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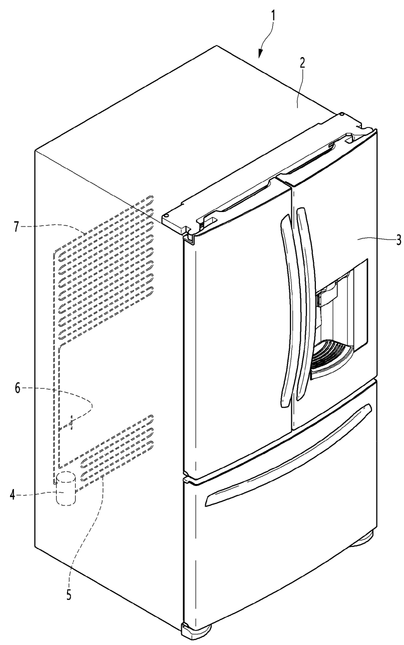
(54) **VACUUM ADIABATIC BODY**

(57) The vacuum adiabatic body of the present invention may include: a first plate having a first temperature; a second plate having a second temperature that differs from the first temperature; and a vacuum space provided between the first and second plates.

【Figure 1】



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Description

TECHNICAL FIELD

[0001] The present invention relates to a vacuum adiabatic body.

BACKGROUND ART

[0002] Adiabatic performance may be improved by forming an adiabatic wall using vacuum. A device of which at least a portion of an internal space is provided in a vacuum state to achieve an adiabatic effect may be called a vacuum adiabatic body.

[0003] The applicant has developed a technology to obtain a vacuum adiabatic body that may be used in various devices and home appliances, and has disclosed a vacuum adiabatic body and a refrigerator in Korean Patent Publication No. 1020200001396A. The vacuum adiabatic body of the cited document discloses a structure in which a heat exchanger is installed inside a vacuum space.

[0004] The cited document proposes a self-configuration and support structure in which the heat exchanger is placed in the vacuum space. The cited document does not disclose a specific installation structure of the heat exchanger and its relationship with other members. For example, it does not disclose the relationship between the heat exchanger and other members inside the vacuum space, or a method of mounting the heat exchanger.

DISCLOSURE OF THE INVENTION /TECHNICAL PROBLEM

[0005] The present invention proposes an installation structure of a heat exchanger without a loss of adiabatic efficiency.

[0006] In addition to the examples proposed above, the present invention proposes specific solutions to problems and solutions for solving the problems in [Technical Solution] and [Best Mode].

TECHNICAL SOLUTION

[0007] The vacuum adiabatic body of the present invention may include: a first plate having a first temperature; a second plate having a second temperature that differs from the first temperature; and a vacuum space provided between the first and second plates. The vacuum adiabatic body of the present invention may include a sealing part that seals the first plate and the second plate to provide the vacuum space. A radiation resistance sheet may be provided to reduce radiation heat transfer through the vacuum space. The heat exchanger mounted in the vacuum space may be included.

[0008] Optionally, the radiation resistance sheet may be provided as a single sheet. A removed part through which the heat exchanger passes may be provided on one sheet. The radiation resistance sheet may be provided in a plurality of sheets. At least two of the plurality of sheets may not be in contact with each other. At least two of the plurality of sheets may be placed on the same plane. The heat exchanger may be placed in a space between at least two of the plurality of sheets. The heat exchanger may not be placed in a gap between at least two of the plurality of sheets. At least two of the radiation resistance sheets may be provided to be spaced apart in a height direction of the vacuum space. The at least two radiation resistance sheets may have the same or different boundary areas and removed part in a height direction of the vacuum space.

[0009] Optionally, a dew formation prevention mechanism may be provided on the second plate adjacent to a position through which the heat exchanger passes. The dew formation prevention mechanism may be an insulator provided on an outer or inner surface of the second plate. The dew formation prevention mechanism may be a heater, a heat pipe, or a surface heating device provided on the outer or inner surface of the second plate. The dew formation prevention mechanism may be a heat diffusion plate provided on the outer or inner surface of the second plate. The dew formation prevention mechanism may be provided in the first terminal of the heat exchanger adjacent to an evaporator. At least a portion of the heat exchanger may include a surrounding radiation shield layer. A cross-section of the radiation shield layer may be provided as a closed curve. The radiation shield layer may be provided with a resin layer and two reflective layers. The radiation shield layer may have a greater shielding effect on a contact part of the two refrigerant pipes constituting the heat exchanger than other portions. At least a portion of the radiation shield layer may be provided in a circular shape. At least a portion of the radiation shield layer may be provided in a shape corresponding to a shape of the heat exchanger. The radiation shield layer may be provided in the form of a tube.

[0010] Optionally, a gap maintaining member supported by the radiation resistance sheet may be provided so that the radiation resistance sheet maintains a predetermined gap in the thickness direction of the vacuum space. At least a portion of the gap maintaining member may be fitted into the radiation resistance sheet. The gap maintaining member may include a removal area on which the radiation resistance sheet is not provided. At least one of the insulator and the radiation shield layer may be included in the removal area. A distance between at least one of the insulator or the radiation shield layer and one of the first and second plates adjacent to the insulator and the radiation shield layer may be shorter than a distance between at least one of the insulator or the radiation shield layer and the heat exchanger. The radiation resistance sheet may further include a gap maintaining member that is supported by the radiation resistance sheet to maintain the gap of the radiation resistance sheet, and an end portion of the gap maintaining member may be in contact with at least one of the insulator or the radiation shield layer.

[0011] Optionally, a deformation part provided on the radiation resistance sheet to accommodate the heat exchanger may be provided. The radiation shield layer may be interposed between the deformation part and the heat exchanger. The radiation shield layer may be a tube. The radiation resistance sheet may support the heat exchanger. A support may be included to maintain the gap between the vacuum spaces. The support may be included to maintain the gap of the vacuum space, and the deformation part may be in contact with the support. The support may include a support plate and a bar extending from the support plate toward the vacuum space. A distance between the deformation part and the support plate may be shorter than a distance between the deformation part and the heat exchanger. The radiation resistance sheet may include at least two radiation resistance sheets vertically spaced apart from the heat exchanger. In the at least two radiation resistance sheets, at least one may not be provided with the deformation part. In the at least two radiation resistance sheets, at least one may be opened. The deformation parts of the at least two radiation resistance sheets may be provided in a mirror shape with respect to each other. At least a portion of the deformations may be provided in a circular shape. At least a portion of the deformation parts may be provided to be flat. At least a portion of the deformation part may not be in contact with the heat exchanger. The support may include a support plate and a bar extending from the support plate toward the vacuum space. A size of the deformation part may be larger than the gap between the adjacent bars.

[0012] Optionally, a gap block may be provided between the radiation resistance sheet and the heat exchanger to allow at least some of the heat exchanger and the radiation resistance sheet to be spaced apart from each other. The radiation shield layer may be interposed between the heat exchanger and the gap block. At least one of a contact surface between the radiation resistance sheet and the gap block, a contact surface between the gap block and the heat exchanger, or a contact surface between the gap block and the radiation shield layer may be in line contact with each other. At least one of a contact surface between the radiation resistance sheet and the gap block, a contact surface between the gap block and the heat exchanger, or a contact surface between the gap block and the radiation shield layer may be in point contact with each other. A cross-sectional shape of the gap block may be a closed curve. The cross-sectional shape of the gap block may be an open curve. At least some of an outer shape of the gap block and an inner shape of the radiation resistance sheet may be identical to each other.

[0013] Optionally, the insulator may be provided adjacent to the heat exchanger. The insulator may be adjacent to at least one of the first or second plate rather than the heat exchanger. The deformation part may be provided for deforming the radiation resistance sheet so that the radiation resistance sheet approaches the plate.

ADVANTAGEOUS EFFECTS

[0014] According to the present invention, the vacuum adiabatic body having the high adiabatic efficiency may be proposed.

[0015] According to the present invention, the vacuum adiabatic body may be conveniently manufactured.

[0016] The effects of the present invention are disclosed in more detail in [Specific details for carrying out the invention].

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a perspective view of a refrigerator according to an embodiment.

Fig. 2 is a view schematically illustrating a vacuum adiabatic body used in a main body and a door of the refrigerator.

Fig. 3 is a view illustrating an example of a support that maintains a vacuum space.

Fig. 4 is a view for explaining an example of the vacuum with respect to a heat transfer resistor.

Fig. 5 is a graph illustrating results obtained by observing a process of exhausting the inside of the vacuum adiabatic body with a time and pressure when the support is used.

Fig. 6 is a graph illustrating results obtained by comparing a vacuum pressure to gas conductivity.

Fig. 7 is a view for explaining a method for manufacturing a vacuum adiabatic body.

FIG. 8 is a view illustrating an example in which a support and a heat exchanger are installed.

FIG. 9 is a view illustrating a relationship between the support, a heat exchanger, and a radiation resistance sheet.

FIG. 10 is a view illustrating a relationship between the radiation resistance sheet and the heat exchanger.

FIGS. 11 and 12 are views illustrating a configuration in which the radiation resistance sheet is provided as a plurality of sheets.

FIG. 13 is a view illustrating a state in which at least two radiation resistance sheets are disposed in a height direction of a vacuum space.

FIG. 14 is a view illustrating a case in which a dew formation prevention mechanism is disposed on an outer surface of a second plate.

FIG. 15 is a cross-sectional view of a heat exchanger, on which a radiation shield layer is provided, and a cross-sectional view of the radiation shield layer.

FIG. 16 is a cross-sectional view of the radiation shield layer according to an embodiment.

FIG. 17 is a perspective view of the radiation shield layer and a view of an end portion of the radiation shield layer.

FIG. 18 is a view illustrating an example of a method for shielding heat transfer of the heat exchanger.

FIG. 19 is a view illustrating an example of shielding radiation heat of the heat exchanger according to various embodiments.

FIG. 20 is a view illustrating an example in which a gap block is disposed between the radiation resistance sheet and the heat exchanger according to an embodiment.

FIG. 21 is a view illustrating an example in which an insulator is provided according to an embodiment.

FIG. 22 is a view of the radiation resistance sheet according to various embodiments.

MODE FOR CARRYING OUT THE INVENTION

[0018] Hereinafter, specific embodiments will be described in detail 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.

[0019] The present invention may have many embodiments in which the idea is implemented, and in each embodiment, any portion may be replaced with a corresponding portion or a portion having a related action according to another embodiment. The present invention may be any one of the examples presented below or a combination of two or more examples.

[0020] The present disclosure may be a vacuum adiabatic body including a first plate; a second plate; and a vacuum space provided between the first and second plates. The vacuum adiabatic body may include a sealing part for providing the vacuum state space (vacuum space). The vacuum space may be a space in a vacuum state provided in an internal space between the first plate and the second plate. The seal may seal the first plate and the second plate to provide the internal space provided in the vacuum state. The vacuum adiabatic body may optionally include a side plate connecting the first plate to the second plate. In the present disclosure, the expression "plate" may mean at least one of the first and second plates or the side plate. At least a portion of the first and second plates and the side plate may be integrally provided, or at least portions may be sealed to each other. Optionally, the vacuum adiabatic body may include a support that maintains the vacuum space. The vacuum adiabatic body may selectively include a thermal insulator that reduces an amount of heat transfer between a first space provided in vicinity of the first plate and a second space provided in vicinity of the second plate or reduces an amount of heat transfer between the first plate and the second plate.

[0021] Optionally, the vacuum adiabatic body may include a component coupling portion provided on at least a portion of the plate. Optionally, the vacuum adiabatic body may include another adiabatic body. Another adiabatic body may be provided to be connected to the vacuum adiabatic body. Another adiabatic body may be an adiabatic body having a degree of vacuum, which is equal to or different from a degree of vacuum of the vacuum adiabatic body. Another adiabatic body may be an adiabatic body that does not include a degree of vacuum less than that of the vacuum adiabatic body or a portion that is in a vacuum state therein. In this case, it may be advantageous to connect another object to another adiabatic body.

[0022] In the present disclosure, a direction along a wall defining the vacuum space may include a longitudinal direction of the vacuum space and a height direction of the vacuum space. The height direction of the vacuum space may be defined as any one direction among virtual lines connecting the first space to the second space to be described later while passing through the vacuum space. The longitudinal direction of the vacuum space may be defined as a direction perpendicular to the set height direction of the vacuum space.

[0023] In the present disclosure, that an object A is connected to an object B means that at least a portion of the object A and at least a portion of the object B are directly connected to each other, or that at least a portion of the object A and at least a portion of the object B are connected to each other through an intermedium interposed between the objects A and B. The intermedium may be provided on at least one of the object A or the object B. The connection may include that the object A is connected to the intermedium, and the intermedium is connected to the object B.

[0024] A portion of the intermedium may include a portion connected to either one of the object A and the object B. The other portion of the intermedium may include a portion connected to the other of the object A and the object B. As a modified example, the connection of the object A to the object B may include that the object A and the object B are integrally prepared in a shape connected in the above-described manner. In the present disclosure, an embodiment of the connection may be support, combine, or a seal, which will be described later.

[0025] In the present disclosure, that the object A is supported by the object B means that the object A is restricted in movement by the object B in one or more of the +X, -X, +Y, -Y, +Z, and -Z axis directions. In the present invention, an embodiment of the support may be the combine or seal, which will be described later. In the present invention, that the object A is combined with the object B may define that the object A is restricted in movement by the object B in one or more of the X, Y, and Z-axis directions.

[0026] In the present disclosure, an embodiment of the combining may be the sealing to be described later. In the present disclosure, that the object A is sealed to the object B may define a state in which movement of a fluid is not allowed at the portion at which the object A and the object B are connected. In the present disclosure, one or more objects, i.e., at least a portion of the object A and the object B, may be defined as including a portion of the object A, the whole of the object A, a portion of the object B, the whole of the object B, a portion of the object A and a portion of the object B, a portion of the object A and the whole of the object B, the whole of the object A and a portion of the object B, and the whole of the object A and the whole of the object B. In the present disclosure, that the plate A may be a wall defining the space A may be defined as that at least a portion of the plate A may be a wall defining at least a portion of the space A.

[0027] That is, at least a portion of the plate A may be a wall forming the space A, or the plate A may be a wall forming at least a portion of the space A. In the present disclosure, a central portion of the object may be defined as a central portion among three divided portions when the object is divided into three sections based on the longitudinal direction of the object. A periphery of the object may be defined as a portion disposed at a left or right side of the central portion among the three divided portions. The periphery of the object may include a surface that is in contact with the central portion and a surface opposite thereto.

[0028] The opposite side may be defined as a border or edge of the object. Examples of the object may include a vacuum adiabatic body, a plate, a heat transfer resistor, a support, a vacuum space, and various components to be introduced in the present disclosure. In the present disclosure, a degree of heat transfer resistance may indicate a degree to which an object resists heat transfer and may be defined as a value determined by a shape including a thickness of the object, a material of the object, and a processing method of the object. The degree of the heat transfer resistance may be defined as the sum of a degree of conduction resistance, a degree of radiation resistance, and a degree of convection resistance.

[0029] The vacuum adiabatic body according to the present disclosure may include a heat transfer path defined between spaces having different temperatures, or a heat transfer path defined between plates having different temperatures. For example, the vacuum adiabatic body according to the present disclosure may include a heat transfer path through which cold is transferred from a low-temperature plate to a high-temperature plate. In the present disclosure, when a curved portion includes a first portion extending in a first direction and a second portion extending in a second direction different from the first direction, the curved portion may be defined as a portion that connects the first portion to the second portion (including 90 degrees).

[0030] In the present disclosure, the vacuum adiabatic body may optionally include a component coupling portion. The component coupling portion may be defined as a portion provided on the plate to which components are connected to each other. The component connected to the plate may be defined as a penetration portion disposed to pass through at least a portion of the plate and a surface component disposed to be connected to a surface of at least a portion of the plate.

[0031] At least one of the penetration component or the surface component may be connected to the component coupling portion. The penetration component may be a component that defines a path through which a fluid (electricity, refrigerant, water, air, etc.) passes mainly. In the present disclosure, the fluid is defined as any kind of flowing material. The fluid includes moving solids, liquids, gases, and electricity. For example, the component may be a component that defines a path through which a refrigerant for heat exchange passes, such as a suction line heat exchanger (SLHX) or a refrigerant tube.

[0032] The component may be an electric wire that supplies electricity to an apparatus. As another example, the component may be a component that defines a path through which air passes, such as a cold duct, a hot air duct, and an exhaust port. As another example, the component may be a path through which a fluid such as coolant, hot water, ice, and defrost water pass. The surface component may include at least one of a peripheral adiabatic body, a side panel, injected foam, a pre-prepared resin, a hinge, a latch, a basket, a drawer, a shelf, a light, a sensor, an evaporator, a front decor, a hotline, a heater, an exterior cover, or another adiabatic body.

[0033] As an example to which the vacuum adiabatic body is applied, the present disclosure may include an apparatus having the vacuum adiabatic body. Examples of the apparatus may include an appliance. Examples of the appliance may include home appliances including a refrigerator, a cooking appliance, a washing machine, a dishwasher, and an air conditioner, etc. As an example in which the vacuum adiabatic body is applied to the apparatus, the vacuum adiabatic body may constitute at least a portion of a body and a door of the apparatus.

[0034] As an example of the door, the vacuum adiabatic body may constitute at least a portion of a general door and a door-in-door (DID) that is in direct contact with the body. Here, the door-in-door may mean a small door placed inside the general door. As another example to which the vacuum adiabatic body is applied, the present disclosure may include a wall having the vacuum adiabatic body. Examples of the wall may include a wall of a building, which includes a window.

[0035] Hereinafter, the present disclosure will be described in detail with reference to the accompanying drawings. Each of the drawings accompanying the embodiment may be different from, exaggerated, or simply indicated from an actual article, and detailed components may be indicated with simplified features. The embodiment should not be interpreted as being limited only to the size, structure, and shape presented in the drawings. In the embodiments accompanying each of the drawings, unless the descriptions conflict with each other, some configurations in the drawings of one embodiment may be applied to some configurations of the drawings in another embodiment, and some structures in one embodiment may be applied to some structures in another embodiment.

[0036] In the description of the drawings for the embodiment, the same reference numerals may be assigned to different drawings as reference numerals of specific components constituting the embodiment. Components having the same reference number may perform the same function. For example, the first plate constituting the vacuum adiabatic body has a portion corresponding to the first space throughout all embodiments and is indicated by reference number 10. The first plate may have the same number for all embodiments and may have a portion corresponding to the first space, but the shape of the first plate may be different in each embodiment. Not only the first plate, but also the side plate, the second plate, and another adiabatic body may be understood as well.

[0037] Fig. 1 is a perspective view of a refrigerator according to an embodiment, and FIG. 2 is a schematic view illustrating a vacuum adiabatic body used for a body and a door of the refrigerator. 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 and close the main body 2.

[0038] The door 3 may be rotatably or slidably disposed to open or close the cavity 9. The cavity 9 may provide at least one of a refrigerating compartment and a freezing compartment.

[0039] A cold source that supplies cold to the cavity may be provided. For example, the cold source may be an evaporator 7 that evaporates the refrigerant to take heat. The evaporator 7 may be connected to a compressor 4 that compresses the refrigerant evaporated to the cold source. The evaporator 7 may be connected to a condenser 5 that condenses the compressed refrigerant to the cold source. The evaporator 7 may be connected to an expander 6 that expands the refrigerant condensed in the cold source.

[0040] A fan corresponding to the evaporator and the condenser may be provided to promote heat exchange. As another example, the cold source may be a heat absorption surface of a thermoelectric element. A heat absorption sink may be connected to the heat absorption surface of the thermoelectric element. A heat sink may be connected to a heat radiation surface of the thermoelectric element. A fan corresponding to the heat absorption surface and the heat generation surface may be provided to promote heat exchange.

[0041] Referring to FIG. 2, plates 10, 15, and 20 may be walls defining the vacuum space. The plates may be walls that partition the vacuum space from an external space of the vacuum space. An example of the plates is as follows. The present disclosure may be any one of the following examples or a combination of two or more examples.

[0042] The plate may be provided as one portion or may be provided to include at least two portions connected to each other.

[0043] As a first example, the plate may include at least two portions connected to each other in a direction along a wall defining the vacuum space. Any one of the two portions may include a portion (e.g., a first portion) defining the vacuum space. The first portion may be a single portion or may include at least two portions that are sealed to each other. The other one of the two portions may include a portion (e.g., a second portion) extending from the first portion of the first plate in a direction away from the vacuum space or extending in an inner direction of the vacuum space.

[0044] As a second example, the plate may include at least two layers connected to each other in a thickness direction of the plate. Any one of the two layers may include a layer (e.g., the first portion) defining the vacuum space. The other one of the two layers may include a portion (e.g., the second portion) provided in an external space (e.g., a first space and a second space) of the vacuum space.

[0045] In this case, the second portion may be defined as an outer cover of the plate. The other one of the two layers may include a portion (e.g., the second portion) provided in the vacuum space. In this case, the second portion may be defined as an inner cover of the plate.

[0046] The plate may include a first plate 10 and a second plate 20. One surface of the first plate (the inner surface of the first plate) provides a wall defining the vacuum space, and the other surface (the outer surface of the first plate) of the first plate A wall defining the first space may be provided. The first space may be a space provided in the vicinity of the first plate, a space defined by the apparatus, or an internal space of the apparatus. In this case, the first plate may be referred to as an inner case. When the first plate and the additional member define the internal space, the first plate and the additional member may be referred to as an inner case.

[0047] The inner case may include two or more layers. In this case, one of the plurality of layers may be referred to as an inner panel. One surface of the second plate (the inner surface of the second plate) provides a wall defining the vacuum space, and the other surface (the outer surface of the first plate) of the second plate A wall defining the second space may be provided. The second space may be a space provided in vicinity of the second plate, another space defined by the apparatus, or an external space of the apparatus. In this case, the second plate may be referred to as an outer case. When the second plate and the additional member define the external space, the second plate and the additional member may be referred to as an outer case. The outer case may include two or more layers. In this case, one of the plurality of layers may be referred to as an outer panel.

[0048] The second space may be a space having a temperature higher than that of the first space or a space having a temperature lower than that of the first space. Optionally, the plate may include a side plate 15. In FIG. 2, the side plate may also perform a function of a conductive resistance sheet 60 to be described later, according to the disposition of the side plate. The side plate may include a portion extending in a height direction of a space defined between the first plate and the second plate.

[0049] The side plate may include a portion extending in a height direction of the vacuum space.

[0050] One surface of the side plate may provide a wall defining the vacuum space, and the other surface of the side plate may provide a wall defining an external space of the vacuum space. The external space of the vacuum space may be at least one of the first space or the second space or a space in which another adiabatic body to be described later is disposed. The side plate may be integrally provided by extending at least one of the first plate or the second plate or a separate component connected to at least one of the first plate or the second plate.

[0051] The plate may optionally include a curved portion. In the present disclosure, the plate including a curved portion may be referred to as a bent plate. The curved portion may include at least one of the first plate, the second plate, the side plate, between the first plate and the second plate, between the first plate and the side plate, or between the second plate and the side plate. The plate may include at least one of a first curved portion or a second curved portion, an example of which is as follows.

[0052] First, the side plate may include the first curved portion. A portion of the first curved portion may include a portion connected to the first plate. Another portion of the first curved portion may include a portion connected to the second curved portion. In this case, a curvature radius of each of the first curved portion and the second curved portion may be large. The other portion of the first curved portion may be connected to an additional straight portion or an additional curved portion, which are provided between the first curved portion and the second curved portion. In this case, a curvature radius of each of the first curved portion and the second curved portion may be small.

[0053] Second, the side plate may include the second curved portion. A portion of the second curved portion may include a portion connected to the second plate. The other portion of the second curved portion may include a portion connected to the first curved portion. In this case, a curvature radius of each of the first curved portion and the second curved portion may be large. The other portion of the second curved portion may be connected to an additional straight portion or an additional curved portion, which are provided between the first curved portion and the second curved portion. In this case, a curvature radius of each of the first curved portion and the second curved portion may be small. Here, the straight portion may be defined as a portion having a curvature radius greater than that of the curved portion. The straight portion may be understood as a portion having a perfect plane or a curvature radius greater than that of the curved portion. Third, the first plate may include the first curved portion. A portion of the first curved portion may include a portion connected to the side plate. A portion connected to the side plate may be provided at a position that is away from the second plate at a portion at which the first plate extends in the longitudinal direction of the vacuum space.

[0054] Fourth, the second plate may include the second curved portion. A portion of the second curved portion may include a portion connected to the side plate. A portion connected to the side plate may be provided at a position that is away from the first plate at a portion at which the second plate extends in the longitudinal direction of the vacuum space. The present disclosure may include a combination of any one of the first and second examples described above and any one of the third and fourth examples described above.

[0055] In the present disclosure, the vacuum space 50 may be defined as a third space. The vacuum space may be a space in which a vacuum pressure is maintained. In the present disclosure, 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.

[0056] In the present disclosure, the seal 61 may be a portion provided between the first plate and the second plate. Examples of sealing are as follows. The present disclosure may be any one of the following examples or a combination of two or more examples. The sealing may include fusion welding for coupling the plurality of objects by melting at least a portion of the plurality of objects. For example, the first plate and the second plate may be welded by laser welding in a state in which a melting bond such as a filler metal is not interposed therebetween, a portion of the first and second plates and a portion of the component coupling portion may be welded by highfrequency brazing or the like, or a plurality of objects may be welded by a melting bond that generates heat. The sealing may include pressure welding for coupling the plurality of objects by a mechanical pressure applied to at least a portion of the plurality of objects.

[0057] For example, as a component connected to the component coupling portion, an object made of a material having a degree of deformation resistance less than that of the plate may be pressure-welded by a method such as pinch-off.

[0058] A machine room 8 may be optionally provided outside the vacuum adiabatic body. The machine room may be defined as a space in which components connected to the cold source are accommodated. Optionally, the vacuum adiabatic body may include a port 40. The port may be provided at any one side of the vacuum adiabatic body to discharge air of the vacuum space 50.

[0059] Optionally, the vacuum adiabatic body may include a conduit 64 passing through the vacuum space 50 to install components connected to the first space and the second space.

[0060] Fig. 3 is a view illustrating an example of a support that maintains the vacuum space. An example of the support is as follows. The present disclosure may be any one of the following examples or a combination of two or more examples.

[0061] The supports 30, 31, 33, and 35 may be provided to support at least a portion of the plate and a heat transfer resistor to be described later, thereby reducing deformation of at least some of the vacuum space 50, the plate, and the heat transfer resistor to be described later due to external force.

[0062] The external force may include at least one of a vacuum pressure or external force excluding the vacuum pressure. When the deformation occurs in a direction in which a height of the vacuum space is lower, the support may reduce an increase in at least one of radiant heat conduction, gas heat conduction, surface heat conduction, or support heat conduction, which will be described later.

[0063] The support may be an object provided to maintain a gap between the first plate and the second plate or an object provided to support the heat transfer resistor. The support may have a degree of deformation resistance greater than that of the plate or be provided to a portion having weak degree of deformation resistance among portions constituting the vacuum adiabatic body, the apparatus having the vacuum adiabatic body, and the wall having the vacuum adiabatic body.

[0064] According to an embodiment, a degree of deformation resistance represents a degree to which an object resists deformation due to external force applied to the object and is a value determined by a shape including a thickness of the object, a material of the object, a processing method of the object, and the like. Examples of the portions having the weak degree of deformation resistance include the vicinity of the curved portion defined by the plate, at least a portion of the curved portion, the vicinity of an opening defined in the body of the apparatus, which is provided by the plate, or at least a portion of the opening.

[0065] The support may be disposed to surround at least a portion of the curved portion or the opening or may be provided to correspond to the shape of the curved portion or the opening.

[0066] However, it is not excluded that the support is provided in other portions. The opening may be understood as a portion of the apparatus including the body and the door capable of opening or closing the opening defined in the body.

[0067] An example in which the support is provided to support the plate is as follows. First, at least a portion of the support may be provided in a space defined inside the plate. The plate may include a portion including a plurality of layers, and the support may be provided between the plurality of layers. Optionally, the support may be provided to be connected to at least a portion of the plurality of layers or be provided to support at least a portion of the plurality of layers.

[0068] Second, at least a portion of the support may be provided to be connected to a surface defined on the outside of the plate. The support may be provided in the vacuum space or an external space of the vacuum space. For example, the plate may include a plurality of layers, and the support may be provided as any one of the plurality of layers. Optionally, the support may be provided to support the other one of the plurality of layers. For example, the plate may include a plurality of portions extending in the longitudinal direction, and the support may be provided as any one of the plurality of portions.

[0069] Optionally, the support may be provided to support the other one of the plurality of parts. As further another example, the support may be provided in the vacuum space or the external space of the vacuum space as a separate component, which is distinguished from the plate. Optionally, the support may be provided to support at least a portion of a surface defined on the outside of the plate. Optionally, the support may be provided to support one surface of the first plate and one surface of the second plate.

[0070] One surface of the first plate and one surface of the second plate may be provided to face each other.

[0071] Third, the support may be provided to be integrated with the plate. An example in which the support is provided to support the heat transfer resistor may be understood instead of the example in which the support is provided to support the plate. A duplicated description will be omitted.

[0072] An example of the support in which heat transfer through the support is designed to be reduced is as follows. First, at least a portion of the components disposed in the vicinity of the support may be provided so as not to be in contact with the support or provided in an empty space provided by the support. Examples of the components include a tube or component connected to the heat transfer resistor to be described later, an exhaust port, a getter port, a tube or component passing through the vacuum space, or a tube or component of which at least a portion is disposed in the vacuum space.

[0073] Exampled of the tube may include the exhaust port, a getter port. Examples of the empty space may include an empty space provided in the support, an empty space provided between the plurality of supports, and an empty space provided between the support and a separate component that is distinguished from the support.

[0074] Optionally, at least a portion of the component may be disposed in a through-hole defined in the support, be disposed between the plurality of bars, be disposed between the plurality of connection plates, or be disposed between the plurality of support plates. Optionally, at least a portion of the component may be disposed in a spaced space between the plurality bars, be disposed in a spaced space between the plurality of connection plates, or be disposed in a spaced space between the plurality of support plates. Second, the adiabatic body may be provided on at least a portion of the support or in the vicinity of at least a portion of the support.

[0075] The adiabatic body may be provided to be in contact with the support or provided so as not to be in contact with the support. The adiabatic body may be provided at a portion in which the support and the plate are in contact with each other. The adiabatic body may be provided on at least a portion of one surface and the other surface of the support or be provided to cover at least a portion of one surface and the other surface of the support. The adiabatic body may be provided on at least a portion of a periphery of one surface and a periphery of the other surface of the support or be provided to cover at least a portion of a periphery of one surface and a periphery of the other surface of the support.

[0076] The support may include a plurality of bars. The adiabatic body may be disposed on an area from a point at which any one of the plurality of bars is disposed to a midpoint between the one bar and the surrounding bars. Third, when cold is transferred through the support, a heat source may be disposed at a position at which the heat adiabatic body described in the second example is disposed. When a temperature of the first space is lower than a temperature of the second space, the heat source may be disposed on the second plate or in the vicinity of the second plate. When heat is transmitted through the support, a cold source may be disposed at a position at which the heat adiabatic body described in the second example is disposed.

[0077] When a temperature of the first space is higher than a temperature of the second space, the cold source may be disposed on the second plate or in the vicinity of the second plate. As fourth example, the support may include a portion having heat transfer resistance higher than a metal or a portion having heat transfer resistance higher than the plate. The support may include a portion having heat transfer resistance less than that of another adiabatic body.

[0078] The support may include at least one of a non-metal material, PPS, and glass fiber (GF), low outgassing PC, PPS, or LCP. This is done for a reason in which high compressive strength, low outgassing, and a water absorption rate, low thermal conductivity, high compressive strength at a high temperature, and excellent workability are being capable of obtained.

[0079] Examples of the support may be the bars 30 and 31, the connection plate 35, the support plate 35, a porous material 33, and a filler 33. In this embodiment, the support may include any one of the above examples, or an example in which at least two examples are combined.

[0080] As first example, the support may include bars 30 and 31. The bar may include a portion extending in a direction in which the first plate and the second plate are connected to each other to support a gap between the first plate and the second plate. The bar may include a portion extending in a height direction of the vacuum space and a portion extending in a direction that is substantially perpendicular to the direction in which the plate extends. The bar may be provided to support only one of the first plate and the second plate or may be provided both the first plate and the second plate.

[0081] For example, one surface of the bar may be provided to support a portion of the plate. the other surface of the bar may be provided so as not to be in contact with the other portion of the plate. As another example, one surface of the bar may be provided to support at least a portion of the plate. the other surface of the bar may be provided to support the other portion of the plate.

[0082] The support may include a bar having an empty space therein or a plurality of bars, and an empty space are provided between the plurality of bars. In addition, the support may include a bar, and the bar may be disposed to provide an empty space between the bar and a separate component that is distinguished from the bar.

[0083] The support may selectively include a connection plate 35 including a portion connected to the bar or a portion connecting the plurality of bars to each other. The connection plate may include a portion extending in the longitudinal direction of the vacuum space or a portion extending in the direction in which the plate extends. An XZ-plane cross-sectional area of the connection plate may be greater than an XZ-plane cross-sectional area of the bar. The connection plate may be provided on at least one of one surface and the other surface of the bar or may be provided between one surface and the other surface of the bar.

[0084] At least one of one surface and the other surface of the bar may be a surface on which the bar supports the plate. The shape of the connection plate is not limited. The support may include a connection plate having an empty space therein or a plurality of connection plates. An empty space may be provided between the plurality of connection plates. In addition, the support may include a connection plate.

[0085] The connection plate may be disposed to provide an empty space between the connection plate and a separate component that is distinguished from the connection plate. As a second example, the support may include a support plate 35. The support plate may include a portion extending in the longitudinal direction of the vacuum space or a portion extending in the direction in which the plate extends. The support plate may be provided to support only one of the first plate and second plate.

[0086] The support plate may be provided to support both the first plate and the second plate. For example, one surface of the support plate may be provided to support a portion of the plate, and the other surface of the support plate may be provided so as not to be in contact with the other portion of the plate. As another example, one surface of the support plate may be provided to support at least a portion of the plate, and the other surface of the support plate may be provided to support the other portion of the plate. A cross-sectional shape of the support plate is not limited.

[0087] The support may include a support plate having an empty space therein or a plurality of support plates, and an empty space are provided between the plurality of support plates. In addition, the support may include a support plate, and the support plate may be disposed to provide an empty space between the support plate and a separate component that is distinguished from the support plate.

[0088] As a third example, the support may include a porous material 33 or a filler 33. The inside of the vacuum space may be supported by the porous material or the filler. The inside of the vacuum space may be completely filled by the porous material or the filler. The support may include a plurality of porous materials or a plurality of fillers. The plurality of porous materials or the plurality of fillers may be disposed to be in contact with each other.

[0089] When an empty space is provided inside the porous material, provided between the plurality of porous materials, or provided between the porous material and a separate component that is distinguished from the porous material, the porous material may be understood as including any one of the aforementioned bar, connection plate, and support plate.

[0090] When an empty space is provided inside the filler, provided between the plurality of fillers, or provided between the filler and a separate component that is distinguished from the filler, the filler may be understood as including any one of the aforementioned bar, connection plate, and support plate. The support according to the present disclosure may include any one of the above examples or an example in which two or more examples are combined.

[0091] Referring to Fig. 3a, as an embodiment, the support may include a bar 31 and a connection plate and support plate 35. The connection plate and the supporting plate may be designed separately. Referring to Fig. 3b, as an embodiment, the support may include a bar 31, a connection plate and support plate 35, and a porous material 33 filled in the vacuum space. The porous material 33 may have emissivity greater than that of stainless steel, which is a material of the plate, but since the vacuum space is filled, resistance efficiency of radiant heat transfer is high.

[0092] The porous material may also function as a heat transfer resistor to be described later. More preferably, the porous material may perform a function of a radiation resistance sheet to be described later. Referring to Fig. 3c, as an embodiment, the support may include a porous material 33 or a filler 33. The porous material 33 and the filler may be provided in a compressed state to maintain a gap between the vacuum space.

[0093] The film 34 may be provided in a state in which a hole is punched as, for example, a PE material. The porous material 33 or the filler may perform both a function of the heat transfer resistor and a function of the support, which will be described later. More preferably, the porous material may perform both a function of the radiation resistance sheet and a function of the support to be described later.

[0094] Fig. 4 is a view for explaining an example of the vacuum adiabatic body based on heat transfer resistors 32, 33, 60, and 63 (e.g., thermal insulator and a heat transfer resistance body). The vacuum adiabatic body according to the present disclosure may optionally include a heat transfer resistor. An example of the heat transfer resistor is as follows. The present disclosure may be any one of the following examples or a combination of two or more examples.

[0095] The heat transfer resistors 32, 33, 60, and 63 may be objects that reduce an amount of heat transfer between the first space and the second space or objects that reduce an amount of heat transfer between the first plate and the second plate. The heat transfer resistor may be disposed on a heat transfer path defined between the first space and the second space. The heat transfer resistor may be disposed on a heat transfer path formed between the first plate and the second plate. The heat transfer resistor may include a portion extending in a direction along a wall defining the vacuum space.

[0096] The heat transfer resistor may include a portion extending in a direction in which the plate extends. Optionally, the heat transfer resistor may include a portion extending from the plate in a direction away from the vacuum space. The heat transfer resistor may be provided on at least a portion of the periphery of the first plate or the periphery of the second plate.

[0097] The heat transfer resistor may be provided on at least a portion of an edge of the first plate or an edge of the second plate. The heat transfer resistor may be provided at a portion, in which the through-hole is defined. The heat transfer resistor may be provided as a tube connected to the through-hole. A separate tube or a separate component that is distinguished from the tube may be disposed inside the tube.

[0098] Exampled of the aforementioned tube may include the exhaust port, a getter port The heat transfer resistor may include a portion having heat transfer resistance greater than that of the plate. In this case, adiabatic performance of the vacuum adiabatic body may be further improved. A shield 62 may be provided on the outside of the heat transfer resistor to be insulated. The inside of the heat transfer resistor may be insulated by the vacuum space. The shield may be provided as a porous material or a filler that is in contact with the inside of the heat transfer resistor.

[0099] The shield may be an adiabatic structure that is exemplified by a separate gasket placed outside the inside of the heat transfer resistor. The heat transfer resistor may be a wall defining the third space.

[0100] An example in which the heat transfer resistor is connected to the plate may be understood as replacing the support with the heat transfer resistor in an example in which the support is provided to support the plate. A duplicate description will be omitted. The example in which the heat transfer resistor is connected to the support may be understood as replacing the plate with the support in the example in which the heat transfer resistor is connected to the plate. A duplicate description will be omitted. The example of reducing heat transfer via the heat transfer body may be applied as a substitute the example of reducing the heat transfer via the support, and thus, the same explanation will be omitted.

[0101] In the present disclosure, the heat transfer resistor may be one of a radiation resistance sheet 32, a porous material 33, a filler 33, and a conductive resistance sheet. In the present disclosure, the heat transfer resistor may include a combination of at least two of the radiation resistance sheet 32, the porous material 33, the filler 33, and the conductive resistance sheet. As a first example, the heat transfer resistor may include a radiation resistance sheet 32.

[0102] The radiation resistance sheet may include a portion having heat transfer resistance greater than that of the plate, and the heat transfer resistance may be a degree of resistance to heat transfer by radiation. The support may perform a function of the radiation resistance sheet together. A conductive resistance sheet to be described later may perform the function of the radiation resistance sheet together. As a second example, the heat transfer resistor may include conduction resistance sheets 60 and 63.

[0103] The conductive resistance sheet may include a portion having heat transfer resistance greater than that of the plate, and the heat transfer resistance may be a degree of resistance to heat transfer by conduction. For example, the conductive resistance sheet may have a thickness less than that of at least a portion of the plate. As another example, the conductive resistance sheet may include one end and the other end, and a length of the conductive resistance sheet may be longer than a straight distance connecting one end of the conductive resistance sheet to the other end of the conductive resistance sheet.

[0104] As another example, the conductive resistance sheet may include a material having resistance to heat transfer greater than that of the plate by conduction. As another example, the heat transfer resistor may include a portion having a curvature radius less than that of the plate.

[0105] Referring to Fig. 4a, for example, a conductive resistance sheet may be provided on a side plate connecting the first plate to the second plate. Referring to Fig. 4b, for example, a conductive resistance sheet 60 may be provided on at least a portion of the first plate and the second plate. A connection frame 70 may be further provided outside the conductive resistance sheet. The connection frame may be a portion from which the first plate or the second plate extends or a portion from which the side plate extends.

[0106] Optionally, the connection frame 70 may include a portion at which a component for sealing the door and the body and a component disposed outside the vacuum space such as the exhaust port and the getter port, which are required for the exhaust process, are connected to each other.

[0107] Referring to Fig. 4c, for example, a conductive resistance sheet may be provided on a side plate connecting the first plate to the second plate. The conductive resistance sheet may be installed in a through-hole passing through the vacuum space. The conduit 64 may be provided separately outside the conductive resistance sheet. The conductive resistance sheet may be provided in a pleated shape. Through this, the heat transfer path may be lengthened, and deformation due to a pressure difference may be prevented. A separate shielding member for insulating the conductive resistance sheet 63 may also be provided. The conductive resistance sheet may include a portion having a degree of deformation resistance less than that of at least one of the plate, the radiation resistance sheet, or the support. The radiation resistance sheet may include a portion having a degree of deformation resistance less than that of at least one of the plate or the support. The plate may include a portion having a degree of deformation resistance less than that of the support. The conductive resistance sheet may include a portion having conductive heat transfer resistance greater than that of at least one of the plate, the radiation resistance sheet, or the support. The radiation resistance sheet may include a portion having radiation heat transfer resistance greater than that of at least one of the plate, the conductive resistance sheet, or the support. The support may include a portion having heat transfer resistance greater than that of the plate.

[0108] For example, at least one of the plate, the conductive resistance sheet, or the connection frame may include stainless steel material, the radiation resistance sheet may include aluminum, and the support may include a resin material.

[0109] Fig. 5 is a graph for observing a process of exhausting the inside of the vacuum adiabatic body with a time and pressure when the support is used. An example of a vacuum adiabatic body vacuum exhaust process vacuum is as follows. The present disclosure may be any one of the following examples or a combination of two or more examples.

[0110] While the exhaust process is being performed, an outgassing process, which is a process in which a gas of the vacuum space is discharged, or a potential gas remaining in the components of the vacuum adiabatic body is discharged, may be performed. As an example of the outgassing process, the exhaust process may include at least one of heating or drying the vacuum adiabatic body, providing a vacuum pressure to the vacuum adiabatic body, or providing a getter to the vacuum adiabatic body. In this case, it is possible to promote the vaporization and exhaust of the potential gas remaining in the component provided in the vacuum space. The exhaust process may include a process of cooling the vacuum adiabatic body. The cooling process may be performed after the process of heating or drying the vacuum adiabatic body is performed. The process of heating or drying the vacuum adiabatic body process of providing the vacuum pressure to the vacuum adiabatic body may be performed together.

[0111] The process of heating or drying the vacuum adiabatic body and the process of providing the getter to the vacuum adiabatic body may be performed together. After the process of heating or drying the vacuum adiabatic body is performed, the process of cooling the vacuum adiabatic body may be performed.

[0112] The process of providing the vacuum pressure to the vacuum adiabatic body and the process of providing the getter to the vacuum adiabatic body may be performed so as not to overlap each other.

[0113] For example, after the process of providing the vacuum pressure to the vacuum adiabatic body is performed, the process of providing the getter to the vacuum adiabatic body may be performed. When the vacuum pressure is provided to the vacuum adiabatic body, a pressure of the vacuum space may drop to a certain level and then no longer drop. Here, after stopping the process of providing the vacuum pressure to the vacuum adiabatic body, the getter may be input. As an example of stopping the process of providing the vacuum pressure to the vacuum adiabatic body, an operation of a vacuum pump connected to the vacuum space may be stopped. When inputting the getter, the process of heating or drying the vacuum adiabatic body may be performed together. Through this, the outgassing may be promoted. As another example, after the process of providing the getter to the vacuum adiabatic body is performed, the process of providing the vacuum pressure to the vacuum adiabatic body may be performed.

[0114] The time during which the vacuum adiabatic body vacuum exhaust process is performed may be referred to as a vacuum exhaust time. The vacuum exhaust time includes at least one of a time $\Delta 1$ during which the process of heating or drying the vacuum adiabatic body is performed, a time $\Delta t2$ during which the process of maintaining the getter in the vacuum adiabatic body is performed, of a time $\Delta t3$ during which the process of cooling the vacuum adiabatic body is performed. Examples of times $\Delta t1$, $\Delta t2$, and $\Delta t3$ are as follows. The present disclosure may be any one of the following examples or a combination of two or more examples. In the vacuum adiabatic body vacuum exhaust process, the time $\Delta t1$ may be a time t1a or more and a time t1b or less. As a first example, the time t1a may be greater than or equal to about 0.2 hr and less than or equal to about 0.5 hr. The time t1b may be greater than or equal to about 1 hr and less than or equal to about 24.0 hr.

[0115] The time $\Delta t1$ may be about 0.3 hr or more and about 12.0 hr or less. The time $\Delta t1$ may be about 0.4 hr or more and about 8.0 hr or less. The time $\Delta t1$ may be about 0.5 hr or more and about 4.0 hr or less. In this case, even if the $\Delta t1$ is kept as short as possible, the sufficient outgassing may be applied to the vacuum adiabatic body. For example, this case may include a case in which a component of the vacuum adiabatic body, which is exposed to the vacuum space, among the components of the vacuum adiabatic body, has an outgassing rate (%) less than that of any one of the component of the vacuum adiabatic body, which is exposed to the external space of the vacuum space. Specifically, the component exposed to the vacuum space may include a portion having a outgassing rate less than that of a thermoplastic polymer.

[0116] More specifically, the support or the radiation resistance sheet may be disposed in the vacuum space, and the outgassing rate of the support may be less than that of the thermoplastic plastic. As another example, this case may include a case in which a component of the vacuum adiabatic body, which is exposed to the vacuum space, among the components of the vacuum adiabatic body, has a max operating temperature (°C) greater than that of any one of the component of the vacuum adiabatic body, which is exposed to the external space of the vacuum space.

[0117] In this case, the vacuum adiabatic body may be heated to a higher temperature to increase in outgassing rate. For example, the component exposed to the vacuum space may include a portion having an operating temperature greater than that of the thermoplastic polymer. As a more specific example, the support or the radiation resistance sheet may be disposed in the vacuum space, and a use temperature of the support may be higher than that of the thermoplastic plastic.

[0118] As another example, among the components of the vacuum adiabatic body, the component exposed to the vacuum space may contain more metallic portion than a non-metallic portion. That is, a mass of the metallic portion may be greater than a mass of the non-metallic portion, a volume of the metallic portion may be greater than a volume of the non-metallic portion, or an area of the metallic portion exposed to the vacuum space may be greater than an area exposed to the non-metallic portion of the vacuum space. When the components exposed to the vacuum space are provided in plurality, the sum of the volume of the metal material included in the first component and the volume of the metal material included in the second component may be greater than that of the volume of the non-metal material included in the first component and the volume of the non-metal material included in the second component. When the components exposed to the vacuum space are provided in plurality, the sum of the mass of the metal material included in the first component and the mass of the metal material included in the second component may be greater than that of the mass of the non-metal material included in the first component and the mass of the non-metal material included in the second component. When the components exposed to the vacuum space are provided in plurality, the sum of the area of the metal material, which is exposed to the vacuum space and included in the first component, and an area of the metal material, which is exposed to the vacuum space and included in the second component, may be greater than that of the area of the non-metal material, which is exposed to the vacuum space and included in the first component, and an area of the non-metal material, which is exposed to the vacuum space and included in the second component.

[0119] As a second example, the time t1a may be greater than or equal to about 0.5 hr and less than or equal to about 1 hr. The time t1b may be greater than or equal to about 24.0 hr and less than or equal to about 65 hr. The time Δt1 may be about 1.0 hr or more and about 48.0 hr or less. The time Δt1 may be about 2 hr or more and about 24.0 hr or less. The time Δt1 may be about 3 hr or more and about 12.0 hr or less.

[0120] In this case, it may be the vacuum adiabatic body that needs to maintain the Δt1 as long as possible. In this case, a case opposite to the examples described in the first example or a case in which the component exposed to the vacuum space is made of a thermoplastic material may be an example. A duplicated description will be omitted. In the vacuum adiabatic body vacuum exhaust process, the time Δt1 may be a time t1a or more and a time t1b or less. The time t2a may be greater than or equal to about 0.1 hr and less than or equal to about 0.3 hr. The time t2b may be greater than or equal to about 1 hr and less than or equal to about 5.0 hr.

[0121] The time Δt2 may be about 0.2 hr or more and about 3.0 hr or less. The time Δt2 may be about 0.3 hr or more and about 2.0 hr or less. The time Δt2 may be about 0.5 hr or more and about 1.5 hr or less. In this case, even if the time Δt2 is kept as short as possible, the sufficient outgassing through the getter may be applied to the vacuum adiabatic body.

[0122] In the vacuum adiabatic body vacuum exhaust process, the time Δt3 may be a time t3a or more and a time t3b or less.

[0123] The time t3a may be greater than or equal to about 0.2 hr and less than or equal to about 0.8 hr. The time t3b may be greater than or equal to about 1 hr and less than or equal to about 65.0 hr. The time Δt3 may be about 0.2 hr or more and about 48.0 hr or less. The time Δt3 may be about 0.3 hr or more and about 24.0 hr or less. The time Δt3 may be about 0.4 hr or more and about 12.0 hr or less. The time Δt3 may be about 0.5 hr or more and about 5.0 hr or less. After the heating or drying process is performed during the exhaust process, the cooling process may be performed.

[0124] For example, when the heating and/or drying process is performed for a long time, the time Δt3 may be long. The vacuum adiabatic body according to the present disclosure may be manufactured so that the time Δt1 is greater than the time Δt2, the time Δt1 is less than or equal to the time Δt3, or the time Δt3 is greater than the time Δt2.

[0125] The following relational expression is satisfied: $\Delta t2<\Delta t1<\Delta t3$. The vacuum adiabatic body according to an embodiment may be manufactured so that the relational expression: $\Delta t1+\Delta t2+\Delta t3$ may be greater than or equal to about 0.3 hr and less than or equal to about 70 hr, be greater than or equal to about 1 hr and less than or equal to about 65 hr, or be greater than or equal to about 2 hr and less than or equal to about 24 hr. The relational expression: $\Delta t1+\Delta t2+\Delta t3$ may be manufactured to be greater than or equal to about 3 hr and less than or equal to about 6 hr.

[0126] An example of the vacuum pressure condition during the exhaust process is as follows. The present disclosure may be any one of the following examples or a combination of two or more examples. A minimum value of the vacuum pressure in the vacuum space during the exhaust process may be greater than about 1.8E-6 Torr. The minimum value of the vacuum pressure may be greater than about 1.8E-6 Torr and less than or equal to about 1.0E-4 Torr, be greater than about 0.5E-6 Torr and less than or equal to about 1.0E-4 Torr, or be greater than about 0.5E-6 Torr and less than or equal to about 0.5E-5 Torr. The minimum value of the vacuum pressure may be greater than about 0.5E-6 Torr and less than about 1.0E-5 Torr.

[0127] As such, the limitation in which the minimum value of the vacuum pressure provided during the exhaust process is because, even if the pressure is reduced through the vacuum pump during the exhaust process, the decrease in vacuum pressure is slowed below a certain level.

[0128] As an embodiment, after the exhaust process is performed, the vacuum pressure of the vacuum space may be maintained at a pressure greater than or equal to about 1.0E-5 Torr and less than or equal to about 5.0E-1 Torr. The maintained vacuum pressure may be greater than or equal to about 1.0E-5 Torr and less than or equal to about 1.0E-1 Torr, be greater than or equal to about 1.0E-5 Torr and less than or equal to about 1.0E-2 Torr, be greater than or equal to about 1.0E-4 Torr and less than or equal to about 1.0E-2 Torr, or be greater than or equal to about 1.0E-5 Torr and less than or equal to about 1.0E-3 Torr. As a result of predicting the change in vacuum pressure with an accelerated experiment of two example products, one product may be provided so that the vacuum pressure is maintained below about 1.0E-04Torr even after about 16.3 years, and the other product may be provided so that the vacuum pressure is maintained below about 1.0E-04Torr even after about 17.8 years.

[0129] As described above, the vacuum pressure of the vacuum adiabatic body may be used industrially only when it is maintained below a predetermined level even if there is a change over time.

[0130] Fig. 5a is a graph of an elapsing time and pressure in the exhaust process according to an example, and Fig. 5b is a view explaining results of a vacuum maintenance test in the acceleration experiment of the vacuum adiabatic body of the refrigerator having an internal volume of about 128 liters.

[0131] Referring to Fig. 5b, it is seen that the vacuum pressure gradually increases according to the aging. For example, it is confirmed that the vacuum pressure is about 6.7E-04 Torr after about 4.7 years, about 1.7E-03 Torr after about 10 years, and about 1.0E-02 Torr after about 59 years. According to these experimental results, it is confirmed that the vacuum adiabatic body according to the embodiment is sufficiently industrially applicable.

[0132] Fig. 6 is a graph illustrating results obtained by comparing the vacuum pressure with gas conductivity.

Referring to Fig. 6, gas conductivity with respect to the vacuum pressure depending on a size of the gap in the vacuum space 50 was represented as a graph of effective heat transfer coefficient (eK). The effective heat transfer coefficient (eK) was measured when the gap in the vacuum space 50 has three values of about 3 mm, about 4.5 mm, and about 9 mm. The gap in the vacuum space 50 is defined as follows. When the radiation resistance sheet 32 exists inside surface vacuum space 50, the gap is a distance between the radiation resistance sheet 32 and the plate adjacent thereto. When the radiation resistance sheet 32 does not exist inside surface vacuum space 50, the gap is a distance between the first and second plates. It was seen that, since the size of the gap is small at a point corresponding to a typical effective heat transfer coefficient of about 0.0196 W/mK, which is provided to an adiabatic material formed by foaming polyurethane, the vacuum pressure is about 5.0E-1 Torr even when the size of the gap is about 3 mm.

[0133] Meanwhile, it was seen that the point at which reduction in adiabatic effect caused by the gas conduction heat is saturated even though the vacuum pressure decreases is a point at which the vacuum pressure is approximately 4.5E-3 Torr. The vacuum pressure of about 4.5E-3 Torr may be defined as the point at which the reduction in adiabatic effect caused by the gas conduction heat is saturated.

[0134] Also, when the effective heat transfer coefficient is about 0.01 W/mK, the vacuum pressure is about 1.2E-2 Torr. An example of a range of the vacuum pressure in the vacuum space according to the gap is presented. The support may include at least one of a bar, a connection plate, or a support plate. In this case, when the gap of the vacuum space is greater than or equal to about 3 mm, the vacuum pressure may be greater than or equal to A and less than about 5E-1 Torr, or be greater than about 2.65E-1 Torr and less than about 5E-1 Torr. As another example, the support may include at least one of a bar, a connection plate, or a support plate. In this case, when the gap of the vacuum space is greater than or equal to about 4.5 mm, the vacuum pressure may be greater than or equal to A and less than about 3E-1 Torr, or be greater than about 1.2E-2 Torr and less than about 5E-1 Torr.

[0135] As another example, the support may include at least one of a bar, a connection plate, or a support plate, and when the gap of the vacuum space is greater than or equal to about 9 mm, the vacuum pressure may be greater than or equal to A and less than about 1.0X10^-1 Torr or be greater than about 4.5E-3 Torr and less than about 5E-1 Torr.

[0136] Here, the A may be greater than or equal to about 1.0X10^-6 Torr and less than or equal to about 1.0E-5 Torr. The A may be greater than or equal to about 1.0X10^-5 Torr and less than or equal to about 1.0E-4 Torr. When the support includes a porous material or a filler, the vacuum pressure may be greater than or equal to about 4.7E-2 Torr and less than or equal to about 5E-1 Torr. In this case, it is understood that the size of the gap ranges from several micrometers to several hundreds of micrometers. When the support and the porous material are provided together in the vacuum space, a vacuum pressure may be created and used, which is middle between the vacuum pressure when only the support is used and the vacuum pressure when only the porous material is used.

[0137] Fig. 7 is a view for explaining a process of manufacturing the vacuum adiabatic body.

[0138] Optionally, the vacuum adiabatic body may be manufactured by a vacuum adiabatic body component preparation process in which the first plate and the second plate are prepared in advance. Optionally, the vacuum adiabatic body may be manufactured by a vacuum adiabatic body component assembly process in which the first plate and the second plate are assembled. Optionally, the vacuum adiabatic body may be manufactured by a vacuum adiabatic body vacuum exhaust process in which a gas in the space defined between the first plate and the second plate is discharged. Optionally, after the vacuum adiabatic body component preparation process is performed, the vacuum adiabatic body component assembly process or the vacuum adiabatic body exhaust process may be performed.

[0139] Optionally, after the vacuum adiabatic body component assembly process is performed, the vacuum adiabatic body vacuum exhaust process may be performed. Optionally, the vacuum adiabatic body may be manufactured by the vacuum adiabatic body component sealing process (S3) in which the space between the first plate and the second plate is sealed. The vacuum adiabatic body component sealing process may be performed before the vacuum adiabatic body vacuum exhaust process (S4). The vacuum adiabatic body may be manufactured as an object with a specific purpose by an apparatus assembly process (S5) in which the vacuum adiabatic body is combined with the components constituting the apparatus. The apparatus assembly process may be performed after the vacuum adiabatic body vacuum exhaust process.

[0140] Here, the components constituting the apparatus means components constituting the apparatus together with the vacuum adiabatic body.

[0141] The vacuum adiabatic body component preparation process (S1) is a process in which components constituting the vacuum adiabatic body are prepared or manufactured. Examples of the components constituting the vacuum adiabatic body may include various components such as a plate, a support, a heat transfer resistor, and a tube. The vacuum adiabatic body component assembly process (S2) is a process in which the prepared components are assembled. The vacuum adiabatic body component assembly process may include a process of disposing at least a portion of the support and the heat transfer resistor on at least a portion of the plate.

[0142] For example, the vacuum adiabatic body component assembly process may include a process of disposing at least a portion of the support and the heat transfer resistor between the first plate and the second plate. Optionally, the vacuum adiabatic body component assembly process may include a process of disposing a penetration component on at least a portion of the plate. For example, the vacuum adiabatic body component assembly process may include a process of disposing the penetration component or a surface component between the first and second plates. After the penetration component may be disposed between the first plate and the second plate, the penetration component may be connected or sealed to the penetration component coupling portion.

[0143] An example of a vacuum adiabatic body vacuum exhaust process vacuum is as follows. The present disclosure may be any one of the, examples or a combination of two or more examples. The vacuum adiabatic body vacuum exhaust process may include at least one of a process of inputting the vacuum adiabatic body into an exhaust passage, a getter activation process, a process of checking vacuum leakage and a process of closing the exhaust port. The process of forming the coupling part may be performed in at least one of the vacuum adiabatic body component preparation process, the vacuum adiabatic body component assembly process, or the apparatus assembly process. Before the vacuum adiabatic body exhaust process is performed, a process of washing the components constituting the vacuum adiabatic body may be performed. Optionally, the washing process may include a process of applying ultrasonic waves to the components constituting the vacuum adiabatic body or a process of providing ethanol or a material containing ethanol to surfaces of the components constituting the vacuum adiabatic body. The ultrasonic wave may have an intensity between about 10 kHz and about 50 kHz. A content of ethanol in the material may be about 50% or more. For example, the content of ethanol in the material may range of about 50% to about 90%. As another example, the content of ethanol in the material may range of about 60% to about 80%.

[0144] As another example, the content of ethanol in the material may be range of about 65% to about 75%. Optionally, after the washing process is performed, a process of drying the components constituting the vacuum adiabatic body may be performed. Optionally, after the washing process is performed, a process of heating the components constituting the vacuum adiabatic body may be performed.

[0145] A heat exchanger may be installed in a vacuum adiabatic body. The following may be optional. The heat exchanger may connect a first space to a second space. The heat exchanger may exchange heat between a refrigerant discharged from an evaporator and a refrigerant suctioned into the evaporator. At least a portion of the heat exchanger may be placed in a third space.

[0146] Matters and descriptions disclosed in any drawing of this document may provide different embodiments. Contents disclosed in any drawing of this document may be applied to the contents of other drawings.

[0147] FIG. 8 is a view illustrating an example in which a support and a heat exchanger are installed.

[0148] The following may be optional. Referring to FIG. 8, the heat exchanger 57 may be installed on a rear surface of the vacuum adiabatic body. A first end portion of a refrigerant tube constituting the heat exchanger may be led out to a machine room 8. The machine room may be placed in a second space. A second end portion of the refrigerant tube constituting the heat exchanger may be led out to a low-temperature space. The low-temperature space may be placed in the first space. The heat exchanger may be provided to a predetermined length to enable sufficient heat exchange. The heat exchanger may have a bent part. The heat exchanger may have a straight part extending in a straight line. At least two straight parts may be provided. The bent part may be provided between the straight parts. At least one bent part may be bent in an extension direction of the third space. At least one bent part may be bent in a thickness direction of the third space.

[0149] The following may be optional. A support 30 placed on a rear surface of the vacuum adiabatic body may be provided as a single structure of one body. The single structure may be provided as a structure in which at least two individual units are connected to each other. The units 301 may be respectively coupled vertically. The units 301 may be coupled so that the upper and lower units are alternately disposed. Thus, the single structure may be provided. There may be a left-right gap in a left and right direction of each of the units. The bent part may not be placed in the left-right gap of each unit. Thus, the positioning of the bent part may be convenient. Thus, the heat exchanger may be stably supported. When there are two bent parts, the two bent parts may be placed on the same unit. The heat exchanger may pass through at least two or more units.

[0150] The following may be optional. The support may be provided as a lattice structure. The heat exchanger may pass between the lattices. The heat exchanger may move while being placed on the single structure. The heat exchanger may be placed on the plate while being placed on the single structure. The support may be made of PPS. The support may be made of PPS containing glass fiber.

[0151] FIG. 9 is a view illustrating a relationship between the support, a heat exchanger, and a radiation resistance sheet. FIG. 10 is a view illustrating a relationship between the radiation resistance sheet and the heat exchanger. This will be described with reference to FIGS. 9 and 10.

[0152] The following may be optional. The support 30 may be provided as a first support 34a at an upper side and a second support 34b at a lower side. The first and second supports may be coupled to each other. A radiation resistance sheet may be provided between the first and second supports. The radiation resistance sheet may be provided with a hole through which a bar 31 passes. The support may be provided by coupling a unit 341. At least a portion of the radiation resistance sheet may be removed at a position through which the heat exchanger passes. At least a portion of the radiation resistance sheet may not be removed at the position through which the heat exchanger passes. The heat exchanger 57 and the radiation resistance sheet 32 may not be in contact with each other. This may reduce thermal conductivity and increase in adiabatic effect. The radiation resistance sheet 32 may be provided as a single sheet. If the lattice-shaped support is not present, the heat exchanger may be placed after inserting the radiation resistance sheet. This is because an installation location of the heat exchanger is unknown. An example of a case in which the lattice-type support is not present is a case in which a porous material is present. In the case of the lattice-type support, an order of arrangement of the radiation resistance sheet and the heat exchanger may be irrelevant. This is because the position of the arrangement of the heat exchanger may be determined through the support.

[0153] FIGS. 11 and 12 are views illustrating a configuration in which the radiation resistance sheet is provided as a plurality of sheets. This will be described with reference to FIGS. 11 and 12.

[0154] The radiation resistance sheet 32 may be provided as a plurality of sheets 32a to 32j. The following contents may be optional. The plurality of sheets may not be in direct contact with each other. The plurality of sheets may be fixed in relative position by a bar 31, etc. The plurality of sheets may be disposed on the same plane. A boundary area 349 may be provided between the plurality of sheets. The heat exchanger may be disposed on at least a portion of the boundary area. At least a portion of the boundary area may not have the heat exchanger disposed thereon. The boundary areas may be spaced a predetermined interval w from each other. The thermal conduction between the sheets may be shielded by the boundary area. At least one boundary area 349 may be provided in at least one direction of horizontal or vertical directions. At least two boundary areas 349 may be provided in at least two directions in both the horizontal and vertical directions. The boundary area 349 may have a horizontal width w1 smaller than a vertical width w2. This allows for further shielding the heat transfer in the horizontal direction. In the boundary areas, an area on which the heat exchanger is placed may have a large width. As a result, the heat transfer between the heat exchanger and the radiation resistance sheet may be suppressed. Any one of the plurality of sheets may be provided with a removed part 341. The removed part 341 may be provided by cutting any portion of the sheet. At least a portion of the heat exchanger may be placed in the removed part. At least a portion of the plurality of sheets may be provided in a rectangular shape.

[0155] FIG. 13 is a view illustrating a state in which at least two radiation resistance sheets are disposed in a height direction of a vacuum space. Descriptions will be made with reference to FIG. 13.

[0156] As illustrated in FIG. 13(a), the radiation resistance sheet may be disposed in the same manner in the height direction of the vacuum space. In other words, the plurality of sheets may be disposed to have the same boundary area 349 and/or removed part 341 even though the layers are different from each other. Accordingly, an area on which direct thermal radiation occurs through the first and second plates may be generated. The first and second supports may be provided to intersect each other.

[0157] As illustrated in FIG. 13(b), the radiation resistance sheet may be disposed in different manners in the height direction of the vacuum space. In other words, the plurality of sheets may be disposed so that the boundary area 349 and/or the removed part 341 are different from each other when the layers are different from each other. Accordingly, at least one radiation resistance sheet may be interposed between the first and second plates. As a result, an amount of heat radiation transfer between the first and second plates may be reduced. It is also possible to implement FIGS. 13(a) and 13(b) together.

[0158] A discharge pipe 651 of the heat exchanger has a low temperature. A suction pipe 652 of the heat exchanger has a high temperature. The heat transfer with the outside may increase due to a temperature difference of the heat exchanger. Dew formation may occur on the plate adjacent to the discharge pipe. The dew formation has a significant effect on the area on which the radiation resistance sheet is not provided. The dew formation may be significantly observed in the boundary area and the removal area. A dew formation prevention mechanism may be provided on the second plate 20 adjacent to a path along which the heat exchanger 57 proceeds. The following contents may be applied selectively. As the dew formation prevention mechanism, at least one of an insulator provided on an outer surface or inner surface of the second plate, a heater or heat pipe or surface heating device provided on the outer surface or inner surface of the second plate, and a heat diffusion plate provided on the outer surface or inner surface of the second plate may be applied. The heat diffusion plate may quickly diffuse cold air from the discharge pipe along an extension direction of the second plate. Thus, the second plate may be prevented from reaching a temperature below a dew point. The dew formation prevention mechanism may adjust its strength according to the temperature of the discharge pipe. For example, an intensity of the heater may increase as it gets closer to the first terminal 65a adjacent to an evaporator. The intensity of the heater may be lowered from the first terminal to the second terminal. The dew formation prevention mechanism may be configured to operate only when an external humidity is high. FIG. 14 is a view illustrating a case in which the dew formation prevention mechanism is disposed on the outer surface of the second plate.

[0159] A discharge pipe 651 of the heat exchanger has a low temperature. A suction pipe 652 of the heat exchanger has a high temperature. The heat transfer with the outside may increase due to a temperature difference of the heat exchanger. The heat transfer is undesirable because it increases in irreversibility. In the heat exchanger 57, it is desirable to ensure that heat transfer occurs only in the heat exchanger, if possible. For this purpose, a radiation shield layer 571 may be installed on an outer circumference of the heat exchanger.

[0160] FIG. 15 is a cross-sectional view of the heat exchanger, on which the radiation shield layer is provided, and a cross-sectional view of the radiation shield layer. FIG. 16 is a cross-sectional view of the radiation shield layer according to an embodiment. FIG. 17 is a perspective view of the radiation shield layer and a view of an end portion of the radiation shield layer. This will be described with reference to FIGS. 15 to 17.

[0161] The following contents may be applied optionally. The radiation shield layer 571 may surround the heat exchanger 57 in a closed curve. At least a portion of the radiation shield layer may be provided in a circular shape. At least a portion of the radiation shield may be spaced apart from the heat exchanger. At least a portion of the radiation shield layer may have an inner circumferential shape corresponding to the outer circumference of the heat exchanger. Each of the plurality of shield layers may be provided as a tube. The radiation shield layer 571 may be provided in a configuration in which a resin layer 571b and a reflective layer 571a are laminated. The resin layer may be made of linear low-density polyethylene (LLDPE). It may be provided with a structure in which aluminum is deposited on each of both surfaces of the resin layer. Examples of the reflective layer include a low-emissivity aluminum sheet, a nickel-plated sheet, and an aluminum-deposited sheet. Cold air of the heat exchanger and hot air of the heat exchanger may not be radiated to the outside. The heat exchange efficiency of the heat exchanger may be improved. The dew formation on the outer surface of the second plate may be prevented by the radiation shield layer. The radiation shield layer 571 may shield a contact part of the two pipes. The radiation shield layer 571 may be closer to the contact part of the two pipes. The radiation shield layer 571 may provide a greater radiation shielding effect at the contact part between the two pipes. The radiation shield layer 571 may be provided at the contact part of the two pipes. This is because the heat radiation is large at the contact part between the two pipes. The contact parts of the two pipes may be bonded by brazing. The radiation resistance sheet may or may not be provided together with the plurality of shield layers 571.

[0162] FIG. 18 is a view illustrating an example of a method for shielding heat transfer of the heat exchanger. FIG. 18(a) illustrates an example of adding a radiation shield plate. FIG. 18(b) illustrates an example of adding an insulator. Descriptions will be made with reference to FIG. 18.

[0163] A radiation shield layer 347 may be provided adjacent to the heat exchanger. The following may be applied optionally. The radiation shield layer may correspond to the boundary area 349 and/or the removed part 341. The radiation shield layer 347 may be fixed at a position adjacent to the support plate 35. The radiation shield layer 347 may be provided on at least one of the first and second support plates. The left-right movement of the radiation shield may be stopped by the bar 31. The radiation shield layer may be stopped from moving vertically by a gap maintaining member 346. The gap maintaining member 346 may be at least partially fitted into the radiation resistance sheet 32. The gap maintaining member 346 may be supported by the radiation resistance sheet. The gap maintaining member 346 may not be supported by the bar 31. The gap maintaining member 346 may be in contact with the radiation shield layer 347. The gap maintaining member 346 may extend in the vertical direction of the vacuum space. The gap maintaining member 346 may prevent the radiation shield layer 347 and the radiation resistance sheet 32 from moving.

[0164] The insulator 348 may be provided adjacent to the heat exchanger. The following may be applied optionally. The insulator may correspond to the boundary area 349 and/or the removed part 341. The boundary area 349 and the removal area 341 may be collectively referred to as a removal area. The insulator 348 may be fixed at a position adjacent to the support plate 35. The insulator 348 may be provided on at least one of the first or second support plate. The insulator may be provided on a position at which there is no support plate. The insulator may be provided in a gap between the units constituting the support. The insulator may be in contact with an inner surface of either the first or second plate. The insulator 348 and the radiation shield layer 347 may be applied together. The left-right movement of the insulator may be stopped by the support 31. A distance between the insulator and any one of the first and second plates 10 and 20 adjacent to the insulator may be shorter than a distance between the insulator and the heat exchanger. Accordingly, an influence of the radiation heat on the first and second plates may be reduced. At least one of the gap maintaining member 346 or the bar 31 may be applied to fix the insulator. The insulator may use a material that includes PPS with low outgassing.

[0165] FIG. 19 is a view illustrating an example of shielding the radiation heat of the heat exchanger according to various embodiments. FIG. 19(a) illustrates the radiation shield layer and the radiation resistance sheet. FIGS. 19(b) and 19(c) illustrate the presence of the radiation resistance sheet. Descriptions will be made with reference to FIG. 19.

[0166] The radiation shield layer 571 may be provided outside the heat exchanger 57. The following may be applied optionally. The radiation shield layer 571 may surround the heat exchanger 57 in a closed curve. At least a portion of the radiation shield layer may be provided in a circular shape. At least a portion of the radiation shield may be spaced apart from the heat exchanger. Each of the plurality of shield layers may be provided as a tube. The radiation shield layer 571 may be provided in a configuration in which the resin layer and the reflective layer are laminated. The resin layer may be made of linear low-density polyethylene (LLDPE). It may be provided with a structure in which aluminum is deposited on each of both surfaces of the resin layer. Examples of the reflective layer include a low-emissivity aluminum sheet, a nickel-plated sheet, and an aluminum-deposited sheet. Cold air of the heat exchanger and hot air of the heat exchanger may not be radiated to the outside except for the heat exchange. The heat exchange efficiency of the heat exchanger may be improved. The dew formation on the outer surface of the second plate may be prevented by the radiation shield layer.

[0167] The radiation resistance sheet 32 may be provided outside the heat exchanger 57. The following may be applied optionally. The heat exchanger may be provided with the radiation resistance sheet 32 on at least one of an upper or lower side. The radiation resistance sheet 32 may be provided in a form that accommodates the heat exchanger 57 therein. The radiation resistance sheet 32 may be provided with deformation parts 32a and 32b. The deformation part may accommodate the heat exchanger. At least a portion of the deformation part may not be in contact with the heat exchanger. At least a portion of the deformation part may not be in contact with the radiation shield layer. A distance between the deformation part 32a and the support plate 35 may be closer than a distance between the deformation part and the heat exchanger. This may reduce heat transfer through the radiation. For this purpose, when the radiation resistance sheet is provided vertically, the deformation part 32a and 32b may be provided in a mirror shape. A distance w between the deformation part 32b and the support plate may be longer than a distance between the deformation part and the heat exchanger. Thus, the radiation resistance sheet may smoothly support the heat exchanger. The radiation resistance sheet may support the heat exchanger. For this purpose, the radiation resistance sheet may be in direct or indirect contact with the heat exchanger. The deformation part may be provided to be flat.

[0168] At least one of gap support between the at least two of the radiation resistance sheets 32-1 and 32-2, gap support between the radiation resistance sheet and the support plate, or heat exchanger support of the radiation resistance sheet may be smoothly performed. For this purpose, the radiation resistance sheet may be supported on the bar. A gap block 311 may be provided in the bar. The gap block may be fitted as a separate member into the bar. At least one end of the gap block may be in contact with the radiation resistance sheet. The bar 31 may be provided with a protrusion 312. At least one end of the protrusion may be contact with the radiation resistance sheet. The gap block and the protrusion may prevent the radiation resistance sheet from moving in the thickness direction of the vacuum space. The deformation parts 32a and 32b may be in contact with the support plate 35. The deformation part may be provided to be flat. As a result, the radiation resistance sheet may be supported over a wide area. The radiation resistance sheet may be supported more stably.

[0169] FIG. 20 is a view illustrating an example in which the gap block is disposed between the radiation resistance sheet and the heat exchanger. FIG. 20(a) illustrates a case in which the gap block has a generally circular shape. FIG. 20(b) illustrates a case in which the gap block has a generally square shape. Descriptions will be made with reference to FIG. 20.

[0170] At least some between the radiation resistance sheet and the heat exchanger may be spaced apart from each other. The following may be applied optionally. All the gaps between the radiation resistance sheet and the heat exchanger may be spaced apart from each other. A gap between the radiation resistance sheet and the heat exchanger may be supported by the gap block. The gap blocks 313 and 314 may use a material with low outgassing. The gap block may be made of ceramic or a resin. The resin can use PPS. The gap block may prevent direct contact between the heat exchanger and the radiation resistance sheet. The gap block may use a material with high adiabatic performance. The radiation shield layer 571 may be interposed between the heat exchanger and the gap block. It is preferable that a surface area of each of the contact surface between the radiation resistance sheet and the gap block, the contact surface between the gap block and the heat exchanger, or the contact surface between the gap block and the radiation shield layer is small. At least one of the contact surface between the radiation resistance sheet and the gap block, the contact surface between the gap block and the heat exchanger, and the contact surface between the gap block and the radiation shield layer may have a rib or the like to form a line contact. At least one of the contact surface between the radiation resistance sheet and the gap block, the contact surface between the gap block and the heat exchanger, and the contact surface between the gap block and the radiation shield layer may have a protrusion or the like to form a point contact. The gap block may be provided in a cross-sectional shape of a closed curve. As a result, the adiabatic performance may be greatly improved. It may be provided as a cross-sectional shape of an open curve of the gap block. A mouth 315 may be provided in the gap block 341. This allows the heat exchanger to be easily inserted into the gap block. An outer appearance of the gap block and an inner appearance of the deformation part may at least partially coincide with each other. This allows the gap block to be positioned easily.

[0171] FIG. 21 is a view illustrating an example in which the insulator is provided. FIG. 21(a) illustrates a case in which only insulator is provided. FIG. 21(b) illustrates a case in which the insulator and the deformation part are provided. Descriptions will be made with reference to FIG. 21.

[0172] The insulator 347 may be provided adjacent to the heat exchanger. The following may be applied optionally. The insulator 347 may be fixed at a position adjacent to the support plate 35. The insulator 347 may be in contact with at least one of the first or second support plate. The insulator 347 may be adjacent to the plates 10 and 20 rather than the heat exchanger. The insulator may be provided on a position at which there is no support plate. The insulator may be provided in a gap between the units constituting the support. The insulator may be in contact with an inner surface of either the first or second plate. A distance between the insulator and any one of the first and second plates 10 and 20 adjacent to the insulator may be shorter than a distance between the insulator and the heat exchanger. Accordingly, an influence of the radiation heat on the first and second plates may be reduced. The insulator may use a material that includes PPS with low outgassing. A length of the removed part from which the radiation resistance sheets are removed in at least two radiation resistance sheets 32-1 and 32-2 may be different from each other. A cut length of the first radiation resistance sheet 32-1 may be shorter than that of the second radiation resistance sheet 32-2. The heat exchanger may be disposed closer to the second radiation resistance sheet 32-2. This is because a degree of an interference with the heat exchanger may vary depending on the radiation resistance sheet. The deformation part 32a32b may be further provided. The deformation part may be closer to the plate than to the heat exchanger. The heat radiation may be blocked more strictly by the deformation part.

[0173] FIG. 22 is a view of the radiation resistance sheet according to various embodiments. FIG. 22(a) illustrates a case in which a relatively large deformation part is provided. FIG. 22(b) illustrates a case in which the deformation part is formed at only one side. FIG. 22(c) illustrates a case in which only one side of the radiation resistance sheet is opened. Descriptions will be made with reference to FIG. 22.

[0174] The following contents may be applied optionally. A width of each of the deformation parts 32a and 32b may be provided to be greater than one time the gap between the bars 31. A width of each of the deformation parts 32a and 32b may be provided to be greater than twice the gap between the bars 31. As the deformation part increases in size, the shape of the deformation part may be easily processed. A processing method may be applied through a press. As the deformation part increases, deformation strength of the radiation resistance sheet may increase. As the deformation part increases, the deformation part may be formed more easily. The deformation part may be provided on at least one of at least two radiation resistance sheets 32-1 and 32-2. Accordingly, the concern about the heat conduction that may occur when the deformation part is in contact with the support plate or the first and second plates may be reduced. The deformation part 32b may be provided only when necessary to support the heat exchanger, etc. Openings 341 and 349 may be provided in at least one of the two radiation resistance sheets 32-1 and 32-2. The opening may be provided in a position at which the heat exchanger and the radiation resistance sheet interfere with each other. Accordingly, an increase in amount of radiation heat transfer between the heat exchanger and the first and second plates may be prevented. The opening may include a gap 341 in the sheet itself or a portion at which the sheet is cut 349.

INDUSTRIAL APPLICABILITY

[0175] According to the present invention, the heat exchanger may be conveniently installed inside the vacuum space.

Claims

1. A vacuum adiabatic body comprising:

    a first plate having a first temperature;
    a second plate having a second temperature different from the first temperature;
    a vacuum space provided between the first plate and the second plate;
    a heat transfer resistor provided inside the vacuum space and at least one of spaces adjacent to the first and second plates to reduce heat transfer between the first plate and the second plate; and
    a pipe having a portion disposed in the vacuum space.

2. The vacuum adiabatic body according to claim 1, wherein the heat transfer resistor comprises a radiation shield layer provided to surround at least a portion of the pipe.

3. The vacuum adiabatic body according to claim 2, wherein the radiation shield layer has a closed curve-shaped cross-section.

4. The vacuum adiabatic body according to claim 2, wherein the radiation shield layer is provided as a resin layer and two reflective layers.

5. The vacuum adiabatic body according to claim 2, wherein the radiation shield layer comprises a portion that is in contact with the pipe.

6. The vacuum adiabatic body according to claim 1, wherein the heat transfer resistor comprises a radiation resistance sheet having an empty space or removed part to provide a space in which at least a portion of the pipe is disposed.

7. The vacuum adiabatic body according to claim 1, wherein the heat transfer resistor comprises a first heat transfer resistor and a second heat transfer resistor spaced apart from the first heat transfer

resistor,
wherein the pipe comprises a portion disposed in an empty space defined to be spaced apart from the first heat transfer resistor and the first heat transfer resistor.

8. The vacuum adiabatic body according to claim 1, wherein the heat transfer resistor comprises a radiation resistance sheet having a portion spaced apart from the pipe so as not to be in contact with the pipe.

9. The vacuum adiabatic body according to claim 1, wherein the heat transfer resistor comprises a radiation resistance sheet configured to reduce radiation heat transfer between the first plate and the second plate,
wherein at least one of an insulator or a radiation shield layer is disposed in a removed area on which the radiation resistance sheet is not provided.

10. The vacuum adiabatic body according to claim 9, wherein a distance between at least one of the insulator or the radiation shield layer and one of the first and second plates adjacent to the insulator and the radiation shield layer is shorter than a distance between at least one of the insulator or the radiation shield layer and the pipe.

11. The vacuum adiabatic body according to claim 9, further comprising a gap maintaining member supported on the radiation resistance sheet to maintain a gap of the radiation resistance sheet,
wherein at least one of the insulator and the radiation shield layer is in contact with an end portion of the gap maintaining member.

12. The vacuum adiabatic body according to claim 1, wherein the heat transfer resistor comprises a radiation resistance sheet configured to reduce radiation heat transfer between the first plat and the second plate,

the vacuum adiabatic body further comprises a gap maintaining member supported on the radiation resistance sheet to maintain a predetermined gap in a thickness direction or height direction of the vacuum space, and
at least a portion of the gap maintaining member is fitted into the radiation resistance sheet.

13. The vacuum adiabatic body according to claim 1, wherein the heat transfer resistor comprises a radiation resistance sheet configured to reduce radiation heat transfer between the first plate and the second plate, and
the vacuum adiabatic body further comprises a deformation part disposed on the radiation resistance sheet to accommodate the pipe.

14. The vacuum adiabatic body according to claim 13, further comprising a support configured to maintain a gap of the vacuum space,
wherein the deformation part is in contact with the support.

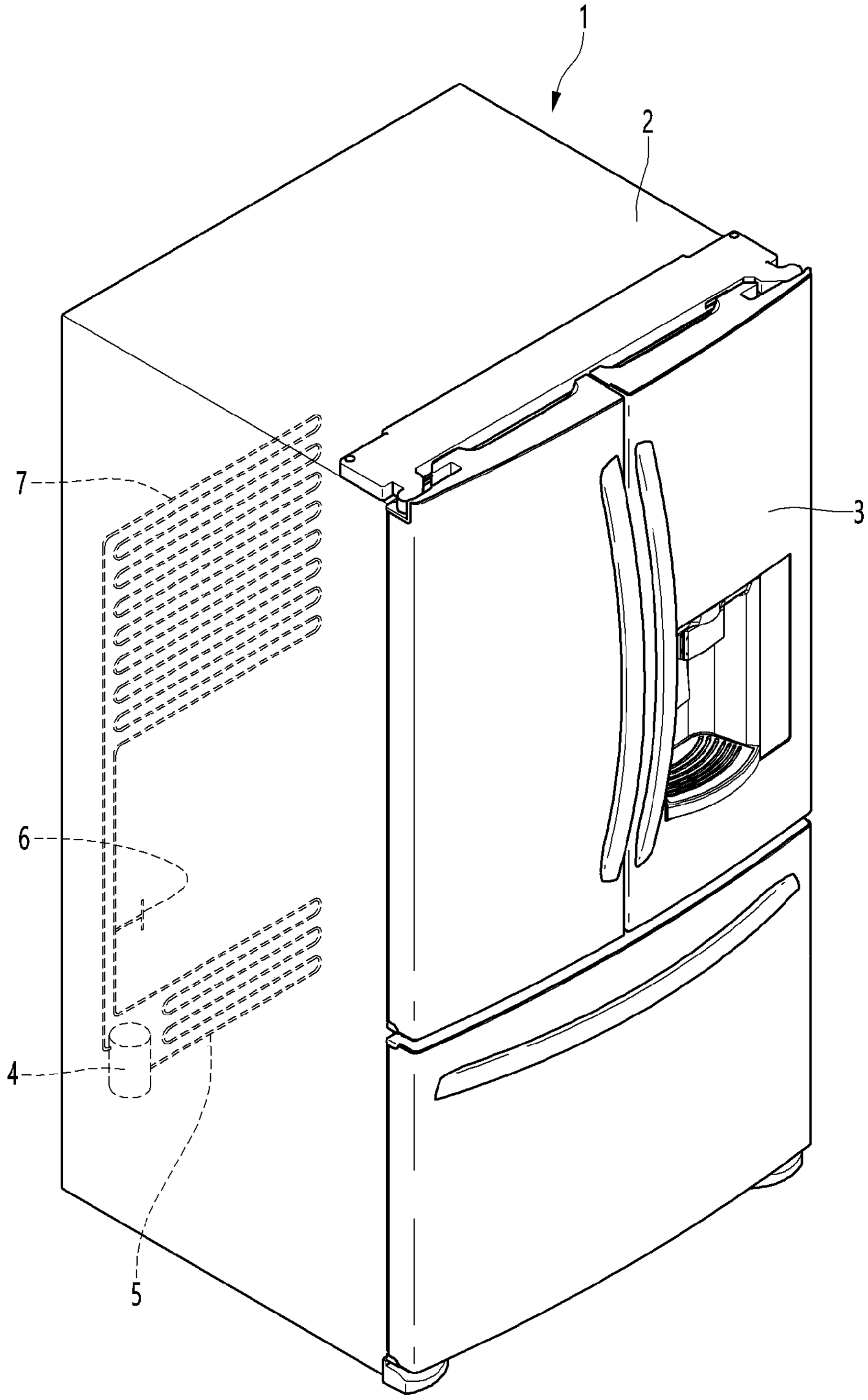
15. The vacuum adiabatic body according to claim 13, further comprising a support configured to maintain a gap of the vacuum space,

wherein the support comprises a support plate and a bar extending from the support plate toward the vacuum space, and
a distance between the deformation part and the support plate is less than a distance between the deformation part and the pipe.

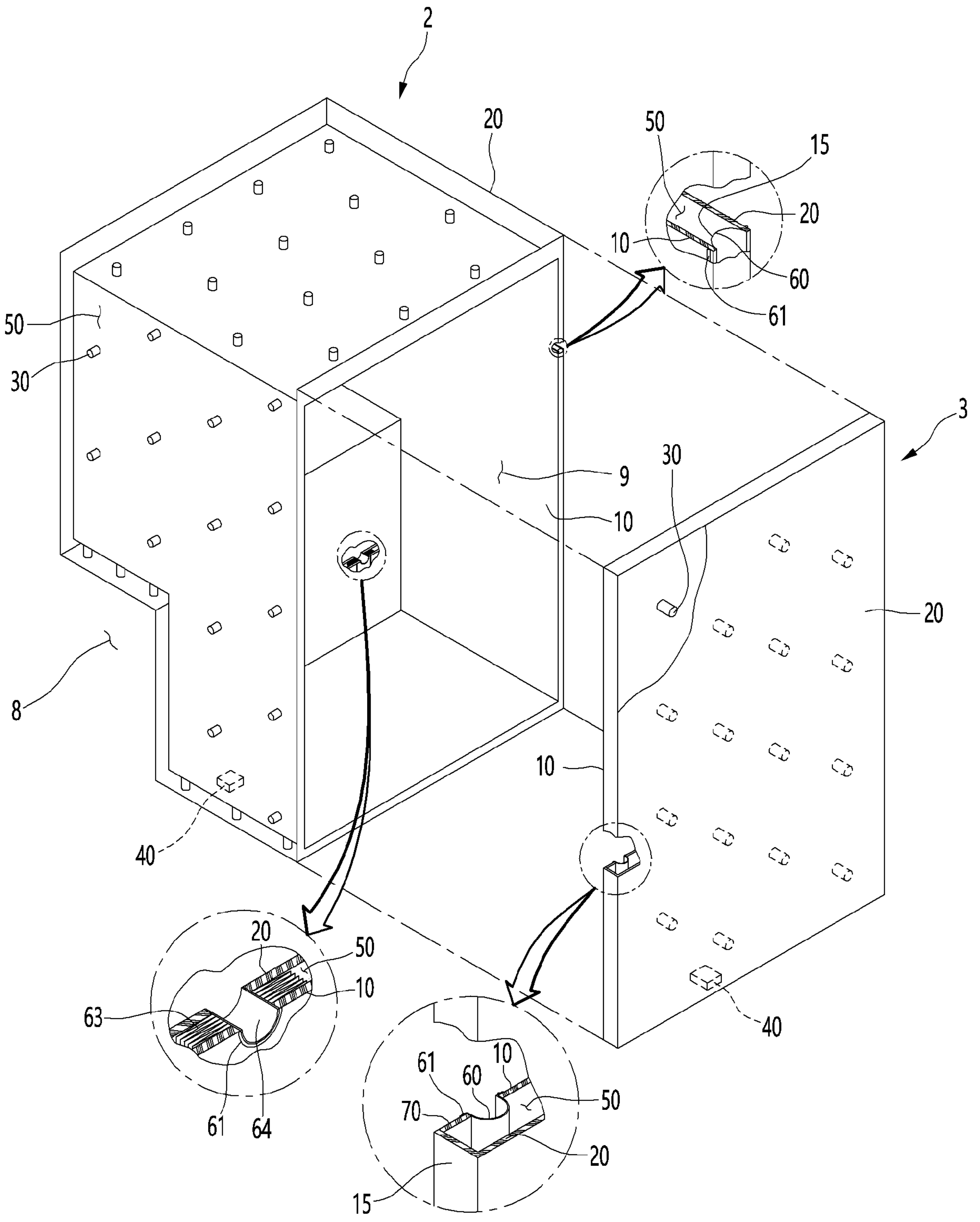
16. The vacuum adiabatic body according to claim 13, wherein at least two radiation resistance sheets spaced apart from each other in a vertical direction of the pipe are provided on the radiation resistance sheet,
wherein at least one of the at least two radiation resistance sheets does not comprise the deformation part, and at least one of the at least two radiation resistance sheets is opened.

17. The vacuum adiabatic body according to claim 1, wherein the heat transfer resistor comprises a radiation resistance sheet configured to reduce radiation heat transfer between the first plate and the second plate, and
the vacuum adiabatic body further comprises a gap block provided between the radiation resistance sheet and the pipe so that at least some of the pipe and the radiation resistance sheet are spaced apart from each other.

【Figure 1】



【Figure 2】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61
60
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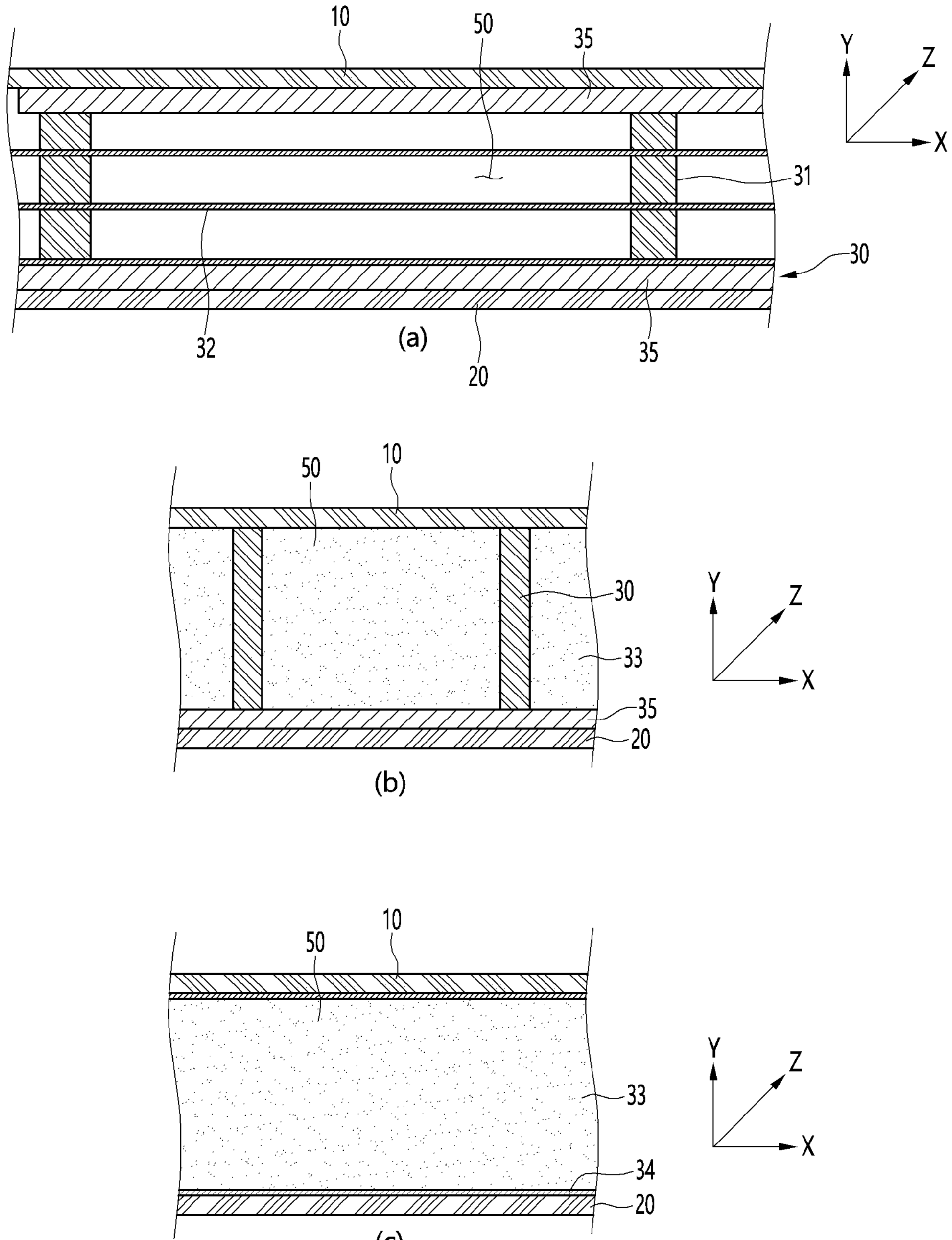
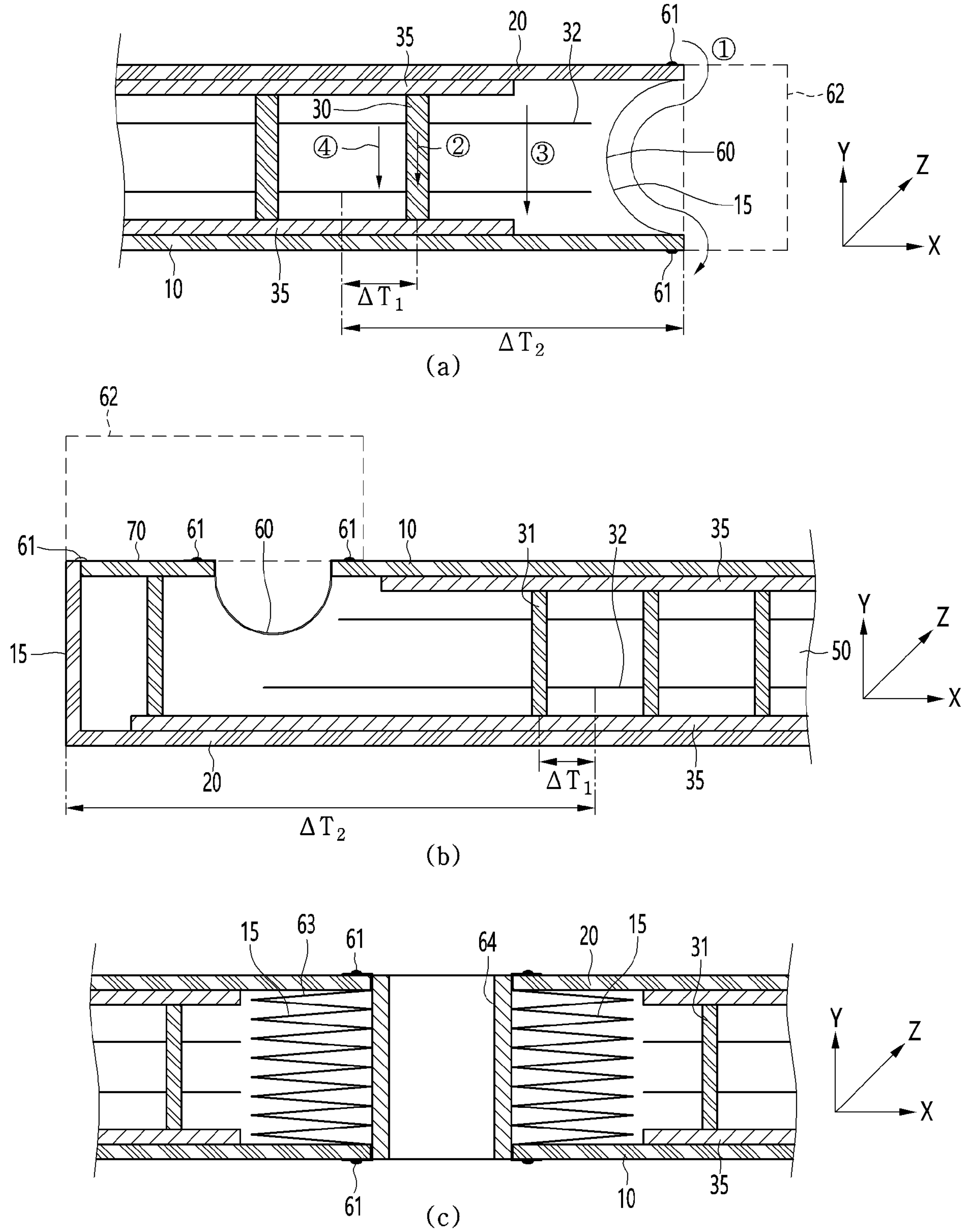
70
20
15

【Figure 3】



【Figure 4】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20
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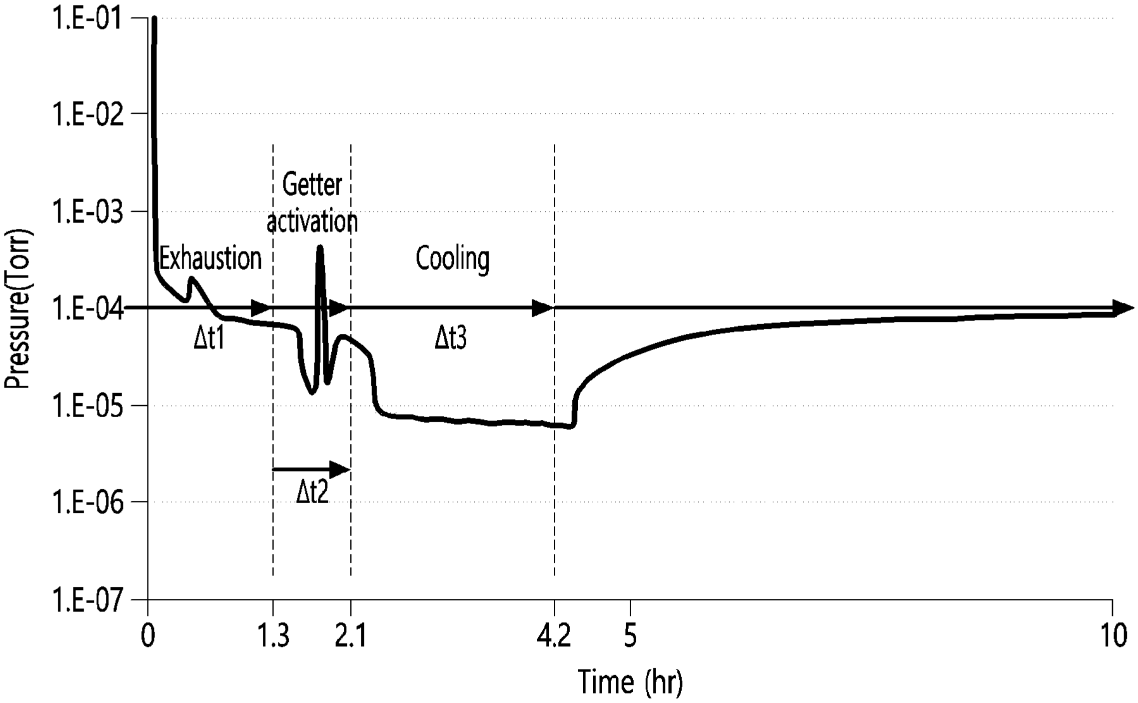
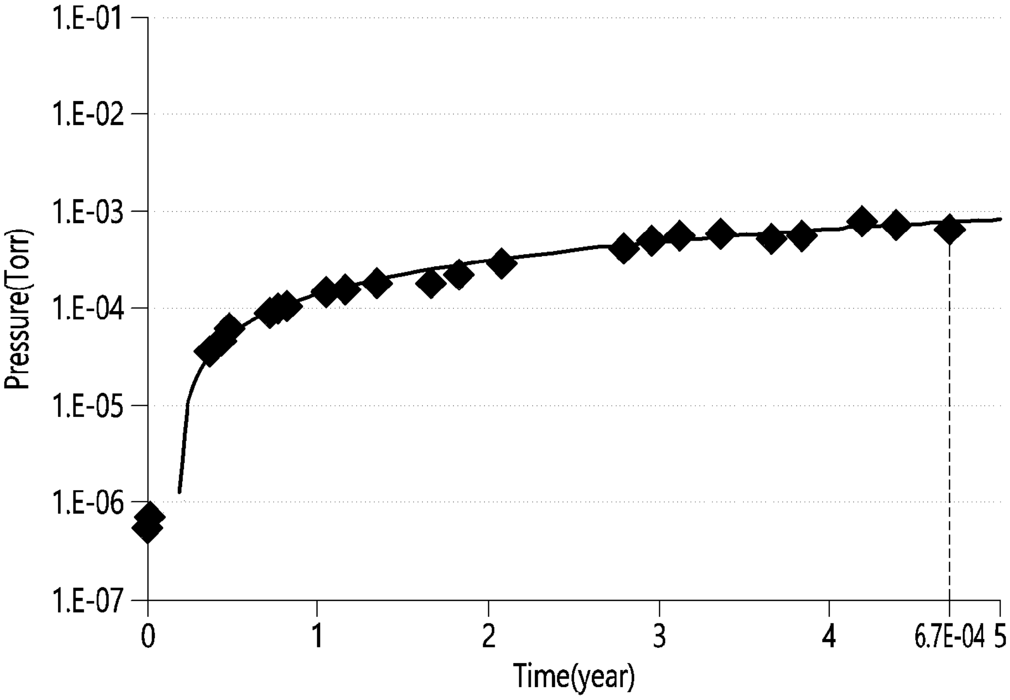
①
62
30
④
②
③
60
15
Y
Z
X
10
35
61
ΔT1
ΔT2
(a)
62
61
70
61
60
61
10
31
32
35
15
50
Y
Z
X
20
ΔT1
35
ΔT2
(b)
15
63
61
64
20
15
31
Y
Z
X
61
10
35
(c)

【Figure 5】

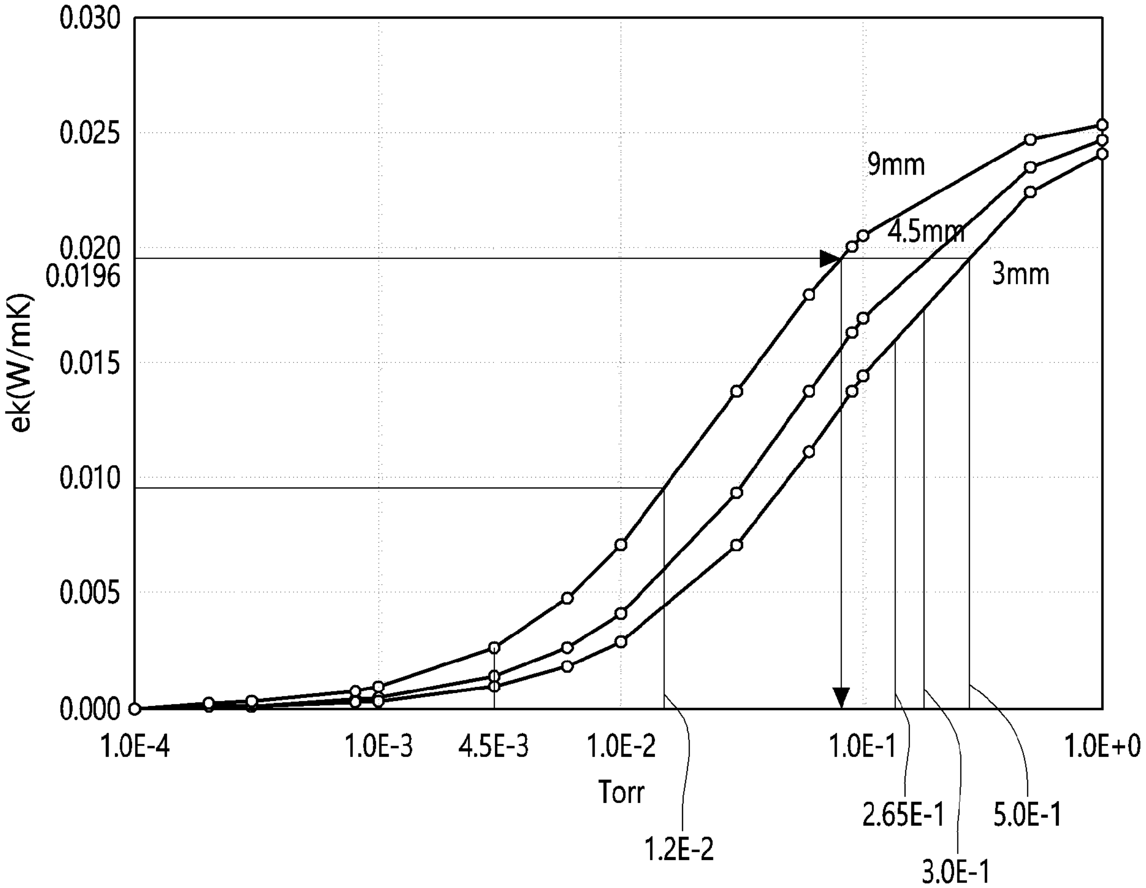

1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
Pressure(Torr)
Exhaustion
Getter activation
Cooling
Δt1
Δt2
Δt3
0
1.3
2.1
4.2
5
10
Time (hr)

(a)

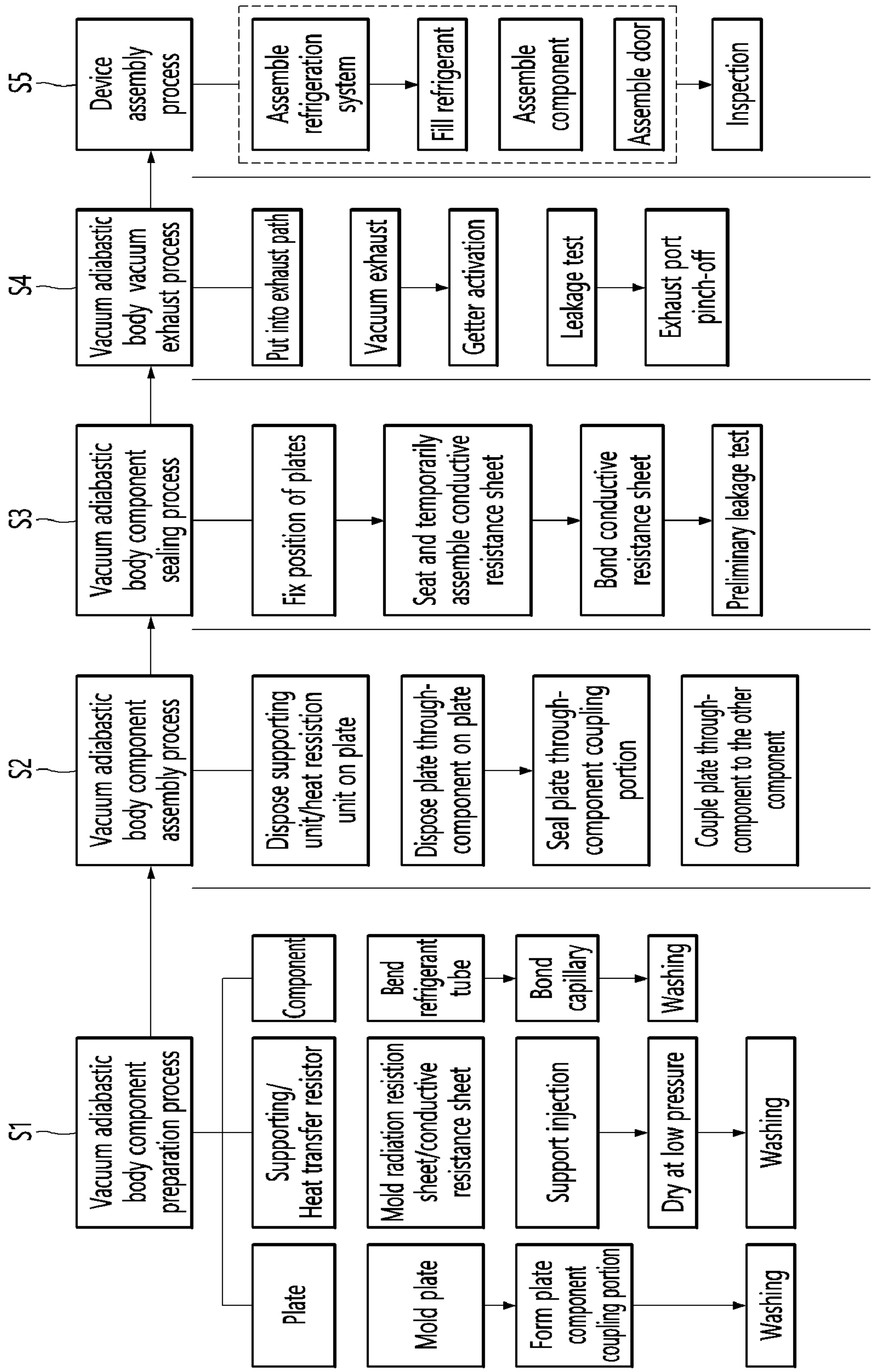

1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
Pressure(Torr)
0
1
2
3
4
6.7E-04
5
Time(year)

(b)

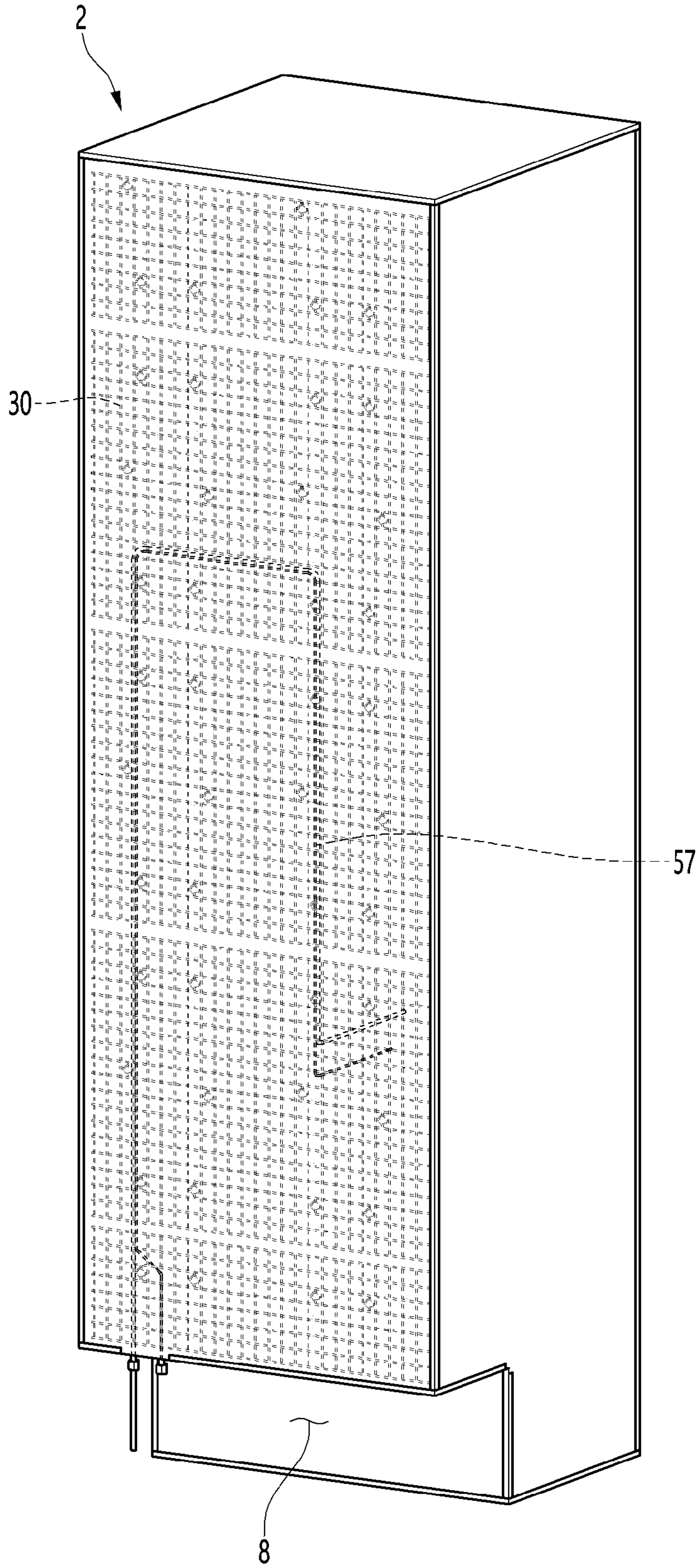
【Figure 6】


0.030
0.025
0.020
0.0196
0.015
0.010
0.005
0.000
ek(W/mK)
9mm
4.5mm
3mm
1.0E-4
1.0E-3
4.5E-3
1.0E-2
1.0E-1
1.0E+0
Torr
1.2E-2
2.65E-1
3.0E-1
5.0E-1

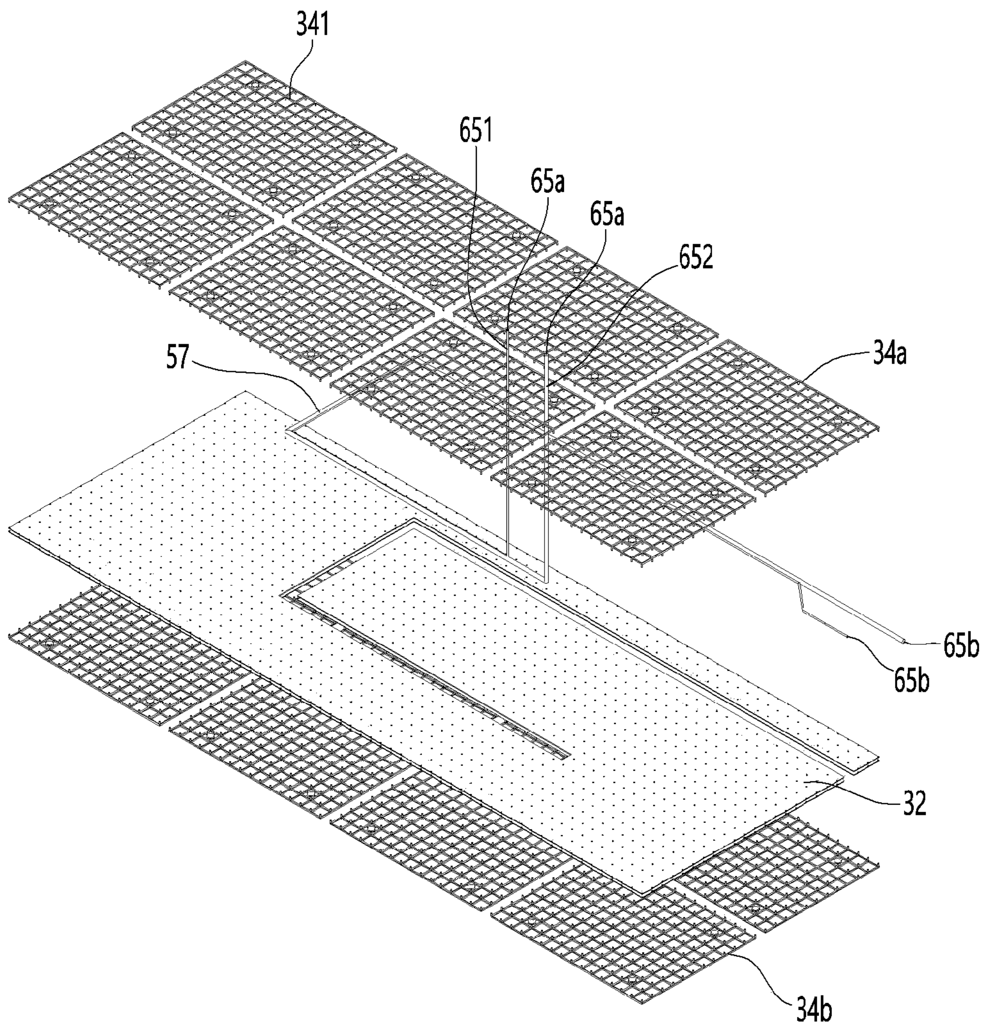
【Figure 7】


S1
Vacuum adiabastic body component preparation process
Plate
Supporting/ Heat transfer resistor
Component
Mold plate
Mold radiation resistion sheet/conductive resistance sheet
Bend refrigerant tube
Form plate component coupling portion
Support injection
Bond capillary
Dry at low pressure
Washing
Washing
Washing
S2
Vacuum adiabastic body component assembly process
Dispose supporting unit/heat ressistion unit on plate
Dispose plate through-component on plate
Seal plate through-component coupling portion
Couple plate through-component to the other component
S3
Vacuum adiabastic body component sealing process
Fix position of plates
Seat and temporarily assemble conductive resistance sheet
Bond conductive resistance sheet
Preliminary leakage test
S4
Vacuum adiabastic body vacuum exhaust process
Put into exhaust path
Vacuum exhaust
Getter activation
Leakage test
Exhaust port pinch-off
S5
Device assembly process
Assemble refrigeration system
Fill refrigerant
Assemble component
Assemble door
Inspection

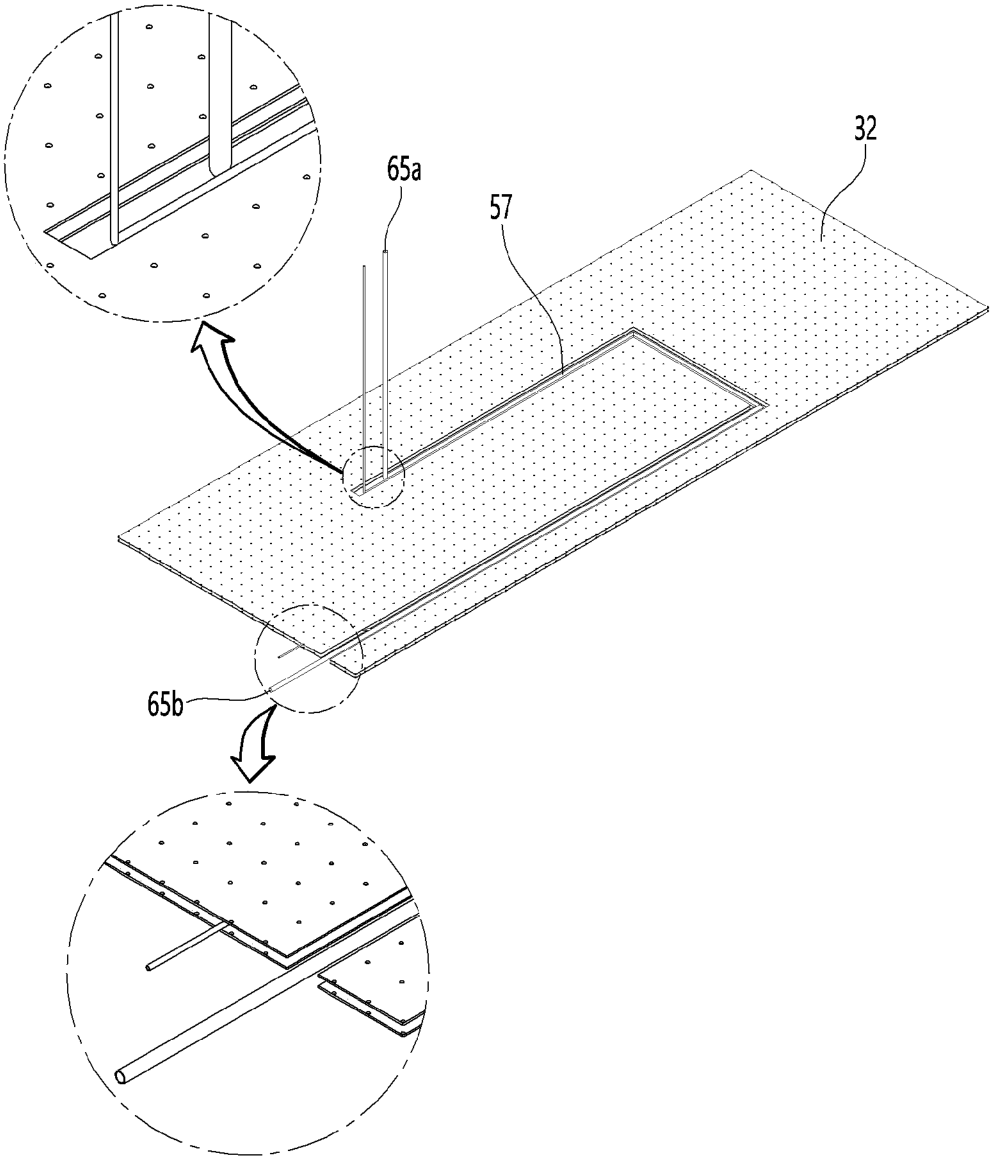
【Figure 8】



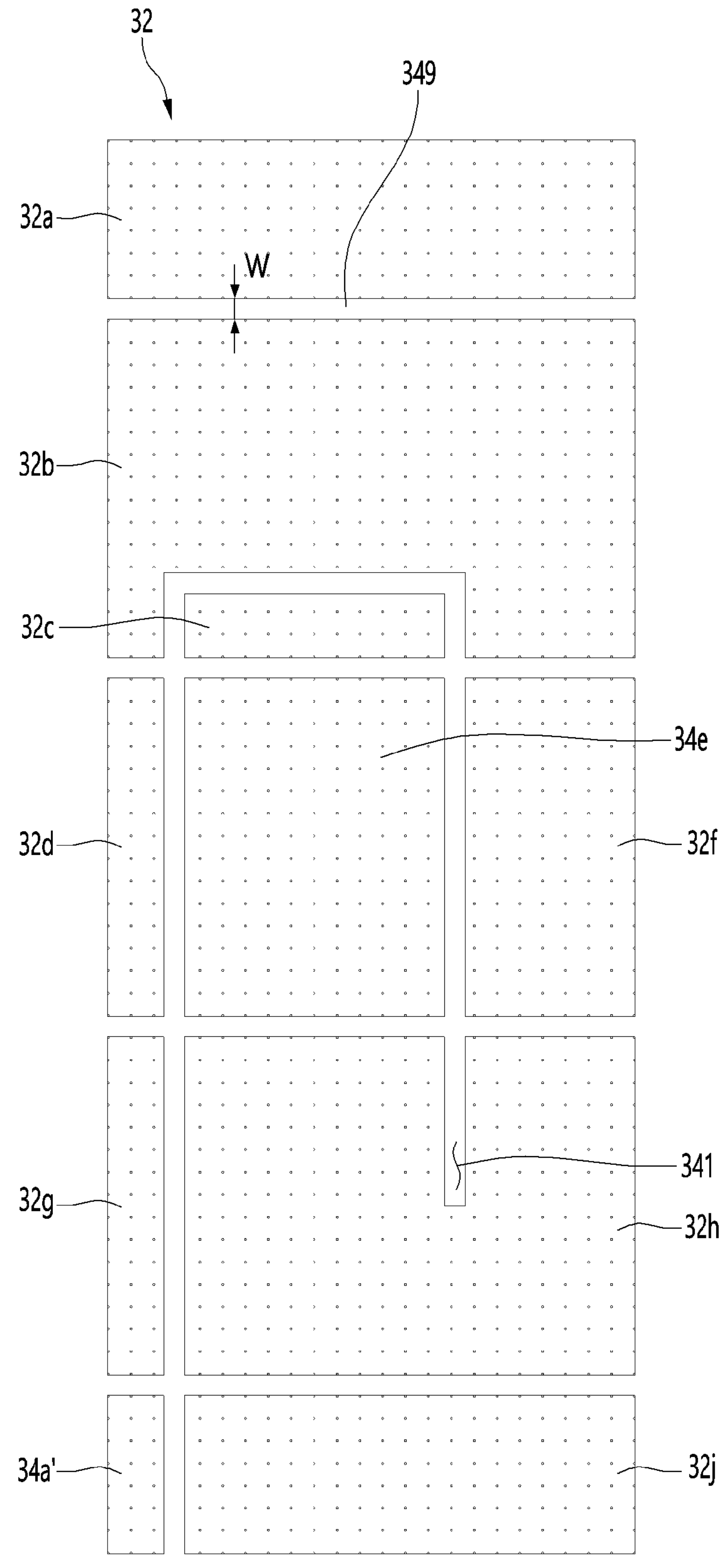
【Figure 9】



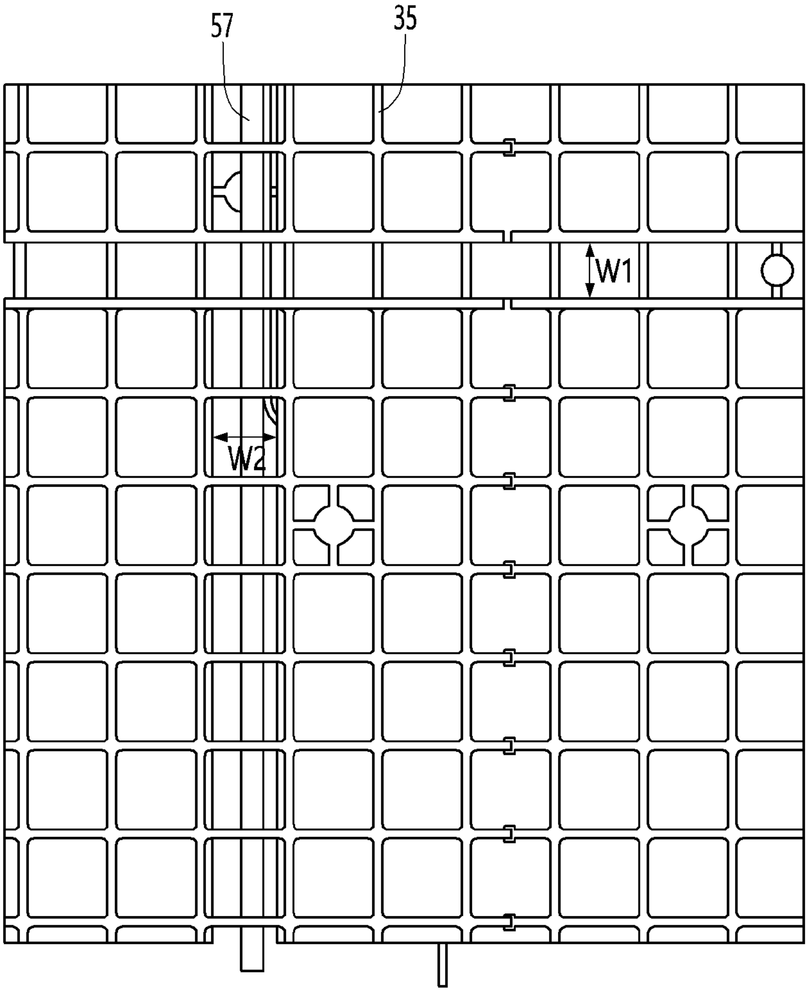
【Figure 10】



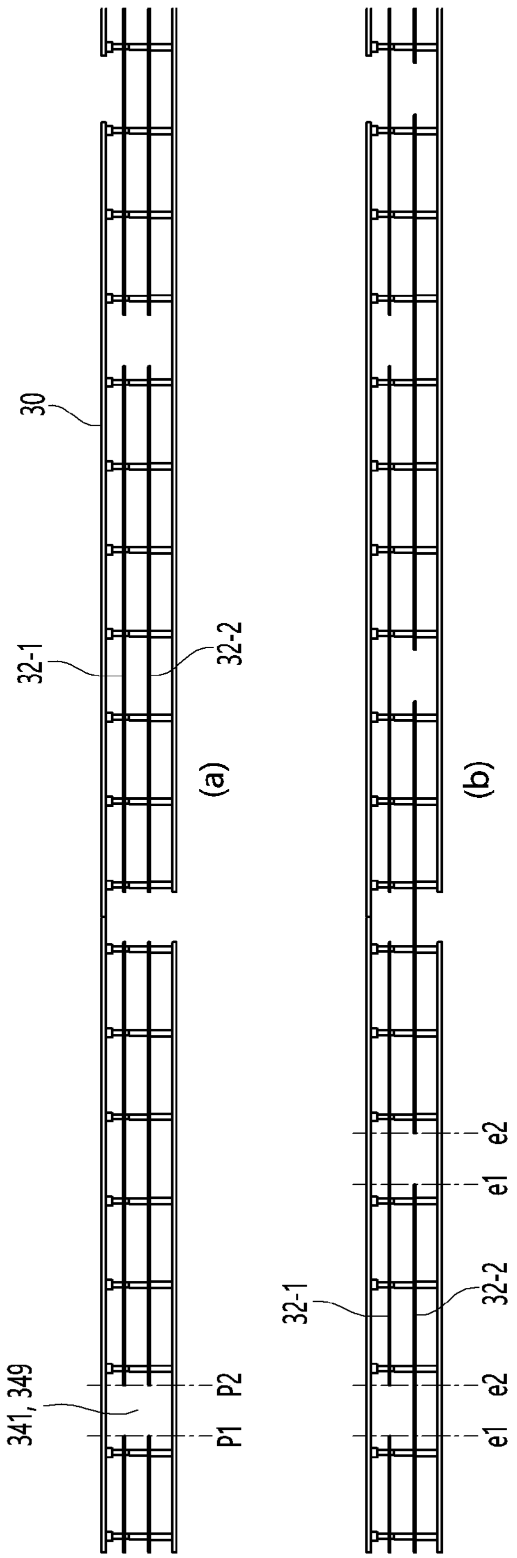
【Figure 11】



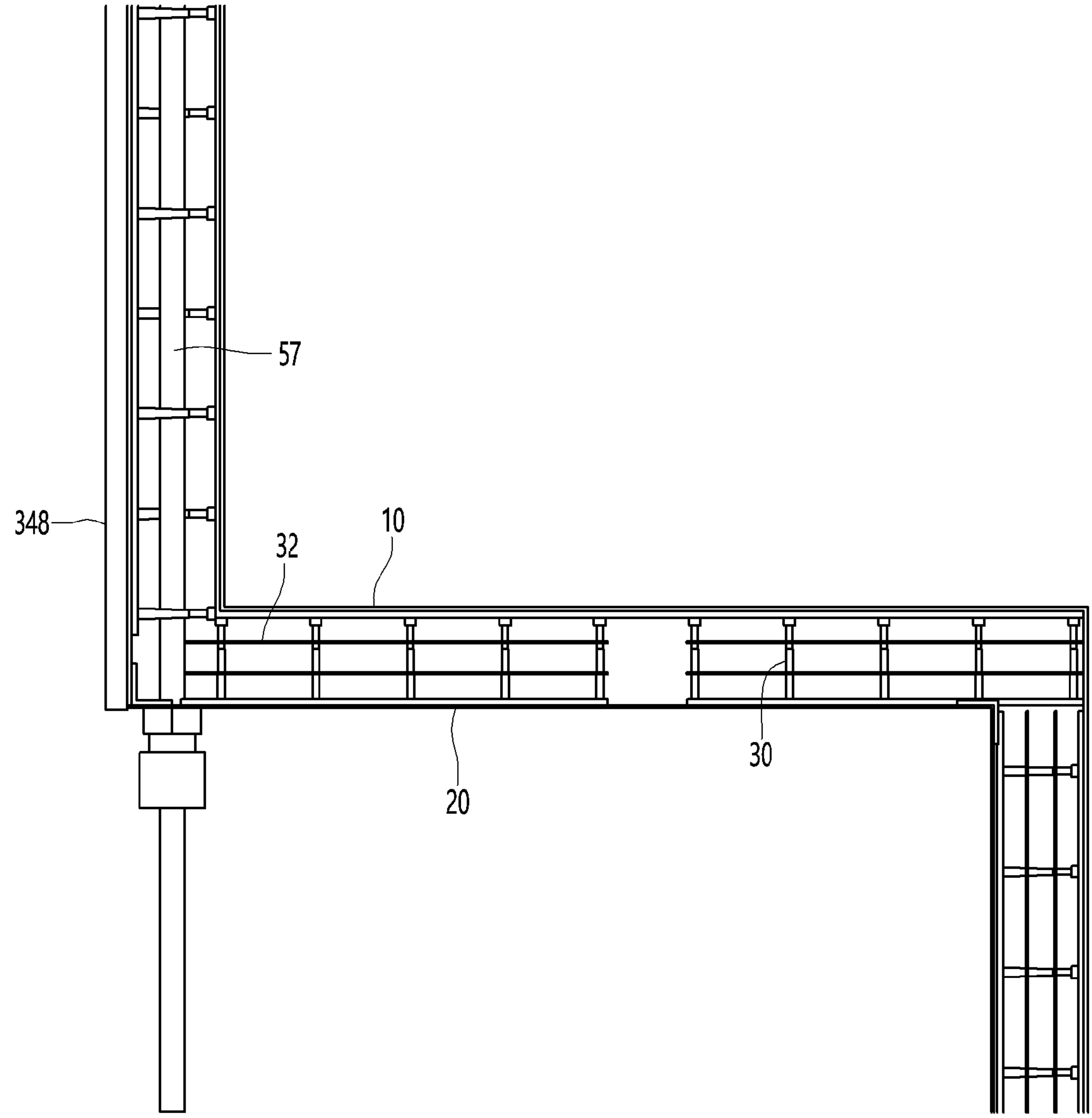
【Figure 12】



【Figure 13】



【Figure 14】



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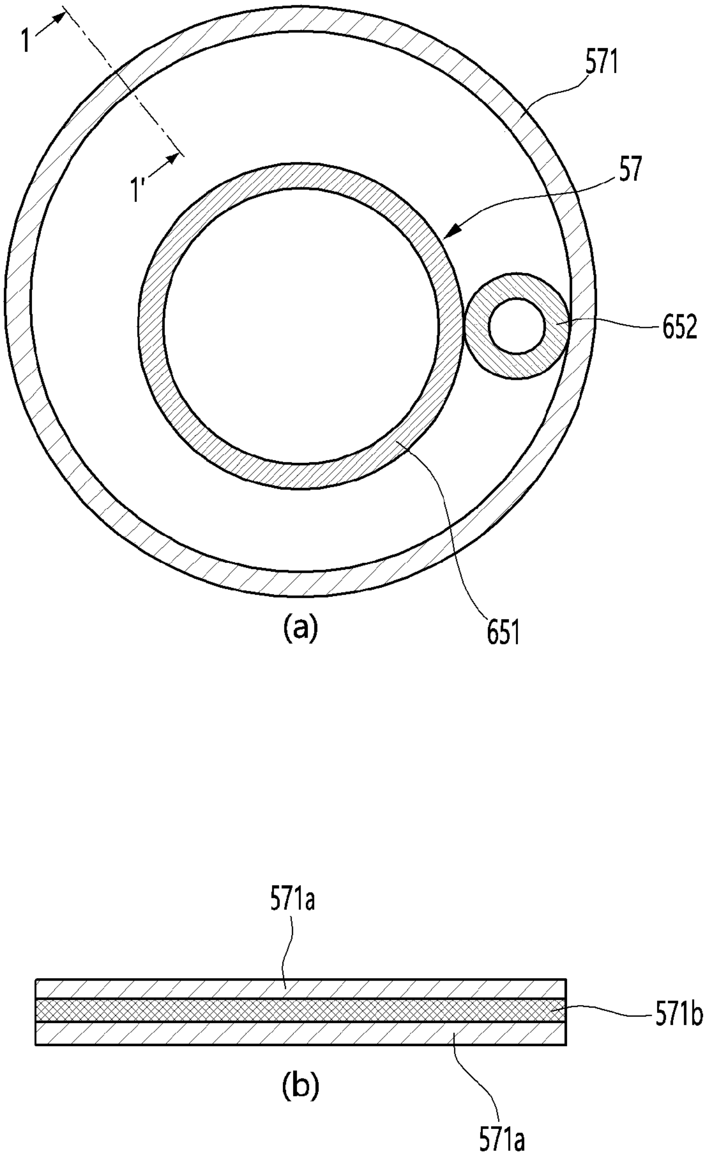
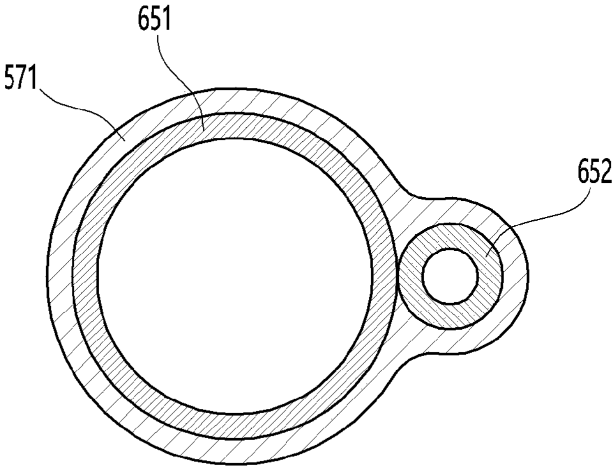
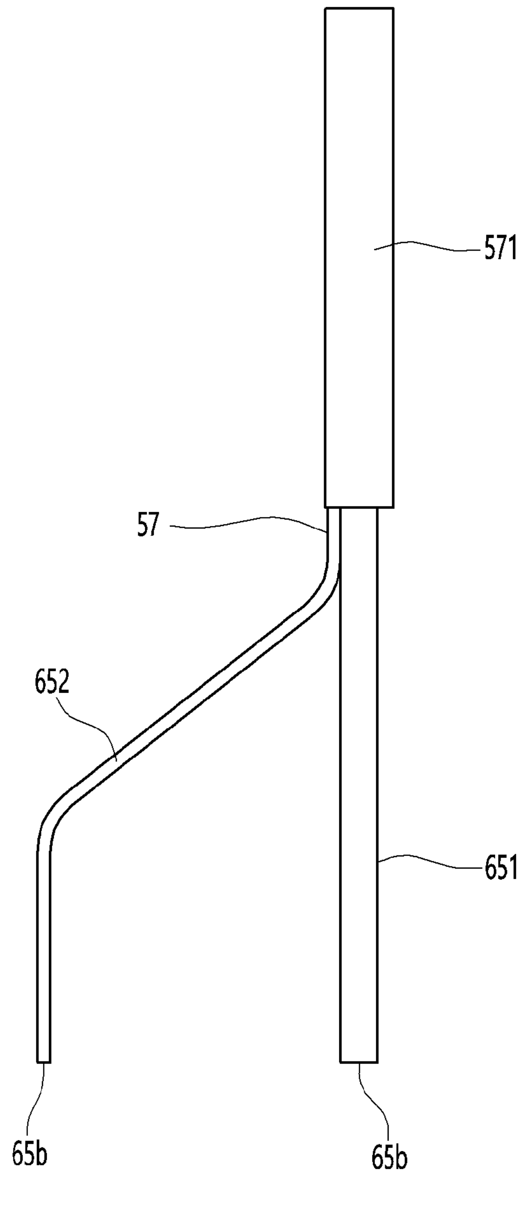


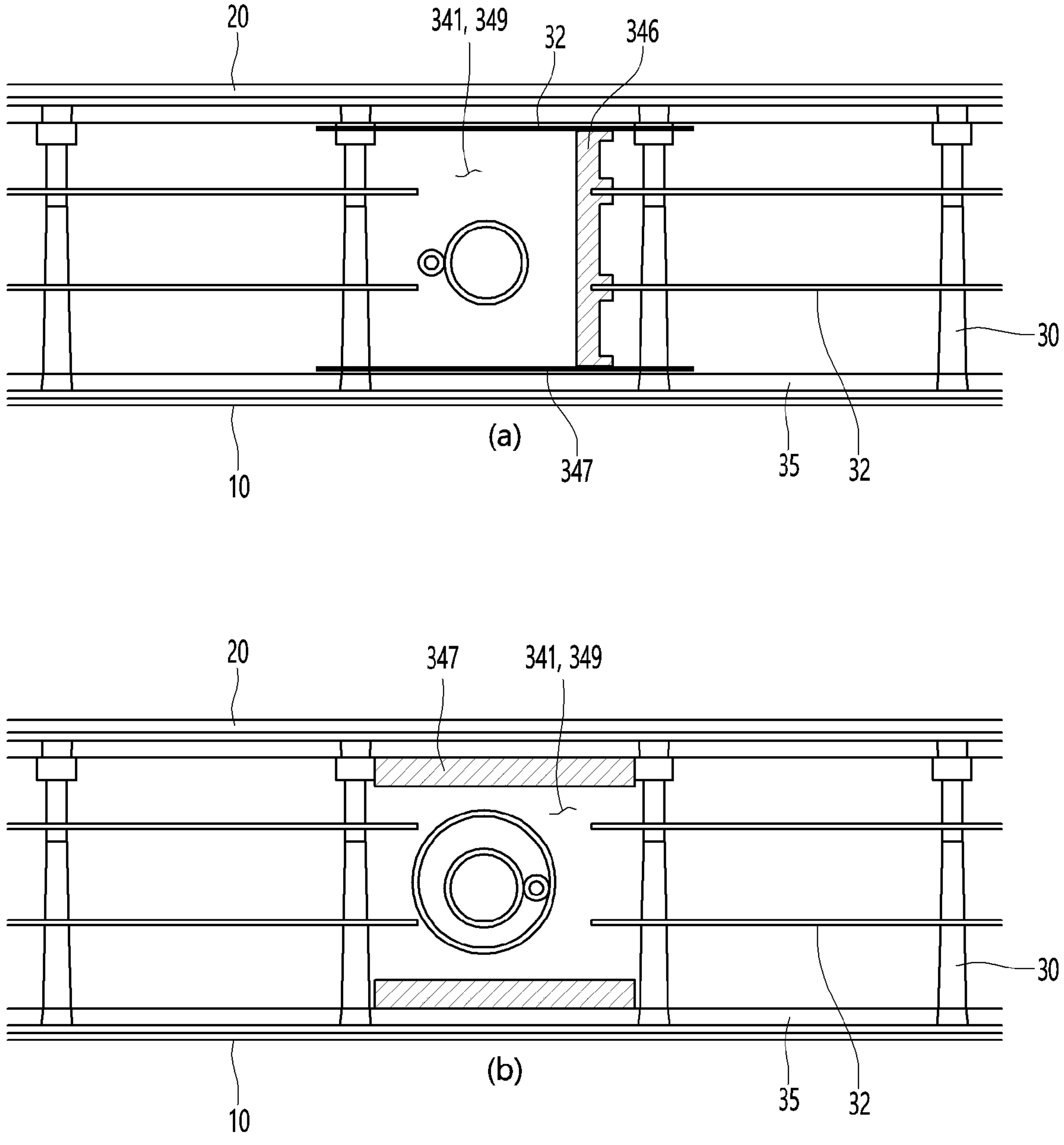
【Figure 16】



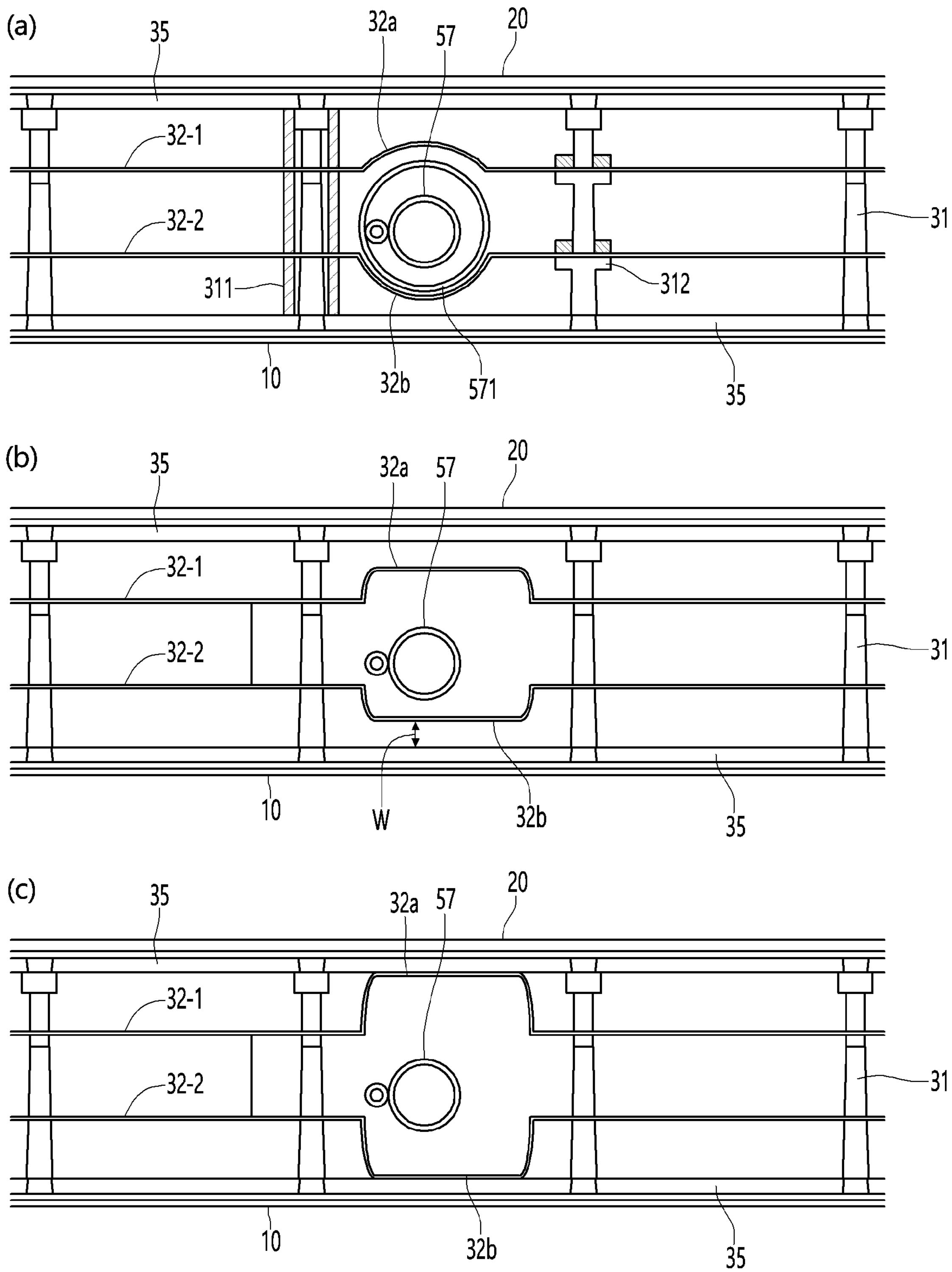
【Figure 17】



【Figure 18】



【Figure 19】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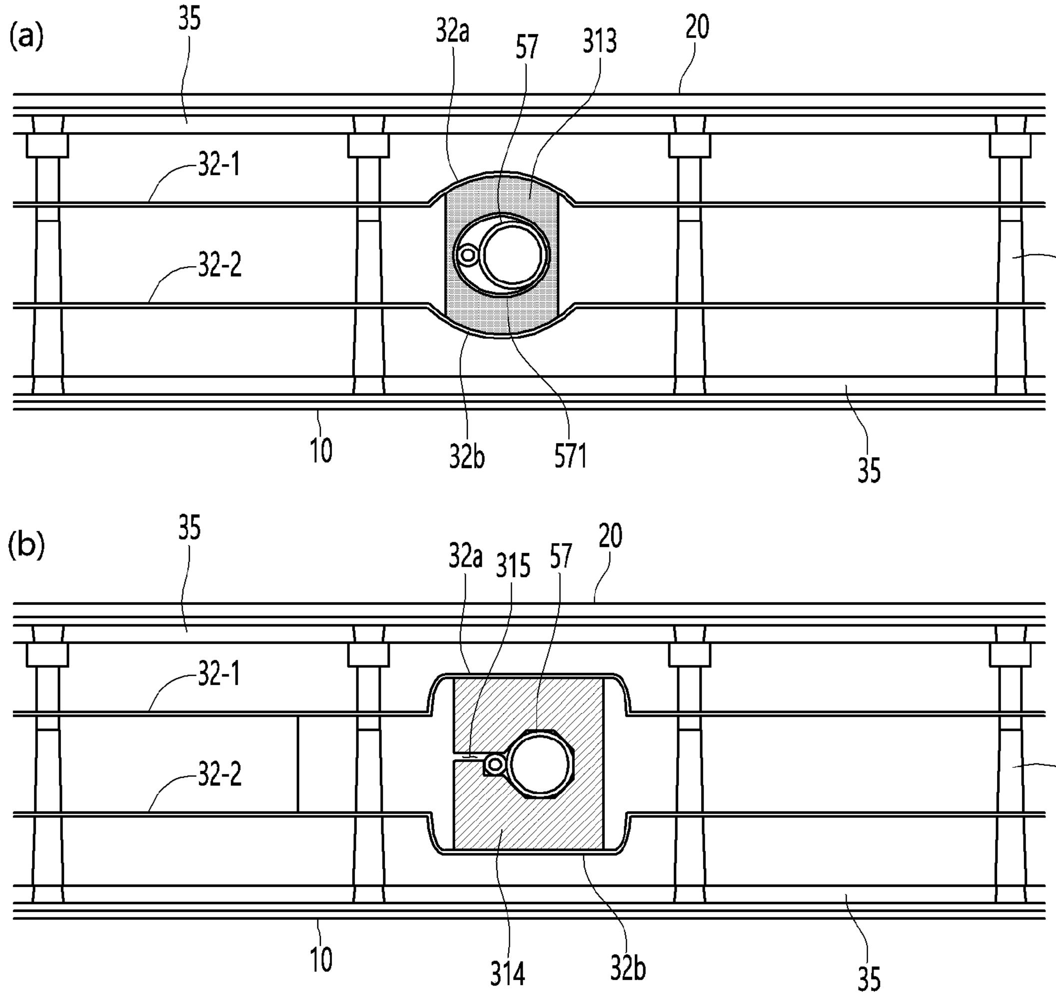
10
32b
571
35
(b)
35
32a
57
20
32-1
32-2
31
10
W
32b
35
(c)
35
32a
57
20
32-1
32-2
31
10
32b
35

【Figure 20】


(a)
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313
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32-1
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10
32b
571
35
(b)
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32a
315
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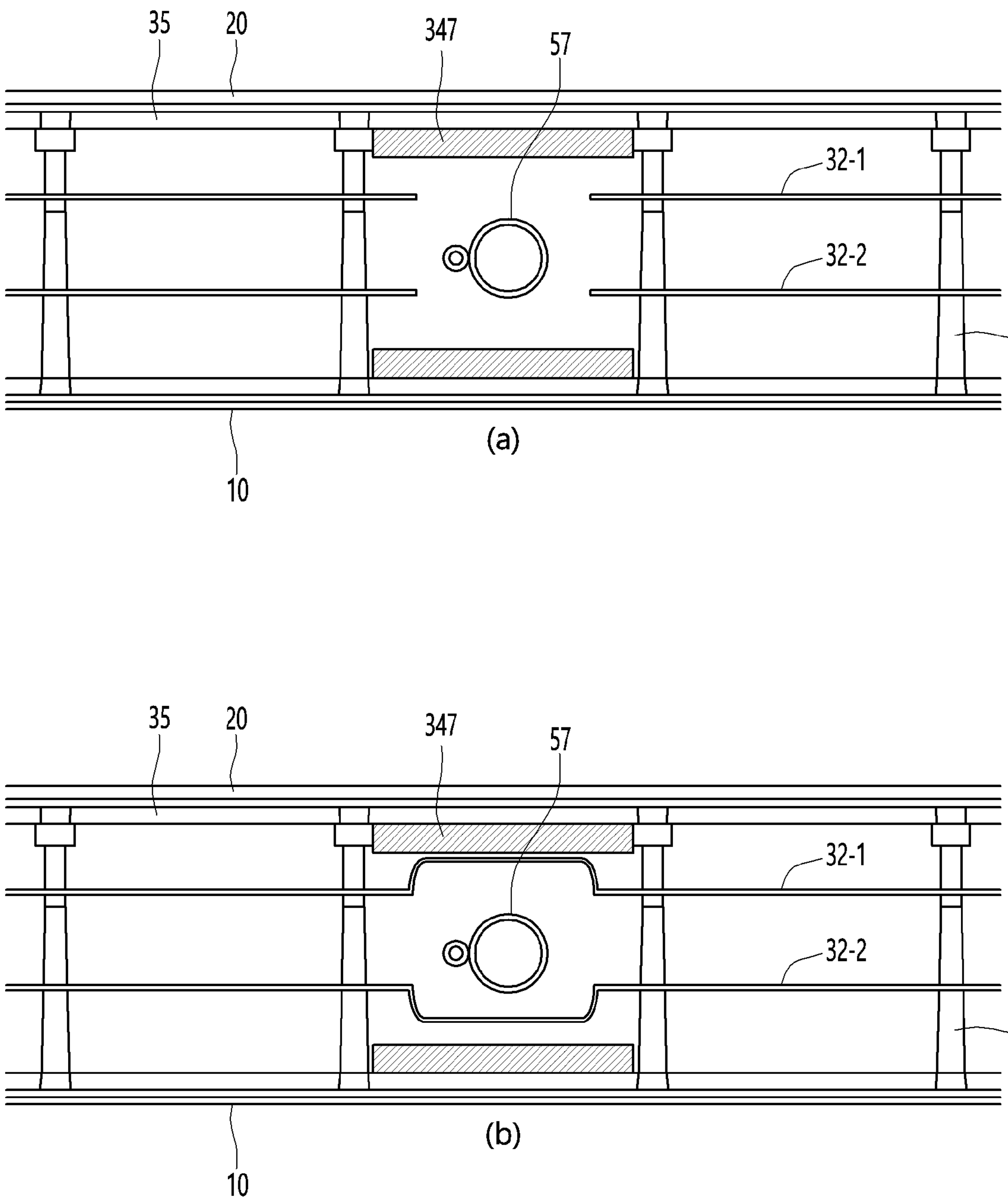
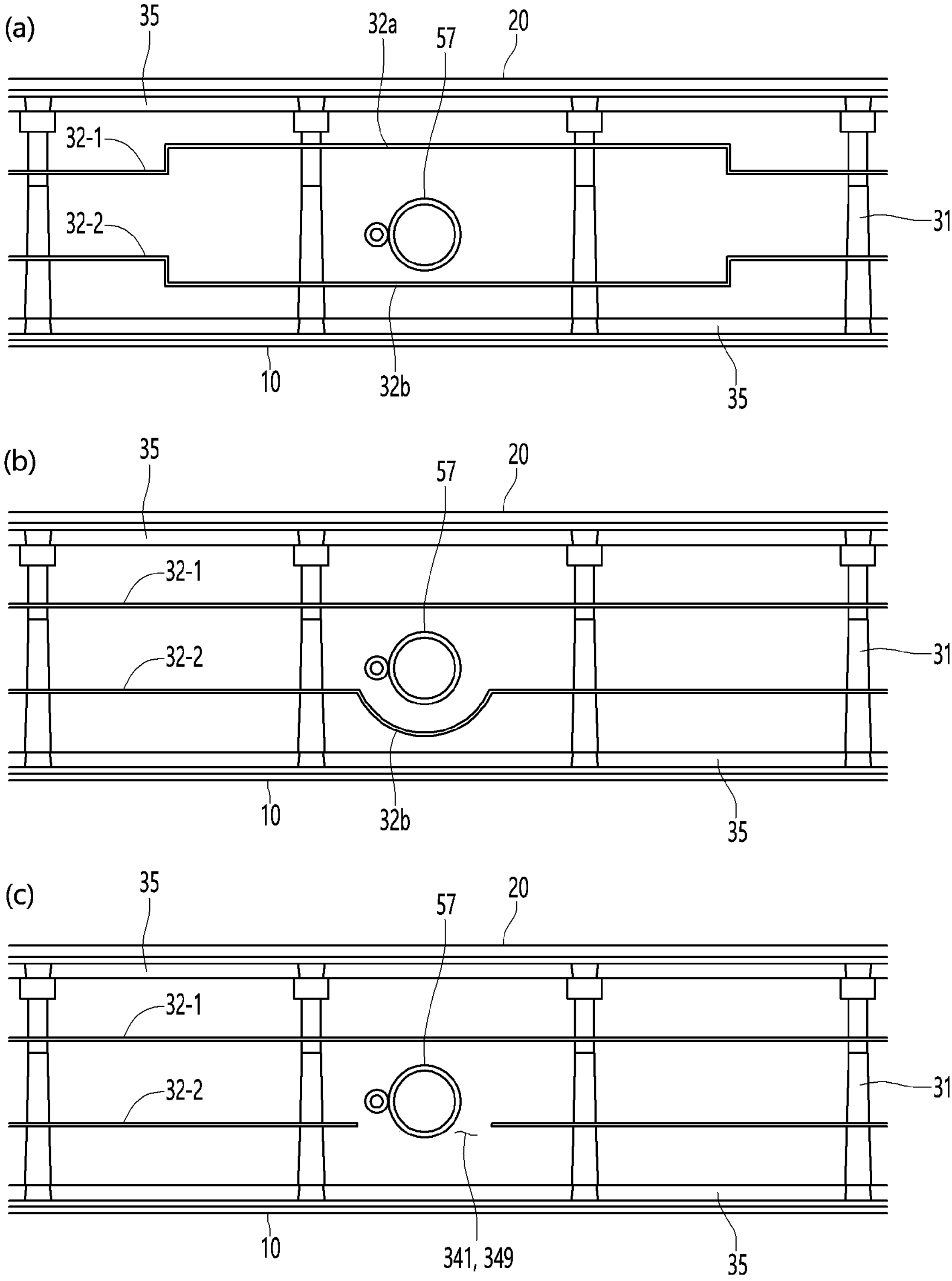
32-1
32-2
31
10
314
32b
35

【Figure 21】



【Figure 22】


(a)
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32b
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(b)
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32-1
32-2
31
10
32b
35
(c)
35
57
20
32-1
32-2
31
10
341, 349
35

INTERNATIONAL SEARCH REPORT

International application No. **PCT/KR2023/008147**

A. CLASSIFICATION OF SUBJECT MATTER

F25D 23/06(2006.01)i; **F16L 59/065**(2006.01)i; **F16L 59/08**(2006.01)i; **F16L 59/12**(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(2006.01); B23K 1/00(2006.01); F16L 3/12(2006.01); F16L 59/065(2006.01); F25D 23/00(2006.01)

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: IPC as above
Japanese utility models and applications for utility models: IPC as above

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

eKOMPASS (KIPO internal) & keywords: 플레이트(plate), 진공공간부(vacuum space), 열전달저항체(heat transfer resistor), 관(pipe), 진공단열체(vacuum insulator)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	KR 10-2020-0001350 A (LG ELECTRONICS INC.) 06 January 2020 (2020-01-06) See paragraphs [0032]-[0094]; claim 1; and figures 2, 8 and 10.	1 2-17
Y	KR 10-2020-0001337 A (LG ELECTRONICS INC.) 06 January 2020 (2020-01-06) See paragraphs [0014]-[0015] and [0130]; and figures 10 and 16.	2-5,17
Y	KR 10-2022-0059344 A (LG ELECTRONICS INC.) 10 May 2022 (2022-05-10) See paragraphs [0049]-[0100]; claim 2; and figures 13-16 and 19.	6-16
Y	KR 10-2020-0001362 A (LG ELECTRONICS INC.) 06 January 2020 (2020-01-06) See paragraphs [0013]-[0110]; and figure 12.	13-16
A	US 2018-0313598 A1 (SAMSUNG ELECTRONICS CO., LTD.) 01 November 2018 (2018-11-01) See claim 1; and figures 1-23.	1-17

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
27 February 2024	**27 February 2024**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office **Government Complex-Daejeon Building 4, 189 Cheongsa-ro, Seo-gu, Daejeon 35208**	
Facsimile No. **+82-42-481-8578**	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2022)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2023/008147

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
KR 10-2020-0001350 A	06 January 2020	CN 111936808 A	13 November 2020
		CN 111936808 B	20 December 2022
		EP 3814704 A1	05 May 2021
		EP 3814704 A4	23 March 2022
		KR 10-2617725 B1	27 December 2023
		US 11662053 B2	30 May 2023
		US 2021-0048137 A1	18 February 2021
		US 2023-0250918 A1	10 August 2023
		WO 2020-004948 A1	02 January 2020
KR 10-2020-0001337 A	06 January 2020	AU 2019-292383 A1	22 October 2020
		AU 2019-292383 B2	04 August 2022
		CN 111936809 A	13 November 2020
		CN 111936809 B	26 August 2022
		CN 115289746 A	04 November 2022
		EP 3814700 A1	05 May 2021
		EP 3814700 A4	09 March 2022
		KR 10-2611508 B1	08 December 2023
		RU 2022-101341 A	03 February 2022
		RU 2765162 C1	26 January 2022
		US 11740008 B2	29 August 2023
		US 2021-0041162 A1	11 February 2021
		US 2023-0349626 A1	02 November 2023
		WO 2020-004914 A1	02 January 2020
KR 10-2022-0059344 A	10 May 2022	WO 2022-092946 A1	05 May 2022
KR 10-2020-0001362 A	06 January 2020	CN 112005065 A	27 November 2020
		CN 112005065 B	06 June 2023
		EP 3814703 A1	05 May 2021
		EP 3814703 A4	23 March 2022
		KR 10-2023-0098768 A	04 July 2023
		KR 10-2550615 B1	04 July 2023
		US 2021-0364225 A1	25 November 2021
		WO 2020-004949 A1	02 January 2020
US 2018-0313598 A1	01 November 2018	CN 108700366 A	23 October 2018
		CN 108700366 B	26 April 2022
		EP 3330650 A1	06 June 2018
		EP 3330650 A4	10 October 2018
		EP 3330650 B1	29 November 2023
		KR 10-2017-0045649 A	27 April 2017
		KR 10-2442071 B1	13 September 2022
		US 11098947 B2	24 August 2021
		WO 2017-069439 A1	27 April 2017

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- KR 1020200001396 A **[0003]**