Telephone No. +82-42-481-8288



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2019/007755

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2017-023095 A1	09/02/2017	AU 2016-303866 A1 CN 107850377 A EP 3332194 A1 KR 10-2017-0016187 A RU 2684469 C1 US 2018-0238610 A1	01/03/2018 27/03/2018 13/06/2018 13/02/2017 09/04/2019 23/08/2018
KR 10-2006-0062056 A	12/06/2006	None	
US 2016-0290690 A1	06/10/2016	CN 103090630 A CN 103090630 B CN 104949428 A CN 104949428 B EP 2589905 A2 EP 2589905 A3 KR 10-1861832 B1 KR 10-1962146 B1 KR 10-2013-0049495 A KR 10-2019-0029557 A US 10228169 B2 US 2013-0111942 A1 US 2019-0203986 A1 US 9377227 B2	08/05/2013 19/08/2015 30/09/2015 12/09/2017 08/05/2013 04/09/2019 29/05/2018 26/03/2019 14/05/2013 20/03/2019 12/03/2019 09/05/2013 04/07/2019 28/06/2016
JP 2017-089945 A	25/05/2017	None	
JP 10-170128 A	26/06/1998	None	