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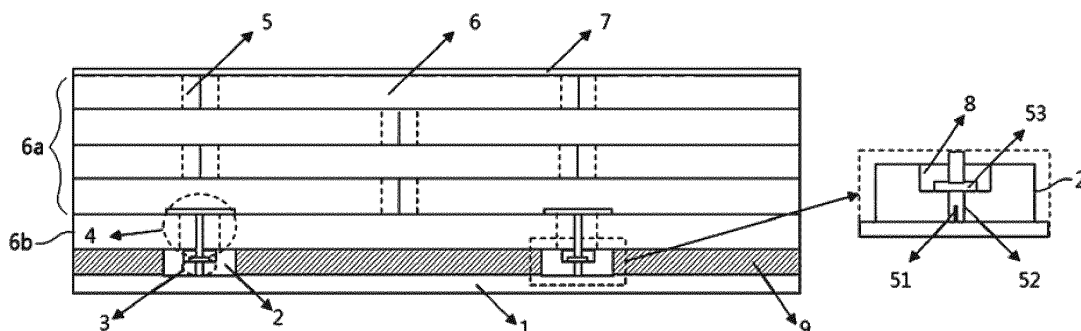
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(54) **STRUCTURE FOR CONNECTING ALTERNATELY STACKED VACUUM INSULATION PANELS OF INDEPENDENT TYPE LIQUEFIED GAS STORAGE TANK**

(57) The present disclosure relates to a structure for connecting vacuum insulation panels of an independent type liquefied gas storage tank provided so as to store liquefied gas such as LNG or LPG. The present disclosure relates to a structure for connecting alternately stacked vacuum insulation panels of an independent type liquefied gas storage tank, the vacuum insulation panel

having a core material and an outer cover, which encompasses the core material and of which the inside is formed in a vacuum, wherein the vacuum insulation panels are continuously and alternately stacked and provided so as to prevent heat loss at the exterior of a tank body of the liquefied gas storage tank, thereby performing insulation.

FIG. 1



Description

[Technical Field]

- 5 **[0001]** The present disclosure relates to a structure for connecting vacuum insulation panels of an independent type liquefied gas storage tank installed to store liquefied gas such as LNG or LPG.

[Background Art]

- 10 **[0002]** Natural gas is transported in a gas state through gas pipelines on land or sea, or transported to distant consumer sides in the form of Liquefied Natural Gas (LNG) or Liquefied Petroleum Gas (LPG) stored in a carrier. LNG is to liquefy natural gas, in which methane is main component, at minus 162°C under atmospheric pressure, the volume ratio of liquid to gas is about 1/600, and the weight of the liquefied state is 0.43-0.50.

- 15 **[0003]** A LNG carrier for navigating the sea with LNG and unloading the LNG to demand sides on land, or LNG Regasification Vessel (RV) for navigating the sea with LNG to arrive demand sides on land and then regasifying the stored LNG to unload in a natural gas state includes a storage tank (often, referred to as "hold") that can withstand cryogenic liquefied natural gas.

- 20 **[0004]** This storage tank can be classified into independent type and membrane type depending on whether or not the load of the cargo directly acts on the insulation material. Usually, the membrane type storage tank is divided into No 96 type and Mark III type, and the independent type storage tank is divided into MOSS type and SPB type. The structure of the MOSS type independent type storage tank is described in Korean Patent No. 10-15063, etc, and the structure of the SPB type independent type storage tank is described in Korean Patent No. 10-30513, etc.

- 25 **[0005]** Generally, the independent type storage tank is made by attaching a relatively hard insulation panel such as polyurethane foam to a tank body made of an alloy such as aluminum alloy, SUS and 9% nickel, which is resistant to low temperature, and is located on a plurality of tank support bodies arranged on the inner bottom of a hull.

- 30 **[0006]** A insulation structure of a liquefied gas storage tank in which a plurality of insulation panels manufactured by a polyurethane foam are installed on the exterior of a tank body is described in Korean Patent No. 10-166608, etc.

- 35 **[0007]** According to the related arts, the insulation structure of the liquefied gas storage tank has the limitation in that the size of one insulation panel cannot be increased beyond a certain level upon installation of the insulation panel because the insulation panel has to have a predetermined thickness. In order to solve the problem, Korean Patent Laid-Open Publication Nos. 10-2011-0051407, 10-2011-0046627, etc. provide including a stud bolt, a first insulation panel fitted to the stud bolt, a fixing member coupled to the stud bolt in order to fixedly maintain the first insulation panel, and a second insulation panel coupled to the fixing member and stacked on the first insulation panel.

- 40 **[0008]** However, when the insulation panel is extended by a mounting member such as a fixing member, the interface of the insulation panel is stacked in a straight line, such that the length that the heat from the atmosphere reaches the tank surface is short and thereby, the insulation performance is reduced. In addition, although the stud bolt, the fixing member, and the charging member such as an insulation material are filled therein, the heat can penetrate from the atmosphere to the tank surface through the gap, such that the insulation is not completely implemented.

- 45 [DISCLOSURE]

[Technical Problem]

- 50 **[0009]** The present disclosure is intended to solve the above problems, and an object of the present disclosure is to provide a structure for connecting alternately stacked vacuum insulation panels of an independent type liquefied gas capable of alternately stacking the vacuum insulation panel on a tank body, thus lengthening the length that the heat from the atmosphere reaches the tank surface along the interface of the vacuum insulation panel to enhance the insulation performance, and having enhanced insulation performance while thinning the thickness of the insulation panel.

- 55 [Technical Solution]

- 60 **[0010]** A structure for connecting alternately stacked vacuum insulation panels of an independent type liquefied gas storage tank of the present disclosure for achieving the object includes a vacuum insulation panel having a core material and an outer cover that encompasses the core material and whose inside is formed in a vacuum; and as the structure for connecting the alternately stacked vacuum insulation panels of the independent type liquefied gas storage tank that continuously, alternately stacks the vacuum insulation panels in order to prevent heat loss at the exterior of a tank body of the liquefied gas storage tank, thus performing insulation, provided is the structure for connecting the alternately stacked vacuum insulation panels of the independent type liquefied gas storage tank, which includes a stud bolt installed

at the exterior of the tank body, the vacuum insulation panel attached to the exterior of the tank body by the stud bolt, a pad fitted to the stud bolt in order to form a gap between the vacuum insulation panel layer and the tank body, and a fixing member for fixing the pad; and the vacuum insulation panel can be fixed by connecting another fixing member to the fixing member.

[Advantageous Effects]

[0011] According to the present disclosure as described above, it is possible to alternately stack the vacuum insulation panels that are continuously attached to the exterior of the tank body, thus lengthening the length that the heat from the atmosphere reaches the tank surface along the interface of the vacuum insulation panel to enhance insulation performance. In addition, it is possible to prevent heat loss from occurring through the mounting member, such as the stud bolt and the fixing member, and the charging member, or through the gap therebetween. In addition, it is possible to have enhanced insulation performance compared to the conventional polyurethane foam insulation panel, thus minimizing the transportation costs of the liquefied gas loading capacity, reducing the thickness of the insulation panel to increase the storage space of the storage tank, and in addition, reducing the weight of the storage tank to reduce the transportation costs.

[Description of Drawings]

[0012]

FIG. 1 is a diagram illustrating a structure for connecting vacuum insulation panels in accordance with the present disclosure.

FIG. 2 is a flowchart illustrating a process in which the vacuum insulation panels are connected in accordance with the present disclosure.

FIG. 3 is a diagram illustrating the effect of the continuously and alternately stacked vacuum insulation panels in accordance with the present disclosure.

FIG. 4 is a diagram illustrating a configuration of the vacuum insulation panel in which a protection layer is included in accordance with the present disclosure.

FIG. 5 is a diagram illustrating a method of mounting a finishing material in the structure for connecting the vacuum insulation panels in accordance with the present disclosure.

[Best Mode for Disclosure]

[0013] Hereinafter, a structure for connecting alternately stacked vacuum insulation panels of an independent type liquefied gas tank in accordance with a preferred embodiment of the present disclosure will be described in detail with reference to the accompanying drawings.

[0014] FIG. 1 is a cross-sectional diagram for explaining a structure for connecting vacuum insulation panels in accordance with a preferred embodiment of the present disclosure, and FIG. 2 sequentially illustrates a process of connecting a mounting member and a vacuum insulation panel to the exterior of a tank body.

[0015] As illustrated in FIGS. 1 and 2, the insulation structure of the independent type liquefied gas tank is formed by stacking a vacuum insulation panel 6 on the exterior of a tank body 1 to form a vacuum insulation panel layer. The vacuum insulation panel 6 is formed as an insulation material having a very low thermal conductivity so that the outer cover having a high shielding property including an aluminum thin film encompasses all surfaces of an organic-based or inorganic-based pore type core material. A plurality of the vacuum insulation panels 6 are continuously arranged adjacently to each other on the exterior of the tank body 1 of a storage tank to form a lower vacuum insulation panel layer 6b, and one or more layers of the vacuum insulation panel are alternately stacked on the lower vacuum insulation panel layer 6b to form an upper vacuum insulation panel layer 6a.

[0016] The lower vacuum insulation panel layer 6b tightly does not adhere to the tank body 1, and a gap 9 is formed by a pad 2. The gap 9 between the tank body 1 and the lower vacuum insulation panel layer 6b can be utilized as a ventilation space and can be also utilized as a passage for leakage liquid upon leakage due to damage of the tank body 1.

[0017] According to the structure for connecting the vacuum insulation panels in accordance with the preferred embodiment of the present disclosure, a stud bolt 51 is installed on the exterior of the tank body 1 at a regular interval. The stud bolt 51 can be fixedly mounted on the exterior of the tank body 1 by welding.

[0018] The pad 2 having a predetermined thickness is fitted on the stud bolt 51. The pad 2 has a stepped portion in which the height of the center portion is lower than that of the circumference thereof, and has a through-groove formed at the center thereof. Accordingly, the stud bolt 51 passes through the through-groove formed in the stepped portion of the pad 2, and a first fixing member 3, which receives the end portion of the stud bolt 51, is screwed thereto. A lower

end portion 52 of one side of the first fixing member 3 is screwed with the stud bolt 51 to fix so that a pressing protrusion 53 formed on the side surface of the first fixing member 3 presses the pad 2 to tightly adhere the pad 2 to the tank body 1. At the central portion of the pad 2, a stepped portion formed by a downwardly stepped empty space 8 is formed. Accordingly, even if the first fixing member 3 is fitted after penetrating the stud bolt 51 into the stepped portion, it does not become an obstacle that the pressing protrusion 53 pressing the vacuum insulation panel 6 in the first fixing member 3 is located within the empty space 8 of the stepped portion to tightly adhere and mount the vacuum insulation panel 6 to the upper vacuum insulation panel layer 6a.

[0019] An extension screw thread is formed on an upper end portion 54 opposite to the lower end portion 52 where the stud bolt 51 is coupled in the first fixing member 3 in order to receive a lower end portion 71 of a second fixing member 4.

[0020] Edges of the vacuum insulation panel 6 forming the lower vacuum insulation panel layer 6b are seated and fixed on the pad 2. That is, each edge of the vacuum insulation panel 6 forming the lower vacuum insulation panel layer 6b is seated and fixed on a different pad 2, respectively. That is, the pad 2 receives the apex portion where the edge of the vacuum insulation panel 6 meets, and the apex portion where another edge of the vacuum insulation panel 6 meets is received by another pad 2. The vacuum insulation panels 6 are continuously mounted on the pad 2 installed at a regular interval to encompass the tank body 1, and the size of the gap 9 between the tank body 1 and the vacuum insulation panel 6 can be kept constant by the pad 2.

[0021] The vacuum insulation panel 6 of the lower vacuum insulation panel layer 6b having each edge caught and mounted on the pad 2 is fixed by screwing the second fixing member 4 to the first fixing member 3 fixing the pad 2. The second fixing member 4 is composed of a plate-shaped pressing plate 72 and the lower end portion 71 installed on the lower portion of the pressing plate 72, such that the pressing plate 72 presses and fixes the edges of each vacuum insulation panel 6 when the lower end portion 71 of the second fixing member 4 is coupled to the first fixing member 3. Accordingly, in the vacuum insulation panel 6, the mounting members including the stud bolt 51 and the first, second fixing members 3, 4 are received at the apex portion where the edge of the vacuum insulation panel 6 meets.

[0022] Meanwhile, an insulation pad 5 formed of a foam having the elasticity or an inorganic fiber base is filled in the empty space 8 of the stepped portion at the center of the pad 2 and between the adjacent vacuum insulation panels 6 in the vacuum insulation panel 6. The insulation pad 5 between the vacuum insulation panels 6 can be attached and mounted to the side surface of the vacuum insulation panel 6 in advance, or can be fitted and mounted after the vacuum insulation panel 6 is mounted. The width of the pad can change depending upon shrinkage or expansion of the tank body 1 as the liquefied gas is supplied or discharged.

[0023] The vacuum insulation panel 6 is configured to be alternately stacked when the upper vacuum insulation panel layer 6a is stacked in plural on the lower vacuum insulation panel layer 6b. As illustrated in FIG. 3(a), when the stacked directional interface between adjacent vacuum insulation panels 6 is stacked in a straight line, the length that the heat from the atmosphere reaches the tank surface is relatively short, thus reducing the insulation performance. On the contrary, as in the preferred embodiment of the present disclosure illustrated in FIG. 3(b), when the vacuum insulation panels 6 are continuously stacked alternately, the stacked directional interface becomes zigzag and thereby, the length that the heat from the atmosphere reaches the tank surface is long, thus enhancing the insulation performance. This is based on the Fourier's law as follows

[0024] The Fourier's law is as in the following Equation 1.

Equation 1

$$Q = -kA(t_2 - t_1) / L$$

(herein, Q: amount of heat transfer, A: cross-sectional area, k: thermal conductivity, $t_2 - t_1$: temperature gradient, L: distance)

[0025] According to the Fourier's law, the amount of the heat transfer is proportional to the cross-sectional area and inversely proportional to the distance with respect to the temperature gradient. That is, it can be seen that when the stacked directional interface of the vacuum insulation panels 6 is alternately stacked in a zigzag manner rather than stacked in a straight line, the length that the heat from the atmosphere reaches the tank surface is longer, thus minimizing the amount of heat and enhancing the insulation performance.

[0026] When one or more vacuum insulation panels 6 are continuously stacked, as illustrated in FIG. 4, at least one thereof can include a protection layer 81 on the vacuum insulation panel. The protection layer 81 protects the inner vacuum damage of the vacuum insulation panel from external temperature environment or pressure, and mechanical impact.

[0027] FIG. 4 illustrates a case where the vacuum insulation panel including the protection layer 81 is stacked on the uppermost portion layer. The protection layer 81 can be stacked on the exterior of the vacuum insulation panel, and can be coated on the outer surface of the vacuum insulation panel. The protection layer 81 can be formed of an organic

material sheet such as polypropylene, polyethylene, polystyrene, polyvinyl alcohol, polycarbonate, polymethyl methacrylate, and polyethylene terephthalate, or an inorganic material sheet such as foamed foam, nonwoven fabric, and glass fiber.

[0028] A finishing material 7 is mounted on the uppermost portion layer of the stacked vacuum insulation panels 6. The finishing material can use a metal material sheet such as galvalume, aluminum, zinc, and stainless steel, or a composite material sheet of phenol resin, epoxy resin, polyester resin, and thermosetting resin reinforced with fiber such as carbon fiber, glass fiber, and rock wool, or a rubber sheet, or a wood plate material, etc.

[0029] A method of mounting the finishing material is illustrated in Fig. 5. When the finishing material 7 is mounted by tightly adhering to and being vertically bolted to the vacuum insulation panel 6 as illustrated in FIG. 5(a), the vacuum formed inside the vacuum insulation panel 6 can be damaged. Accordingly, it is preferable to bend the finishing material 7 at 90 degrees to be horizontally bolted and fitted as illustrated in FIG. 5(b), or as illustrated in FIG. 5(c), to apply an adhesive between the finishing material 7 and the vacuum insulation panel 6 to induce the fixing by an adhesive layer 100, or optionally, to finish it as described above and as in FIG. 5(d), to fix it by a band.

[0030] In the structure for connecting the alternately stacked vacuum insulation panels of the independent type liquefied gas storage tank in accordance with the present disclosure, the composite members constituting the vacuum insulation panel 6 and the mounting member such as the insulation pad 5 and the finishing material 7 can be assembled on the tank body 1, or the vacuum insulation panel 6 and the vacuum insulation panel layer in which the mounting member is configured can be modularized and assembled to be mounted to the tank.

[0031] The structure for connecting the alternately stacked vacuum insulation panels of the independent type liquefied gas storage tank in accordance with the present disclosure can be not only applied to the independent type liquefied gas tank on land, but also to any of the offshore structures that floats on sea where the independent type liquefied gas tank is installed and flow occurs; and to the offshore plant, etc. such as a LNG Floating Production, Storage and Offloading (FPSO) or a LNG Floating Storage and Regasification Unit (FSRU), as well as to the ship such as a liquefied gas carrier or a LNG Regasification Vessel (RV) transporting LNG or LPG, etc.

[0032] As described above, although the structure for connecting the alternately stacked vacuum insulation panels of the independent type liquefied gas storage tank in accordance with the present disclosure has been described with reference to the drawings, it will be apparent by those skilled in the art to which the present disclosure pertains that the present disclosure is not limited to the embodiments and drawings described above, various changes and modifications can be made within the scope of the appended claims.

[Detailed Description of Main Elements]

[0033]

1: tank body	2: pad
3: first fixing member	4: second fixing member
5: insulation pad	6: vacuum insulation panel
7: finishing material	8: empty space
9: gap	51: stud bolt
52: lower end portion of first fixing member	
53: pressing protrusion of first fixing member	
54: upper end portion of first fixing member	
71: lower end portion of second fixing member	
72: pressing plate	81: protection layer
100: adhesive layer	

Claims

1. A structure for connecting alternately stacked vacuum insulation panels of an independent type liquefied gas storage tank, comprising:

in the structure for connecting the vacuum insulation panels of the independent type liquefied gas storage tank, which installs a stud bolt on the surface of a tank body at a predetermined interval and stacks an insulation panel to encompass the exterior of the tank body through the stud bolt, thus insulating the tank body from the atmosphere,

the insulation panel is provided as the vacuum insulation panel for encompassing a core material and having an outer cover whose inside is formed in a vacuum,

a pad fitted to the stud bolt in order to form a gap between a lower vacuum insulation panel layer, which is installed to continuously arrange the vacuum insulation panel to encompass the tank body, and the tank body;
a first fixing member for fixing the pad by a pressing protrusion at the center thereof with a lower end portion of one side thereof fastened to the stud bolt, and having a screw thread formed on an upper end portion of the other side thereof;

a lower vacuum insulation panel layer installed so that edges of adjacent vacuum insulation panels are seated on the pad;

a second fixing member having a pressing plate so that the edges of the lower vacuum insulation panels seated on the pad are connected to the first fixing member to be pressed and fixed; and

an upper vacuum insulation panel layer formed on an upside of the lower vacuum insulation panel layer so that the vacuum insulation panels are alternately stacked with one or more layers with respect to the lower vacuum insulation panel.

2. The structure for connecting the alternately stacked vacuum insulation panels of the independent type liquefied gas storage tank according to claim 1, comprises a protection layer stacked on at least one of the vacuum insulation panels.
3. The structure for connecting the alternately stacked vacuum insulation panels of the independent type liquefied gas storage tank according to claim 2, wherein the protection layer comprises an organic material sheet selected from polypropylene, polyethylene, polystyrene, polyvinyl alcohol, polycarbonate, polymethyl methacrylate, and polyethylene terephthalate, or an inorganic material sheet selected from foamed foam, nonwoven fabric, and glass fiber.
4. The structure for connecting the alternately stacked vacuum insulation panels of the independent type liquefied gas storage tank according to claim 1, wherein the vacuum insulation panel further comprises an insulation pad of a foam pad having the elasticity or an inorganic material fiber based pad in an empty space of a stepped portion formed on a side surface thereof and a central portion of the pad.
5. The structure for connecting the alternately stacked vacuum insulation panels of the independent type liquefied gas storage tank according to claim 1, wherein a finishing material of an uppermost portion layer comprises one or more among a metal material sheet selected from galvalume, aluminum, zinc, and stainless steel plate, or a composite material sheet of thermosetting resin selected from phenol resin, epoxy resin, and polyester resin, or a rubber sheet, or a wood plate material.
6. The structure for connecting the alternately stacked vacuum insulation panels of the independent type liquefied gas storage tank according to claim 5, wherein the finishing material is fitted by bending the finishing material by 90 degrees to bolt it horizontally, or is finished by an adhesive, or is fitted by bending the finishing material by 90 degrees to bolt it horizontally and then is fixed by a band.
7. The structure for connecting the alternately stacked vacuum insulation panels of the independent type liquefied gas storage tank according to claim 1, wherein the vacuum insulation panel layer is formed by mounting the vacuum insulation panel, on which the insulation pad of a foam pad or a fiber based pad and a finishing material are integrally attached to the vacuum insulation panel to be modularized, to the tank.

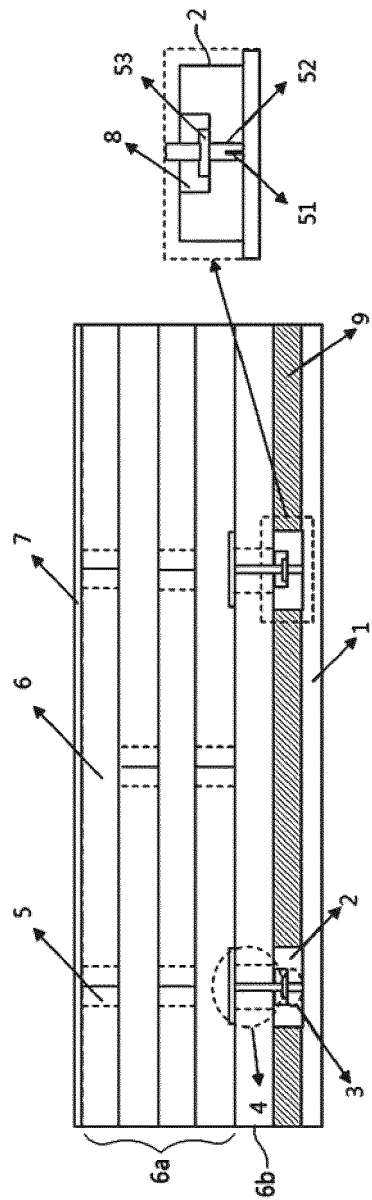


FIG. 1

FIG. 2

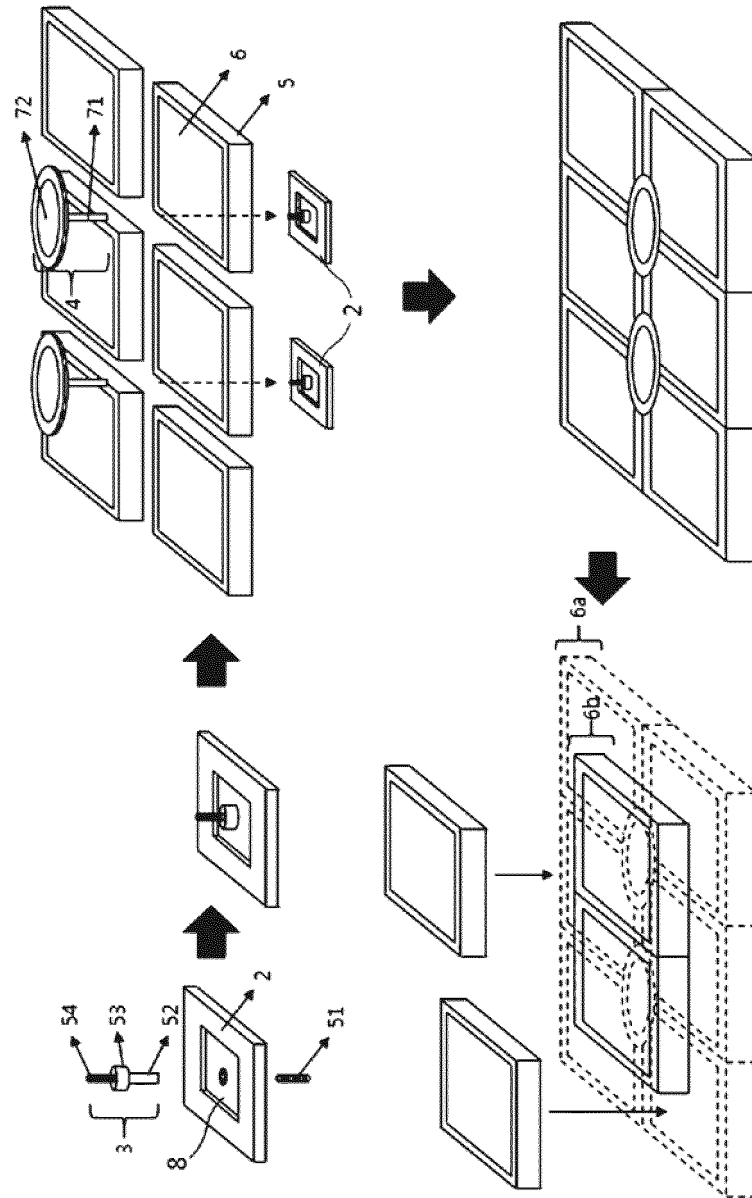


FIG. 3

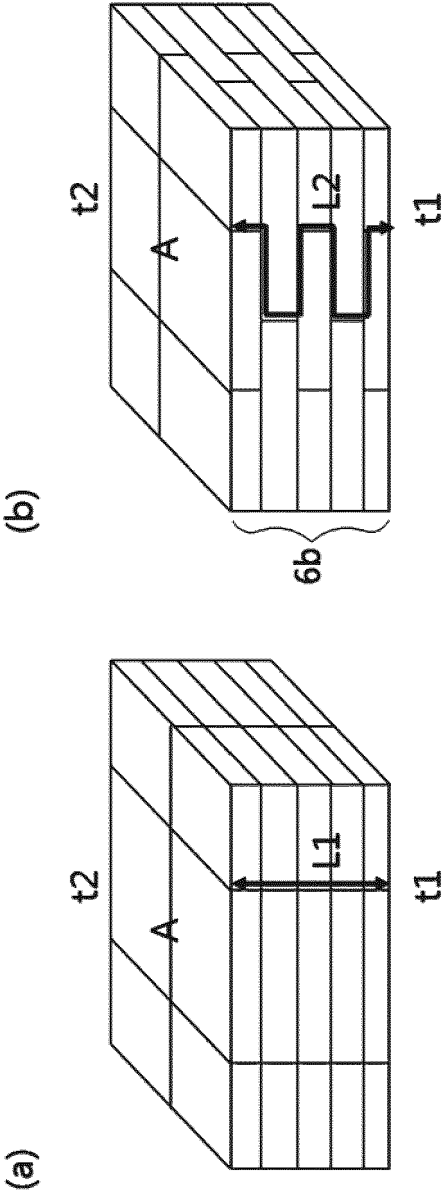


FIG. 4

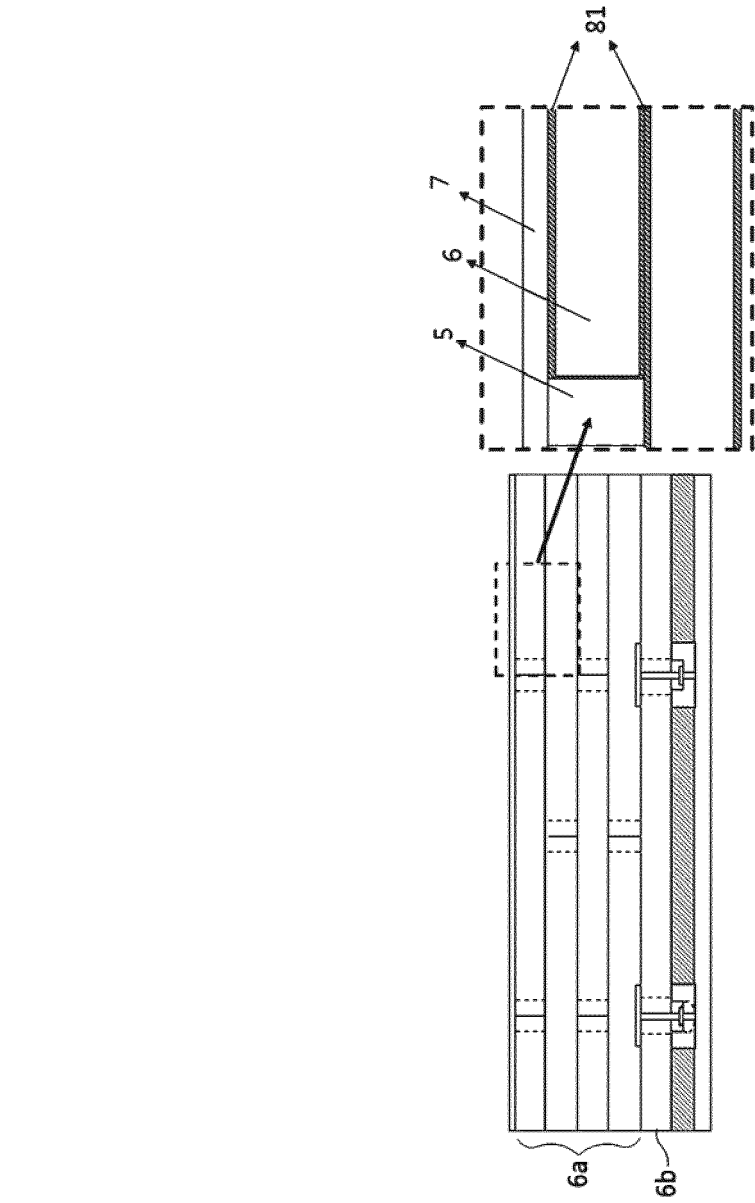
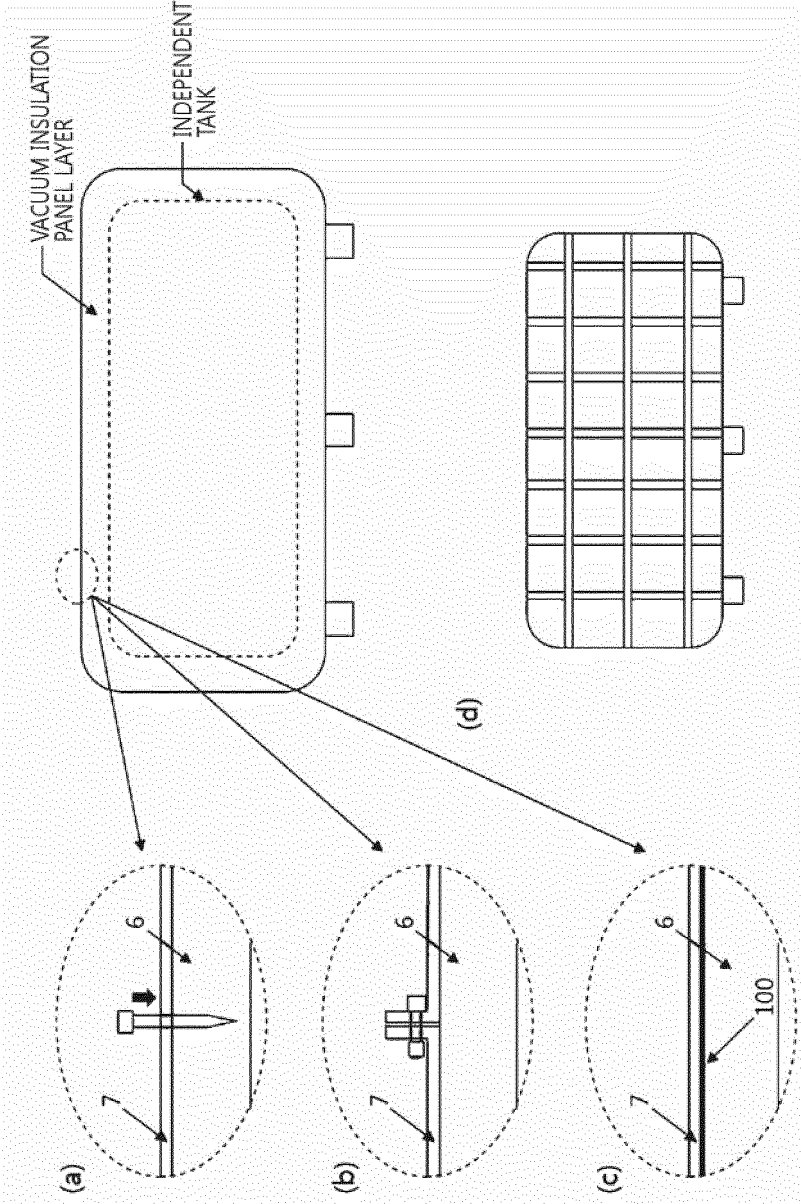


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2016/013425

A. CLASSIFICATION OF SUBJECT MATTER

B63B 25/16(2006.01)i, F17C 3/02(2006.01)i, F17C 1/12(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)

B63B 25/16; B63B 3/68; F17C 3/04; F17C 1/12; F17C 3/02

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: liquefied gas, storage, independent, vacuum insulation panel, connection structure, stud bolt and fixing member

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2011-0046627 A (DONGSUNG FINETEC CO., LTD.) 06 May 2011 See paragraphs [0029]-[0044] and figure 1.	1-7
Y	KR 10-1415899 B1 (KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY) 14 July 2014 See paragraphs [0016], [0020]-[0021], [0024]-[0025] and figure 9.	1-7
Y	KR 10-2009-0097341 A (KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY) 16 September 2009 See paragraph [0015] and figures 8-12.	1-7
A	KR 10-0990179 B1 (SAMSUNG HEAVY IND. CO., LTD.) 29 October 2010 See paragraphs [0021]-[0026] and figure 2.	1-7
A	KR 10-2011-0136431 A (DAEWOO SHIPBUILDING & MARINE ENGINEERING CO., LTD.) 21 December 2011 See paragraphs [0028]-[0031] and figure 4.	1-7

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

* Special categories of cited documents:

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Date of the actual completion of the international search

08 FEBRUARY 2017 (08.02.2017)

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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REFERENCES CITED IN THE DESCRIPTION

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- KR 10166608 [0006]
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