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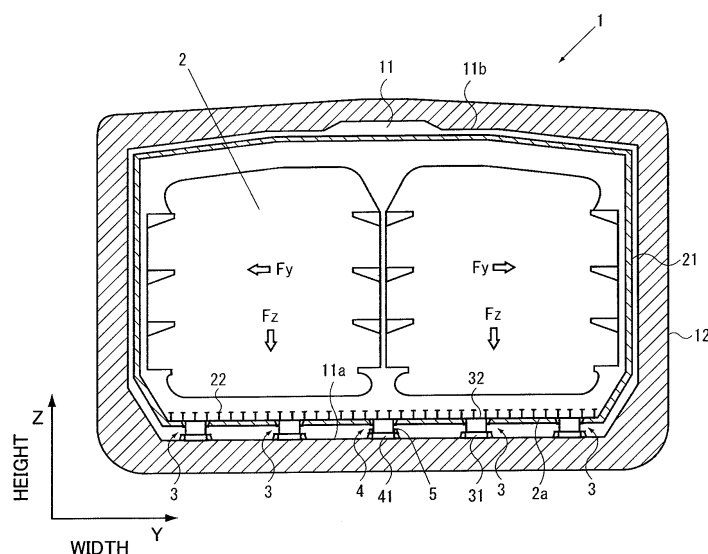
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(54) **SUPPORT STRUCTURE FOR CARGO TANK, FLOATING STRUCTURE, AND SUPPORT METHOD FOR CARGO TANK**

(57) A cargo tank support structure according to the present invention comprises a plurality of first support portions 3 provided at a bottom 2a of a cargo tank 2 in a distributed manner, a second support portion 4 provided at the bottom 2a of the cargo tank 2 to continuously extend in a longitudinal direction X of the floating structure 1, and an engagement portion 5 provided at a floor 11a

of a hold 11 along the length of the second support portion to engage with the second support portion 4, wherein a vertical load F_z applied by the cargo tank 2 is borne by at least the first support portions 3 and a horizontal load (first horizontal load F_y) applied by the cargo tank 2 is borne by at least the second support portion 4 and the engagement portion 5.

FIG. 1



Description**Technical Field**

[0001] The present invention relates to a cargo tank support structure, a floating structure and a method of supporting a cargo tank, more specifically, a support structure bearing vertical and horizontal loads applied by a cargo tank mounted on a floating structure, a floating structure including the support structure, and a method of supporting a cargo tank.

Background Art

[0002] Floating structures, such as carrier vessels or offshore floating equipment, for transporting or storing liquid cargo, such as petroleum, LPG (liquefied petroleum gas) or LNG (liquefied natural gas), of an independent tank type, namely having cargo tanks for such liquid cargo, independent from the floating structure, are in wide use (see patent documents 1 and 2, for example).

[0003] While traveling or moored, floating structures experience heave, or liner vertical motion, sway, or linear lateral motion, surge, or linear longitudinal motion, pitch, or rotation about the transverse axis, yaw, or rotation about the vertical axis, and roll, or rotation about the longitudinal axis, caused by waves. Actually, they experience complex motions resulting from combinations of these motions. It is therefore important to stably support independent cargo tanks that can move relative to the floating structure.

[0004] Patent document 1 discloses, in Figs. 5 and 6, a cargo tank support structure comprising bearing seats, anti-floatation chocks and anti-roll chocks, where the bearing seats bear a vertical load applied by a cargo tank, the anti-roll chocks bear a horizontal load applied by the cargo tank displaced sideways by roll of the ship, and anti-floatation chocks restricts floatation of the cargo tank when the ship is flooded. In this support structure, loads applied by the weight of the floating structure itself and various motions of the floating structure caused by waves are borne primarily by the bearing seats and the anti-roll chocks. As seen in patent document 1, the bearing seats are provided at the floor of the hull, and the anti-roll chokes are provided at the ceiling and the floor of the hull. Patent document 2 discloses, in Fig. 6, a structure in which support members for supporting an independent tank are provided at varying density considering the magnitude of reaction force to be borne by respective support members. The support structure disclosed in patent document 2 is created paying attention to distribution of the vertical load applied by the cargo tank, and exhibits only those support elements which correspond to the bearing seats in patent document 1.

Prior Art Document**Patent Document**

5 [0005]

Patent Document 1: JP 2000-177681 A, Figs. 5 and 6
Patent Document 2: JP S59-5492 U, Fig. 6

10 **Summary of the Invention**

Problems to be solved by the Invention

[0006] The cargo tank support structure disclosed in patent document 1 comprises support members (bearing seats) bearing the vertical load applied by the cargo tank, support members (anti-roll chocks) bearing the horizontal load applied by the cargo tank, and also support members bearing the horizontal load, provided at the ceiling of the floating structure. Since the support members are provided at the floor and the ceiling, construction of the cargo tank as well as construction of the floating structure takes much time. Further, since the cargo tank experience reaction force at the locations at which the cargo tank is supported by the support members, reinforcing members need to be provided on the inner side of the cargo tank at those locations. Also for this reason, a greater number of support members and/or a wider distribution of support members results in a greater amount of time taken for cargo tank construction and higher production costs.

[0007] For the cargo tank support structure disclosed in patent document 2, it is necessary to calculate reaction force to be borne by respective support members and determine in what shapes and at what locations to provide support members on the floating structure, leading to much time taken for design work. In addition, only providing the support members designed to bear the reaction force is not enough to bear a large horizontal load applied when the floating structure experiences motions such as roll, sway and yaw; the provision of support members bearing the horizontal load, such as the anti-roll chocks disclosed in patent document 1, is required. The cargo tank support structure disclosed in patent document 2 is therefore not free of the problem with the structure disclosed in patent document 1.

[0008] The present invention has been made in view of the above problems. An object of the present invention is to provide a cargo tank support structure, a floating structure and a method of supporting a cargo tank, requiring a reduced number of support members and a reduced number of locations at which to provide support members, and thus, enabling a reduction in time taken for construction work and a reduction in construction costs.

Means for Solving the Problems

[0009] In order to achieve the above object, the present invention provides a cargo tank support structure for supporting a cargo tank mounted in a hold in a floating structure, comprising: a plurality of first support portions provided at a bottom of the cargo tank in a distributed manner, a second support portion provided at the bottom of the cargo tank to continuously extend in a longitudinal direction of the floating structure, and an engagement portion provided at a floor of the hold along the length of the second support portion to engage with the second support portion, wherein a vertical load applied by the cargo tank is borne by at least the first support portions and a horizontal load applied by the cargo tank is borne by at least the second support portion and the engagement portion.

[0010] The present invention also provides a floating structure comprising a main body floating by being supported by a buoyant force, the main body having a hold with a cargo tank mounted in, wherein the cargo tank is supported with a cargo tank support structure comprising: a plurality of first support portions provided at a bottom of the cargo tank in a distributed manner, a second support portion provided at the bottom of the cargo tank to continuously extend in a longitudinal direction of the floating structure, and an engagement portion provided at a floor of the hold along the length of the second support portion to engage with the second support portion, wherein a vertical load applied by the cargo tank is borne by at least the first support portions and a horizontal load applied by the cargo tank is borne by at least the second support portion and the engagement portion.

[0011] In the above-described cargo tank support structure and floating structure, the second support portion may be provided along the longitudinal center line of the floating structure. The hold may have a ceiling covering the cargo tank, the ceiling having no support portion bearing the horizontal load applied by the cargo tank.

[0012] The second support portion may be adapted to bear the vertical load applied by the cargo tank. The cargo tank support structure may further comprise first seats and a second seat provided at the floor of the hold, the first seats being adapted to support the first support portions in a manner allowing the first support portions to slide thereon, and the second seat being adapted to support the second support portion, wherein the engagement portion is provided at the second seat.

[0013] The horizontal load may be split into a first horizontal load in a width direction of the floating structure and a second horizontal load in the longitudinal direction of the floating structure, the first horizontal load being borne by the second support portion and the engagement portion, and the second horizontal load being borne by the first support portions.

[0014] The cargo tank support structure may further comprise engagement portions provided at the floor of the hold along the width of the floating structure to engage

with corresponding ones of the first support portions so that the second horizontal load is borne by the engagement portions and the corresponding first support portions.

[0015] The first and second support portions each may comprise a frame providing a downwardly-open recess and a support block fixed in the recess to project from the frame downward.

[0016] The cargo tank support structure may further comprise a plurality of reinforcing members provided at an inner side of the bottom of the cargo tank to extend in the longitudinal direction of the floating structure, parallel to each other, wherein the support block has a width smaller than a distance between the adjacent reinforcing members.

[0017] The present invention also provides a method of supporting a cargo tank mounted in a hold in a floating structure, wherein a vertical load and a horizontal load applied by the cargo tank is borne by support portions all provided on the floor side of the hold.

Advantageous Effects of the Invention

[0018] In the cargo tank support structure, the floating structure and the cargo tank supporting method according to the present invention, support portions bearing the vertical and horizontal loads applied by the cargo tank are all provided on the floor side of the hold, where the horizontal load is borne by the second support portion provided to continuously extend in the longitudinal direction of the floating structure. This enables the vertical and horizontal loads applied by the cargo tank to be borne by a reduced number of support portions at a reduced number of locations, and thus, enables a reduction in time taken for construction work and a reduction in construction costs. Further, omission of chocks at the ceiling means increased independence of the cargo tank, which provides increased freedom of deck design and construction, leading to a reduction in costs and wider application.

Brief Description of the Drawings

[0019]

Fig. 1 is a cross-sectional view showing a first embodiment of a cargo tank support structure according to the present invention,

Fig. 2A is a partial enlarged view showing a first support portion of the support structure shown in Fig. 1, Fig. 2B is a partial enlarged view showing a second support portion of the support structure shown in Fig. 1,

Fig. 3A is a diagram showing a bottom structure of a cargo tank, a constituent part of the support structure shown in Fig. 1,

Fig. 3B is a diagram showing a floor structure of a hold, a constituent part of the support structure shown in Fig. 1,

Fig. 4A is a diagram showing a bottom of a cargo tank for explaining how a horizontal load is borne in a prior-art structure,

Fig. 4B is a diagram showing a top of a cargo tank for explaining how a horizontal load is borne in the prior-art structure,

Fig. 5A is a diagram showing a second embodiment of the cargo tank support structure according to the present invention,

Fig. 5B is a diagram showing a third embodiment of the cargo tank support structure according to the present invention,

Fig. 5C is a diagram showing a fourth embodiment of the cargo tank support structure according to the present invention,

Fig. 5D is a diagram showing a fifth embodiment of the cargo tank support structure according to the present invention,

Fig. 6A is a diagram showing a sixth embodiment of the cargo tank support structure according to the present invention,

Fig. 6B is a diagram showing a seventh embodiment of the cargo tank support structure according to the present invention,

Fig. 7A is a diagram schematically showing the overall structure of a ship, an embodiment of a floating structure according to the present invention, and

Fig. 7B is a diagram schematically showing the overall structure of off-shore floating equipment, another embodiment of the floating structure according to the present invention.

Mode for Carrying out the Invention

[0020] With reference to Figs. 1 to 7, embodiments of the present invention will be described. Fig. 1 is a cross-sectional view showing a first embodiment of a cargo tank support structure according to the present invention, Figs. 2A a partial enlarged view showing a first support portion of the support structure shown in Fig. 1, Fig. 2B a partial enlarged view showing a second support portion thereof, Fig. 3A a diagram showing a bottom structure of a cargo tank, and Fig. 3B a diagram showing a floor structure of a hold, the bottom structure and the floor structure being constituent parts of the support structure shown in Fig. 1. For convenience in the description, the length, width and height of a floating structure 1 are chosen as X-axis, Y-axis and Z-axis, respectively, in Figs. 1 to 3.

[0021] As shown in Figs. 1 to 3, a first embodiment of a cargo tank support structure according to the present invention, designed to support a cargo tank 2 mounted in a hold 11 in a floating structure 1, comprises a plurality of first support portions 3 provided at the bottom 2a of the cargo tank 2 in a distributed manner, a second support portion 4 provided at the bottom 2a of the cargo tank 2 to continuously extend in the longitudinal direction X of the floating structure 1, and an engagement portion 5 provided at the floor 11a of the hold 11 along the length

of the second support portion 4, thus in the X-direction, to engage with the second support portion 4, where a vertical load F_z applied by the cargo tank 2 is borne by at least the first support portions 3 and a horizontal load applied by the cargo tank 2 (first horizontal load F_y , in particular) is borne by at least the second support portion 4 and the engagement portion 5. The horizontal load can be split into a first horizontal load F_y in the width direction Y of the floating structure 1, and a second horizontal load F_x in the longitudinal direction X of the floating structure 1.

[0022] The floating structure 1 is a LNG carrier of a self-supporting prismatic type, for example. As seen in Fig. 1, the self-supporting prismatic LNG carrier (floating structure 1) has a double-hull 12 defining a hold 11 inside for carrying a cargo tank 2. Since the cargo tank 2 is prismatic in shape, the hold 11 is also prismatic in shape. The hold 11 is defined by a floor 11a and a ceiling 11b, the floor 11a facing the bottom 2a of the cargo tank 2 and the ceiling 11b covering the top of the cargo tank 2. In the present embodiment, the ceiling 11b has no support portion bearing the horizontal load applied by the cargo tank 2. Support portions are all provided at the bottom 2a, as will be described below.

[0023] The cargo tank 2 is designed to hold liquid cargo, such as petroleum, LPG or LNG (liquefied natural gas). The present embodiment is based on the assumption that LNG is held in the cargo tank. LNG is natural gas that has converted to liquid form by cooling it to -162°C or below, and requires maintaining at low temperature. Thus, the outer side of the cargo tank 2 is covered with a heat insulating material 21 shaped in panels. This cargo tank 2 is an independent type, namely constructed independently from the hull 12. The cargo tank 2 is mounted in the hold 11, where in order to support its own weight and reduce heat transfer from the hull 12, the cargo tank 2 has support members (first support portions 3 and second support portion 4, for example) at the bottom 2a, which allows the cargo tank to be mounted with the support members on the floor 11a of the hold 11. The present invention is characterized by this cargo tank 2 support structure. Although the cargo tank 2 has various reinforcing members on the inner side, Fig. 1 shows only those reinforcing members 22 provided to extend in the longitudinal direction X of the hull 12, parallel to each other.

[0024] The first support portions 3 bear the weight of the cargo tank 2 itself, or vertical load F_z applied by the cargo tank 2. As shown in Fig. 2A, the first support portions 3 each comprise a frame 31 providing a downwardly-open recess and a support block 32 fixed in the recess to project from the frame 31 downward. The support block 32 is fitted and fixed in the frame 31. The support block 32 is made from square timber, for example, and fixed in the frame 31 by press-fitting. The support block 32 may, of course, be fixed to the frame 31 with metal fastening pieces. A reinforcing material 31a is provided to surround the frame 31 in an appropriate geometry. The support block 32 may be a conventional support block.

For example, it may be made from an elastic material having low thermal conductivity, such as rubber or resin, or square timber with a coat of such elastic material.

[0025] As seen in Fig. 2A, at the floor 11a of the hold 11, first seats 13 are provided to face and support the first support portions 3, respectively, in a manner allowing them to slide thereon. The first seat 13 is a solid or hollow or symbol "#"-shaped metal portion with an approximately-flat top face. A reinforcing material 13a is provided to surround the first seat 13 in an appropriate geometry. The cargo tank is mounted with the support blocks 32 of the first support portions 3 slidably seated on the top faces of the first seats 13. The first seats 13 may be made by machining the floor 11a of the hold 11 itself. When unnecessary, the first seats 13 may be omitted so that the support blocks 32 are supported directly by the floor 11a. As seen in Fig. 3A, the first support portions 3 are arranged on both sides of the longitudinal center line L of the floating structure 1, in a manner distributed over the bottom 2a of the cargo tank 2. In the shown embodiment, the first support portions 3 are arrayed in two rows and eight columns on the portside as well as on the starboard side. As seen in Fig. 3B, the first seats 13 are arranged at the locations corresponding to the first support portions 3.

[0026] The cargo tank support structure may be designed such that the second horizontal load F_x is borne by the first support portions 3 while the first horizontal load F_y is borne by the second support portion 4 and the engagement portion 5. Specifically, as seen in Fig. 3B, the first seats 13 in the second column from the left each have an engagement portion 15 similar in shape to the engagement portion 5, described later. The engagement portions 15 are provided at the floor 11a of the hold 11, along the width of the floating structure 1, thus in the Y-direction, to engage with the corresponding first support portions 3 so that the second horizontal load F_x is borne by the engagement portions 15 and the corresponding first support portions 3. The provision of the engagement portions 15 makes it possible to bear the horizontal load applied in varying magnitude and direction. The engagement portions 15 may be provided in a desired manner; an increased number of the engagement portions 15 may be provided, and the engagement portions 15 may be provided at different locations, as compared with the example shown in the Figure. If the second horizontal load F_x is negligibly small in magnitude as compared with the first horizontal load F_y , the engagement portions 15 may be omitted.

[0027] The second support portion 4 bears at least the horizontal load (first horizontal load F_y) applied by the cargo tank 2. While traveling or moored, the floating structure 1 experiences various motions (heave, sway, surge, pitch, yaw, roll) caused by waves, so that the cargo tank 2 applies first and second horizontal loads F_y , F_x , namely loads in the width and longitudinal directions Y, X of the hull, respectively. The second support portion 4 bears the first horizontal load F_y . Floating structures having a

long and thin hull 12, such as LNG carries, in particular, are likely to experience a great load in the width direction Y; the first horizontal load F_y is likely to be greater than the second horizontal load F_x .

[0028] As seen in Fig. 2B, the second support portion 4 comprises a frame 41 providing a downwardly-open recess and a support block 42 fixed in the recess to project from the frame 41 downward. The support block 42 is fitted and fixed in the frame 41. The support block 42 is made from square timber, for example, and fixed in the frame 41 by press-fitting. The support block 42 may, of course, be fixed to the frame 41 with metal fastening pieces. A reinforcing material 41a is provided to surround the frame 41 in an appropriate geometry. The support block 42 may be a conventional support block. For example, it may be made from an elastic material having low thermal conductivity, such as rubber or resin, or square timber with a coat of such elastic material.

[0029] As seen in Fig. 2B, at the floor 11a of the hold 11, a second seat 14 is provided to face and support the second support portion 4. The second seat 14 is a solid or hollow or symbol "#"-shaped metal portion with an approximately-flat top face. A reinforcement material 14a is provided to surround the second seat 14 in an appropriate geometry. The second seat 14 has the top face at the same level as the top faces of the first seats 13, on which the support block 42 of the second support portion 4 is seated. The second support portion 4 thus shares the vertical load F_z applied by the cargo tank 2. By the second support portion 4 sharing the vertical load F_z , the load to be borne by the first support portions 3 is reduced, which allows a reduction in number of the first support portions 3 and/or a reduction in size of the first support portions 3.

[0030] As seen in Fig. 2B, the engagement portion 5 is provided at the second seat 14. The engagement portion 5 is formed by attaching pieces of structural steel, such as steel angle or plate, to either side of the second seat 14 in the longitudinal direction X, by welding or other process. The engagement portion 5 may be formed by attaching the pieces of structural steel to either the top or the sides of the second seat 14. The engagement portion 5 provided this way can bear the first horizontal load F_y , restricting the movement of the support block 42 on the second seat 14 in the width direction Y.

[0031] As seen in Fig. 3A, the second support portion 4 is provided to extend on the longitudinal center line L of the floating structure 1 in the X-direction. As seen in Fig. 3B, also the second seat 14 and the engagement portion 5 extend on the longitudinal center line L of the floating structure 1 in the X-direction. The second support portion 4 and the engagement portion 5, both extending long in the longitudinal direction X, provide a pressure-receiving area great enough to bear the first horizontal load F_y . Although in the shown embodiment, the engagement portion 5 extends in the X-direction over the entire length of the second seat 14, the engagement portion 5 may have any length enough to bear the expected mag-

nitude of the first horizontal load F_y . The engagement portion 5 may be made of separate longitudinal portions arranged in the longitudinal direction X.

[0032] Figs. 4A and 4B are diagram showing a bottom and a top of a cargo tank, respectively, for explaining how a horizontal load is borne in a prior-art support structure.

[0033] As seen in Figs. 4A and 4B, in the prior art, the cargo tank support structure typically comprises a plurality of tanks supports 30 provided at the bottom 20a of the cargo tank 20 in a distributed manner, and a plurality of anti-roll chocks 40 provided at the top 20b of the cargo tank 20 on the longitudinal center line L of the hull. The cargo tank 20 is mounted with the tank supports 30 on the hold floor and with the anti-roll chocks 40 engaged with engagement portions provided at the hold ceiling. Thus, the vertical load applied by the cargo tank 20 is borne by the tank supports 30, and the horizontal load by the anti-roll chocks 40 and some of the tank supports 30. The cargo tank 20 has a tank dome 20c at the top, which provides access to the inside of the cargo tank for carrying in and out LNG and for tank maintenance.

[0034] The above-described prior-art support structure having the support members (tank supports 30 and anti-roll chocks 40) at both the bottom 20a and the top 20b of the cargo tank has a drawback such that construction of the floating structure as well as construction of the cargo tank 20 takes much time. The present embodiment, by contrast, has a portion functioning as anti-roll chocks at the bottom 2a of the cargo tank 2. Specifically, the present embodiment is a method of supporting a cargo tank 2 mounted in a hold 11 in a floating structure 1, wherein the horizontal load (first horizontal load F_y and second horizontal load F_x) as well as the vertical load F_z applied by the cargo tank 2 is borne by support portions all provided on the floor 11a side of the hold 11. The present embodiment thus does not require that support portions bearing the horizontal load (first horizontal load F_y and second horizontal load F_x) applied by the cargo tank 2 be provided at the top of the cargo tank 2. The present embodiment thus allows a reduction in number of locations at which to provide support members and a reduction in size of support members, which leads to reduced time taken for construction work.

[0035] As seen in Fig. 3A, the second support portion 4 extending linearly and continuously in the longitudinal direction X leads to simple arrangement of heat insulating material 2 around it, as compared with the prior art in which the heat insulating material needs to be arranged to surround each of the separate tank supports 30 provided in a distributed manner in the area of the second support portion 4. This also leads to reduced time taken for construction work. Next, other embodiments of the cargo tank support structure according to the present invention will be described. Figs. 5A to 5D show second to fifth embodiments of the cargo tank support structure according to the present invention, respectively, and Figs. 6A and 6B show sixth and seventh embodiments

of the cargo tank support structure according to the present invention, respectively. Those components which are similar to components of the first embodiment are denoted by the same reference characters, and the description thereof will be omitted.

[0036] In the second to fifth embodiments shown in Figs. 5A to 5D, the first support portions 3 and/or the second support portion 4 is provided in an altered arrangement. Figs. 5A to 5D each show the bottom 2a of the cargo tank 2 in a manner comparable to Fig. 3A.

[0037] In the second embodiment shown in Fig. 5A, the second support portion 4 is divided into parts. Although in the shown example, the second support portion 4 is divided into two parts, it may be divided into three or more parts. Dividing the second support portion 4 into parts provides a passage between the adjacent parts, through which a worker can come and go between the opposite sides of the second support portion 4. This is convenient for maintenance work and others.

[0038] In the third embodiment shown in Fig. 5B, the second support portion 4 is provided to extend in the longitudinal direction X, off the longitudinal center line L. Although it is normally desirable to arrange the second support portion 4 on the longitudinal center line L, the second support portion 4 may be arranged on any longitudinal line other than the longitudinal center line as in the third embodiment, to suit the expected horizontal load, which varies depending on ship type, cargo, shipping route and others.

[0039] In the fourth embodiment shown in Fig. 5C, the second support portion 4 includes a part arranged on another longitudinal line than the longitudinal center line L. Specifically, the second support portion 4 is divided into three parts, of which the middle one 4 is arranged on a longitudinal line near a longitudinal edge of the bottom 2a of the cargo tank 2 and the other two 4 are arranged on the longitudinal center line L. The second support portion 4 may be provided in a distributed manner as in the fourth embodiment to suit the expected horizontal load, which varies depending on ship type, cargo, shipping route and others, within the constraints on arrangement imposed by the hull.

[0040] In the fifth embodiment shown in Fig. 5D, the first support portions 3 are approximately rectangular in shape. Although in the shown example, the first support portion 3 has a greater size in the width direction Y of the floating structure than in the longitudinal direction X thereof, the first support portion 3 may have a greater size in the longitudinal direction X than in the width direction Y. This type of first support portion 3 is provided, as it were, by combining some conventional first support portions 3 into one. Choosing the rectangular shape in place of the square shape makes it possible to reduce the number of support portions 3 while providing the pressure-receiving area enough to bear the vertical load F_z , leading to a reduction in time taken for construction work.

[0041] In the sixth and seventh embodiments shown in Figs. 6A and 6B, the second support portion 4 has an

altered structure. Figs. 6A and 6B each show the second portion 4 in a manner comparable to Fig. 2B.

[0042] In the sixth embodiment shown in Fig. 6A, the second seat 14 is omitted. The second seat 14 can be omitted, for example when the first seats 13 are omitted or when the second support 4 is not intended to bear the vertical load F_z . As seen in the Figure, the engagement portion 5 is provided directly at the floor 11a of the hold 11. A reinforcing material 5a may be provided on the outer side of the engagement portion 5. In the shown example, the second support portion 4 is not intended to bear the vertical load F_z (the vertical load F_z is borne only by the first support portions 3), and thus, the block 42 is not in contact with the floor 11a of the hold 11. It may be altered such that the block 42 is in contact with the floor 11a so that the second support portion 4 shares the vertical load F_z .

[0043] In the seventh embodiment shown in Fig. 6B, the cargo tank 2 has a plurality of reinforcing members 22 provided on the inner side of the bottom to extend in the longitudinal direction X, parallel to each other, where the support block 42 has a width Y_b smaller than the distance Y_g between the adjacent reinforcing members 22, 22. This can reduce the area not covered with the heat insulating material 21, and thus, provide improved cold storage performance. When the heat insulating material 21 is shaped in panels, the second support portion 4 is easily provided between the panels. The second support portion 4 of this type can therefore reduce the area not covered with the heat insulating material 21, and at the same time facilitates application of the heat insulating material 21. This feature is applicable to the first support portions 3. Last, embodiments of a floating structure 1 according to the present invention will be described. Fig. 7A is a diagram schematically showing the overall structure of a ship, an embodiment of a floating structure according to the present invention, and Fig. 7B shows offshore floating equipment, another embodiment of the floating structure. The floating structures 1 shown in Figs. 7A and 7B each comprise a main body 1a floating by being supported by a buoyant force, the main body 1a having a hold 11 with cargo tanks 2 mounted in. Specifically, the floating structure 1 shown in Fig. 7A is a self-supporting prismatic LNG carrier, and the main body 1a is a hull 12. The floating structure 1 is not restricted to the LNG carrier; it may be a petroleum tanker, an LPG carrier, a chemical tanker or the like although it needs to be a vessel designed to carry self-supporting prismatic cargo tanks 2.

[0044] The floating structure 1 shown in Fig. 7B is offshore-floating self-supporting prismatic LNG equipment exemplified by an FPSO (floating production, storage and offloading system). The FPSO is a floating structure 1 moored offshore by mooring cable 1b, having LNG production equipment 1c on the deck, wherein the LNG produced is stored in cargo tanks 2 within the FPSO until offloaded onto a carrier. The FPSO may be designed for processing petroleum or LPG. If the production of such

fuel is not intended, the floating structure 1 may be an FSO (floating storage and offloading system) which is offshore floating equipment not comprising production equipment 1c. The FSO is designed to only store and offload fuel.

[0045] The floating structure 1 has cargo tanks 2 independent from the main body 1a, and the cargo tanks 2 are supported with the support structure according to the present invention, exemplified by the above-described first to seventh embodiments, and thus, the support portions bearing the vertical load F_z and horizontal load (first horizontal load F_y and second horizontal load F_x) applied by the cargo tank 2 are all provided on the floor 11a side of the hold 11. This makes it possible to reduce the number of support members and the number of locations at which to provide support members, leading to reduced time taken for and reduced costs of constructing the floating structure 1.

[0046] In the above description of the cargo tank 2 support structure, the floating structure 1 and the method of supporting the cargo tank 2, the "vertical load" is a load acting vertically on the floating structure 1 buoyed by static water, and the "horizontal load" is a load acting horizontally on the floating structure 1 buoyed by static water. The frame of reference within which these loads are measured may be either a relative coordinate system varying depending on oscillation of the floating structure 1 or an absolute coordinate system fixed irrespective of oscillation of the floating structure 1.

[0047] The present invention is not restricted to the described embodiments, which can be altered in various ways without departing from the scope and spirit of the present invention. For example, the present invention is applicable to floating structures 1 having anti-floatation chocks and floating structures 1 not having a ceiling 11b of a hold 11 covering a cargo tank 2.

Explanation of Reference Signs

1	Floating structure
1a	Main body
2	Cargo tank
2a	Bottom
3	First support portion
4	Second support portion
5	Engagement portion
11	Hold
11a	Floor
11b	Ceiling
13	First seat
14	Second seat
15	Engagement portion
22	Reinforcing member
31, 41	Frame
32, 42	Support block

Claims

1. A cargo tank support structure for supporting a cargo tank mounted in a hold in a floating structure, comprising:

a plurality of first support portions provided at a bottom of the cargo tank in a distributed manner, a second support portion provided at the bottom of the cargo tank to continuously extend in a longitudinal direction of the floating structure, an engagement portion provided at a floor of the hold along the length of the second support portion to engage with the second support portion, wherein a vertical load applied by the cargo tank is borne by at least the first support portions and a horizontal load applied by the cargo tank is borne by at least the second support portion and the engagement portion.
2. The cargo tank support structure according to claim 1, wherein the second support portion is provided along the longitudinal center line of the floating structure.
3. The cargo tank support structure according to claim 1, wherein the hold has a ceiling covering the cargo tank, the ceiling having no support portion bearing the horizontal load applied by the cargo tank.
4. The cargo tank support structure according to claim 1, wherein the second support portion is adapted to bear the vertical load applied by the cargo tank.
5. The cargo tank support structure according to claim 4, further comprising first seats and a second seat provided at the floor of the hold, the first seats being adapted to support the first support portions in a manner allowing the first support portions to slide thereon, and the second seat being adapted to support the second support portion, wherein the engagement portion is provided at the second seat.
6. The cargo tank support structure according to claim 1, wherein the horizontal load is split into a first horizontal load in a width direction of the floating structure and a second horizontal load in the longitudinal direction of the floating structure, the first horizontal load being borne by the second support portion and the engagement portion, and the second horizontal load being borne by the first support portions.
7. The cargo tank support structure according to claim 6, further comprising engagement portions provided at the floor of the hold along the width of the floating structure to engage with corresponding ones of the first support portions so that the second horizontal
- load is borne by the engagement portions and the corresponding first support portions.
8. The cargo tank support structure according to claim 1, wherein the first and second support portions each comprise a frame providing a downwardly-open recess and a support block fixed in the recess to project from the frame downward.
9. The cargo tank support structure according to claim 8, further comprising a plurality of reinforcing members provided at an inner side of the bottom of the cargo tank to extend in the longitudinal direction of the floating structure, parallel to each other, wherein the support block has a width smaller than a distance between the adjacent reinforcing members.
10. A floating structure comprising a main body floating by being supported by a buoyant force, the main body having a hold with a cargo tank mounted in, wherein the cargo tank is supported with a cargo tank support structure according to any of claims 1 to 9.
11. A method of supporting a cargo tank mounted in a hold in a floating structure, wherein a vertical load and a horizontal load applied by the cargo tank is borne by support portions all provided on a floor side of the hold.

FIG. 1

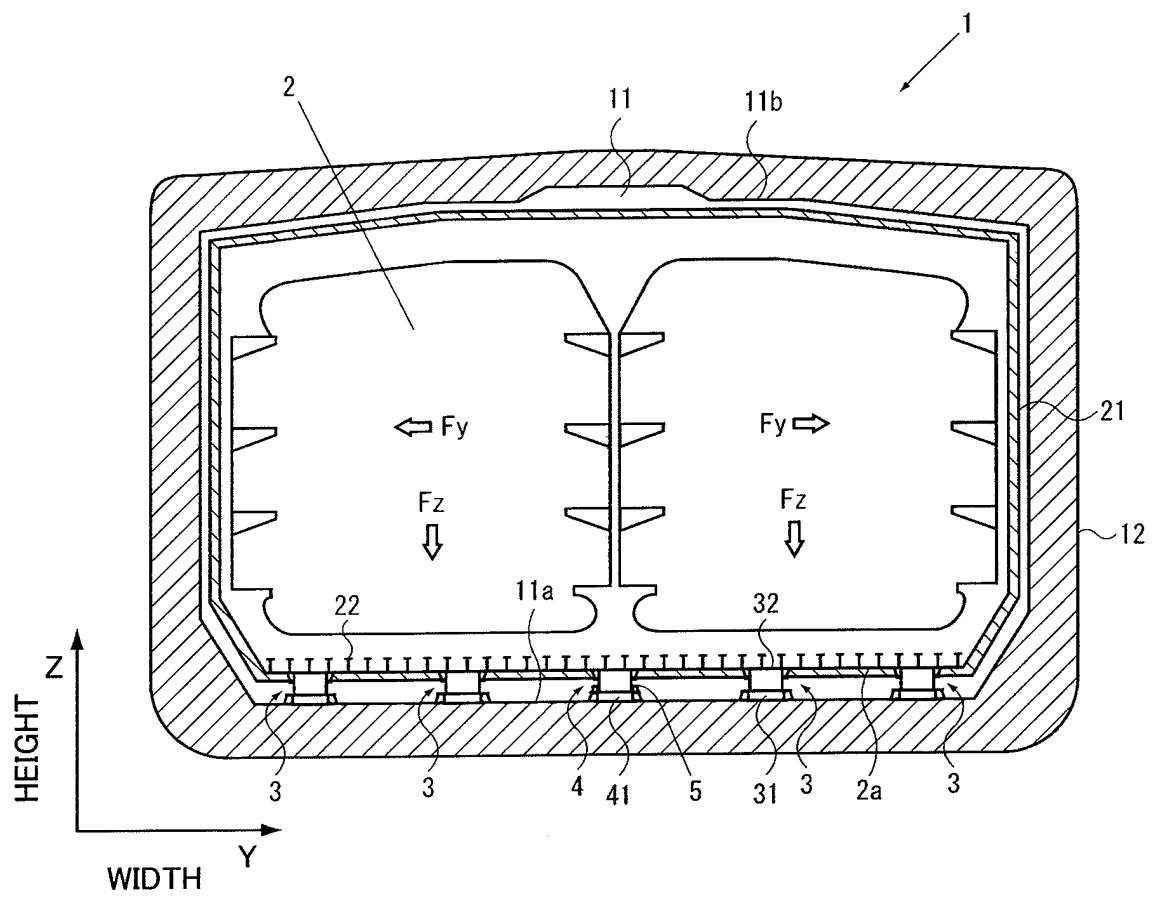


FIG. 2A

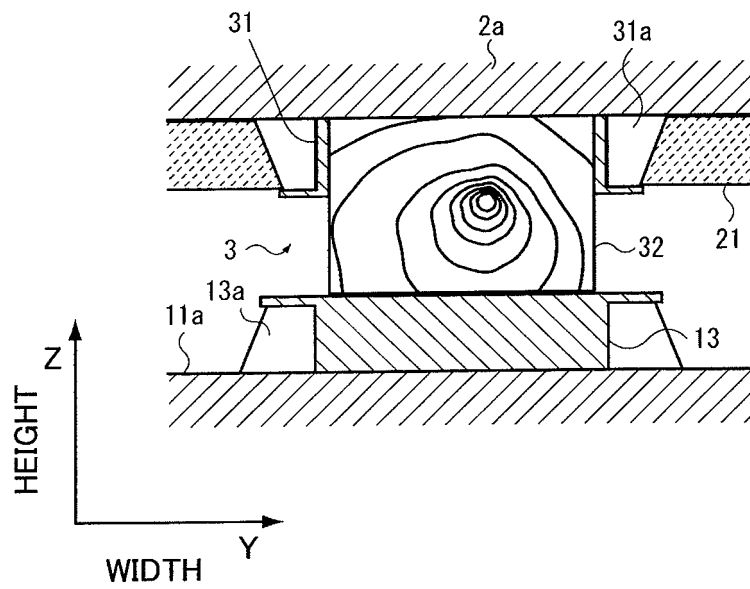


FIG. 2B

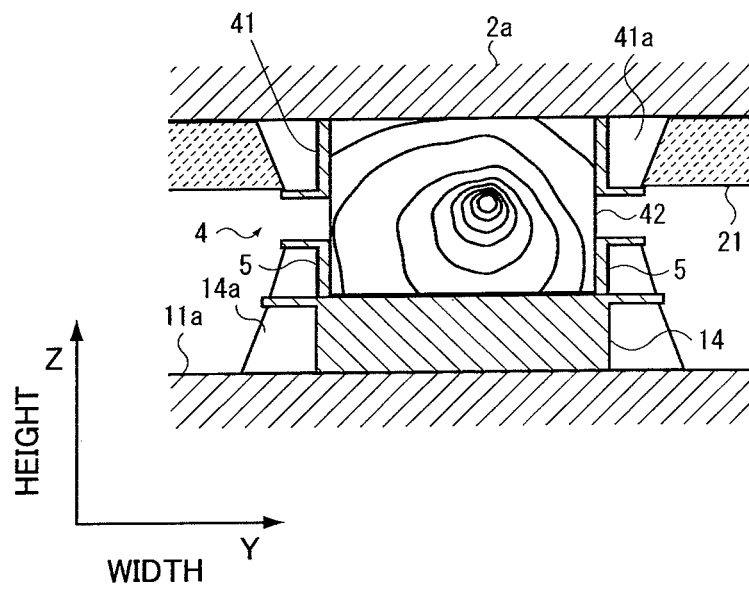


FIG. 3A

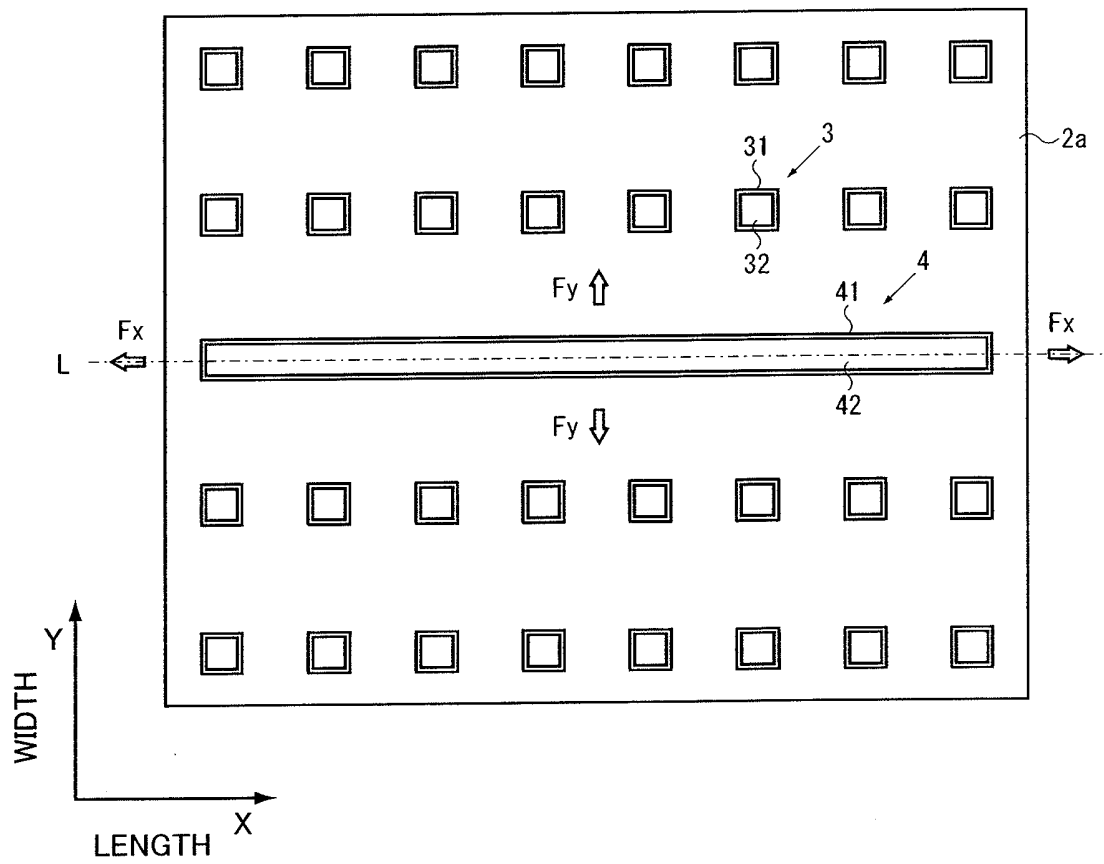


FIG. 3B

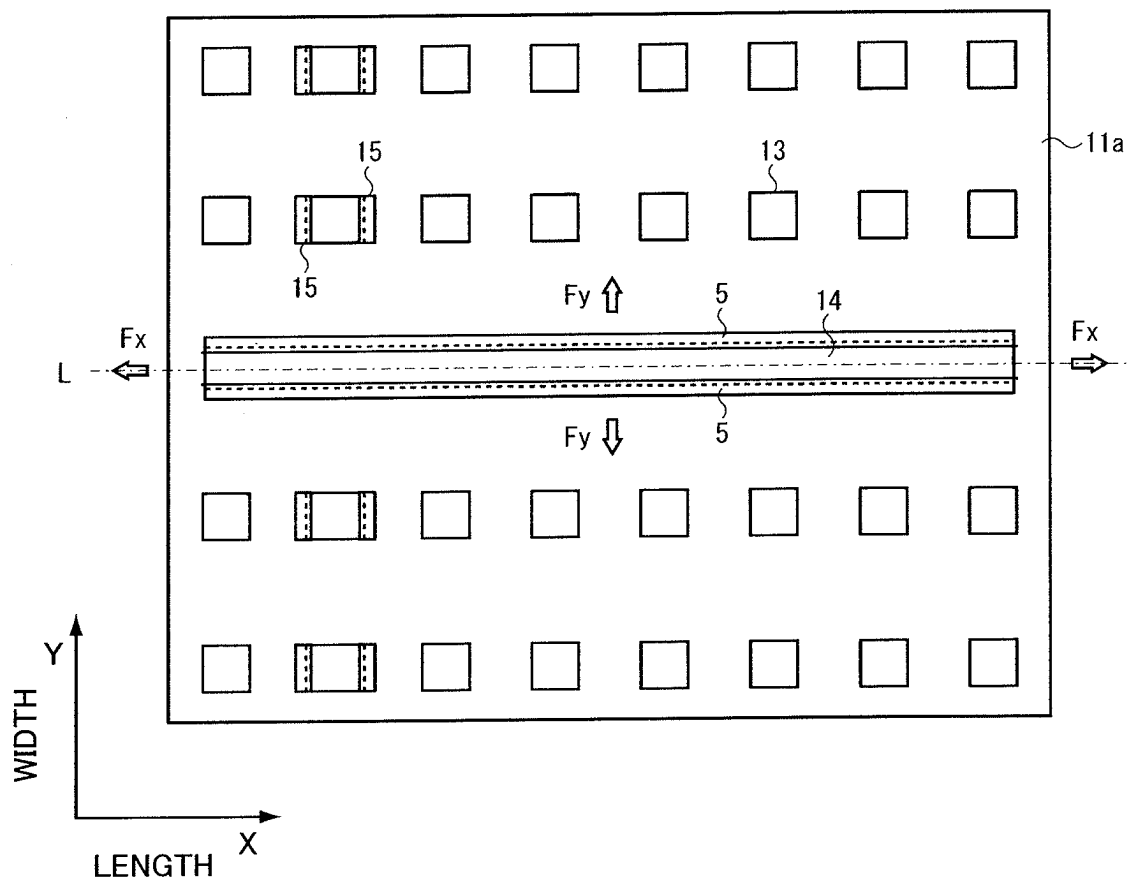


FIG. 4A

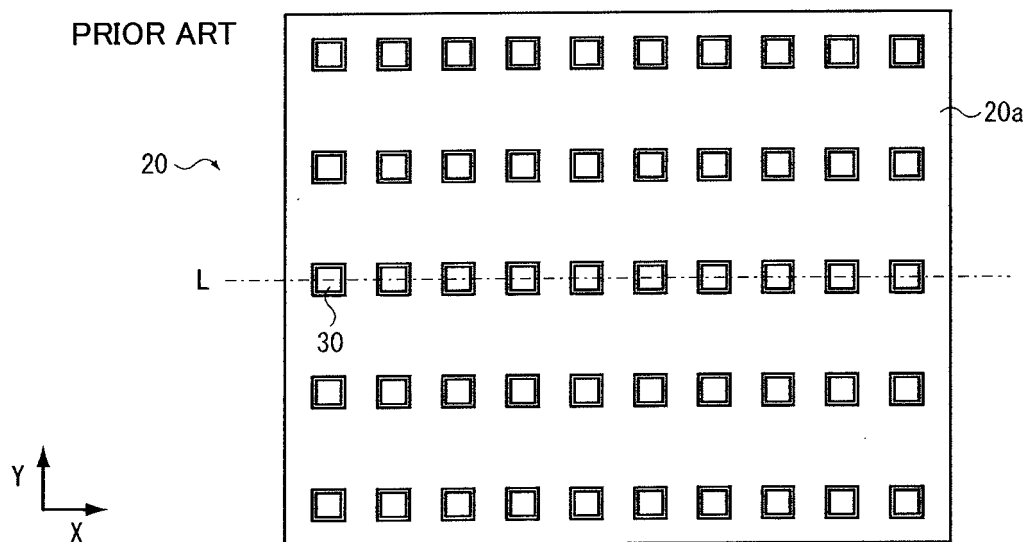


FIG. 4B

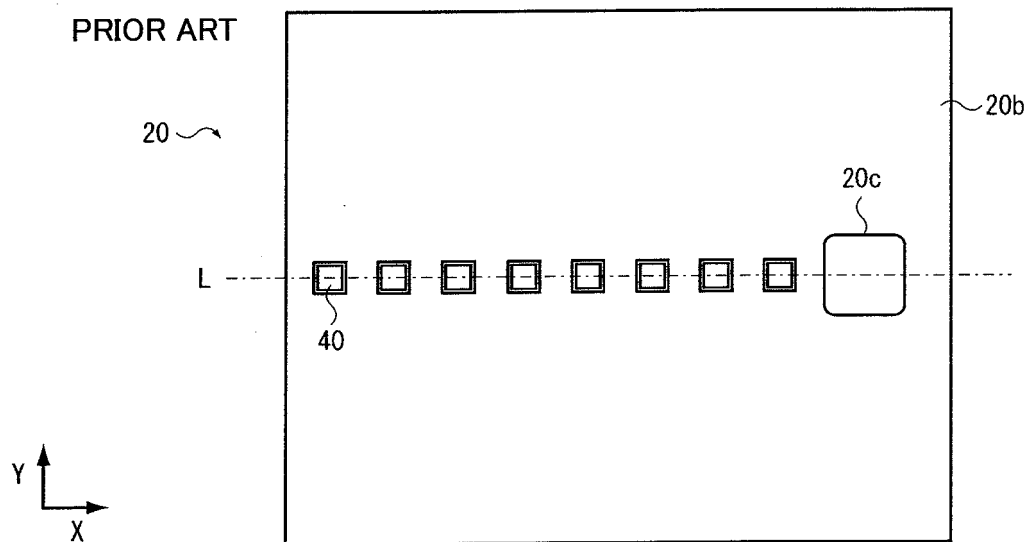


FIG. 5A

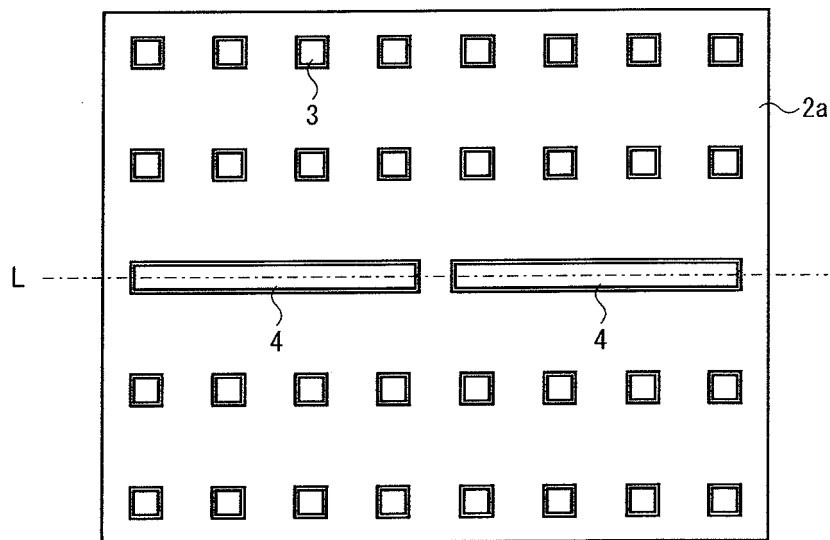


FIG. 5B

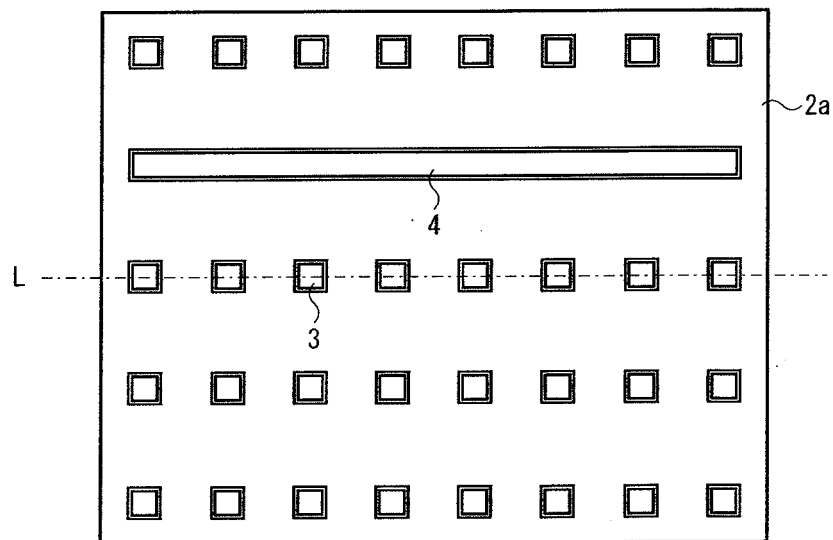


FIG. 5C

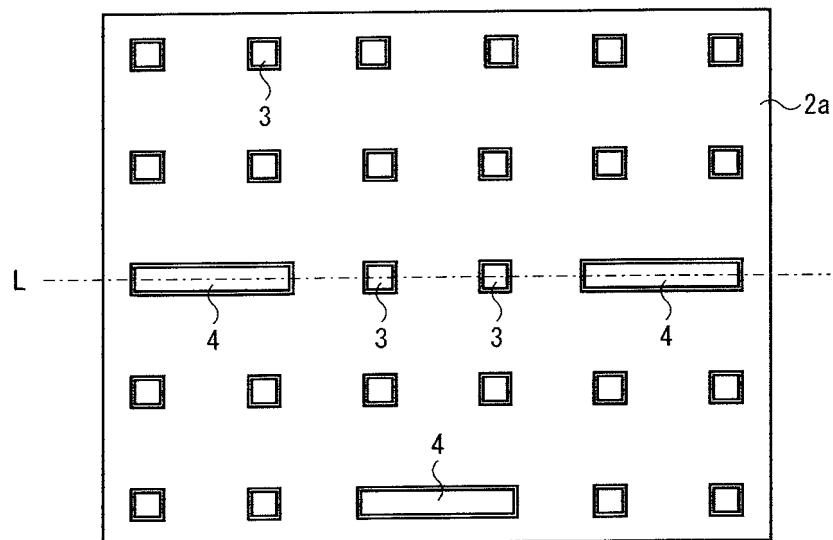


FIG. 5D

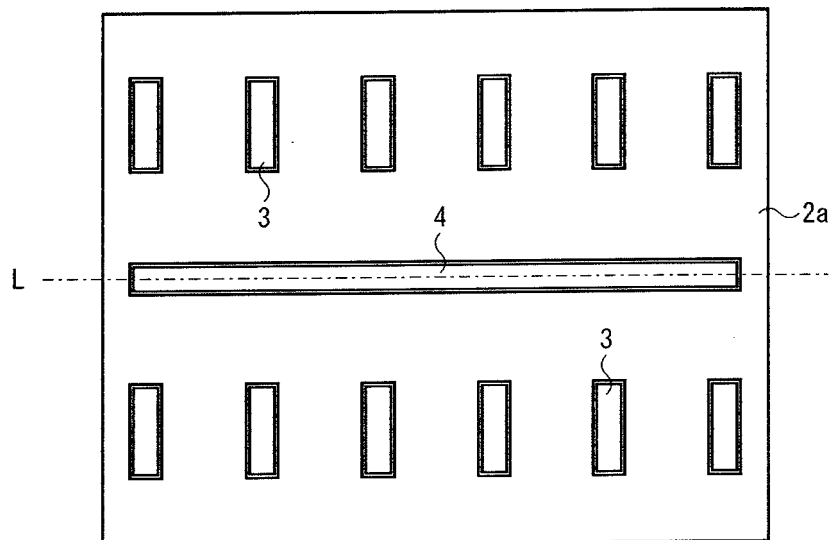


FIG. 6A

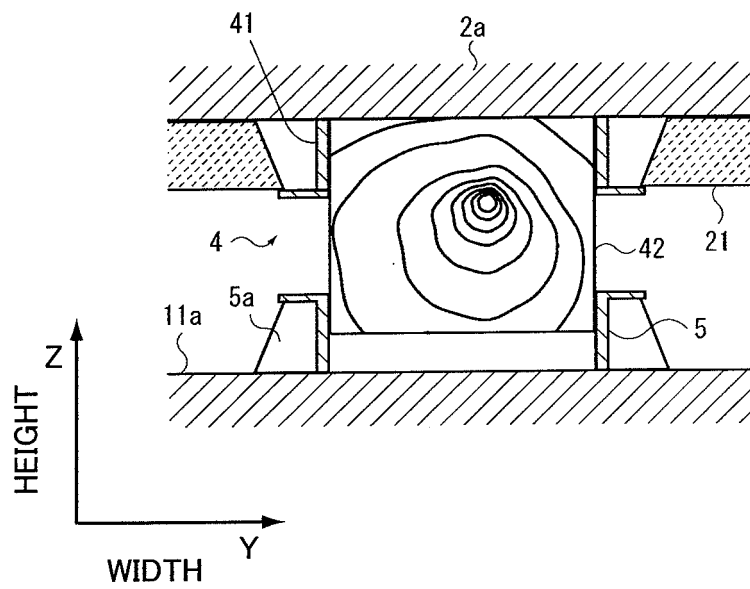


FIG. 6B

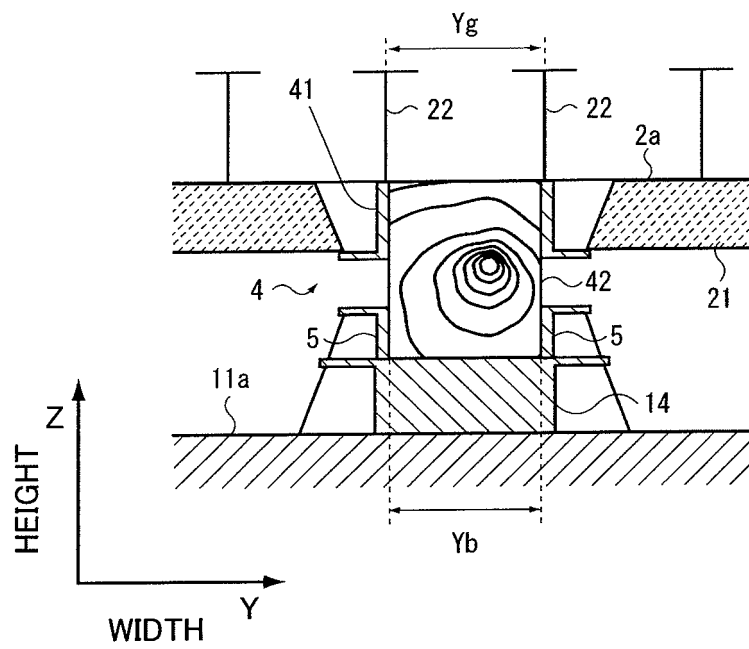


FIG. 7A

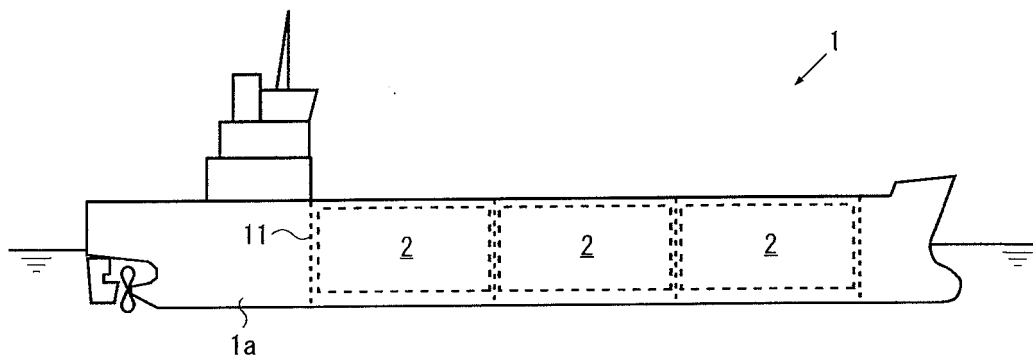
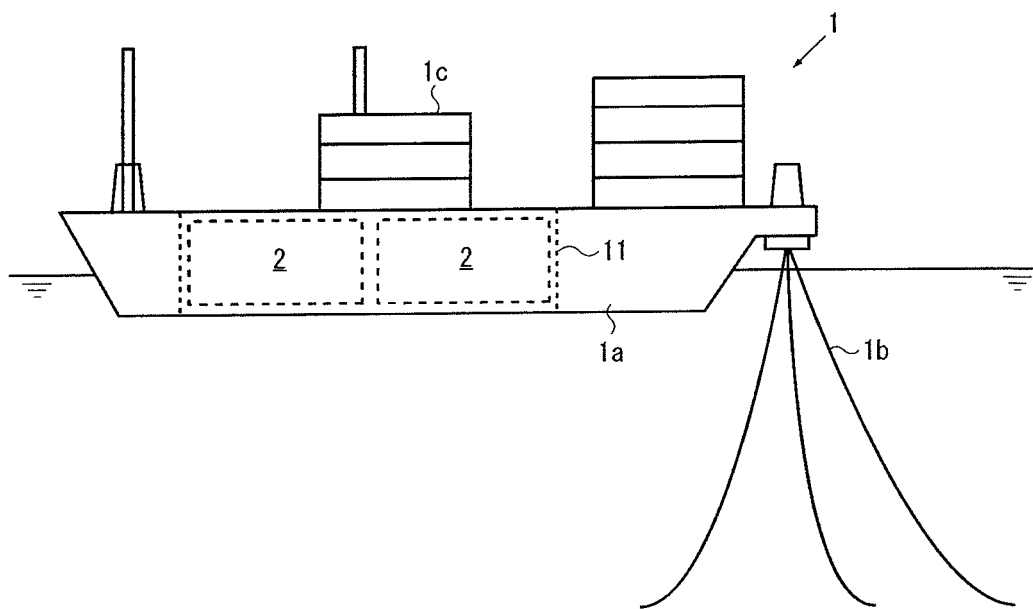


FIG. 7B



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/069008

A. CLASSIFICATION OF SUBJECT MATTER

B63B25/16(2006.01) i, F17C13/08(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)

B63B25/16, F17C13/08

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2011

Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2000-177681 A (Mitsubishi Heavy Industries, Ltd.), 27 June 2000 (27.06.2000), paragraphs [0005] to [0006], [0011] to [0012], [0023]; fig. 1 to 2, 4 to 7, 11 (Family: none)	1-11
Y	JP 40-9812 B1 (Maryland Shipbuilding and Drydock Co.), 19 May 1965 (19.05.1965), page 3, left column, 13th line from the bottom to right column, line 3; fig. 1 to 4 (Family: none)	1-11

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

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Date of the actual completion of the international search
22 November, 2011 (22.11.11)Date of mailing of the international search report
06 December, 2011 (06.12.11)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/069008

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2009-517272 A (TGE Marine Gas Engineering GmbH), 30 April 2009 (30.04.2009), paragraphs [0004], [0015] to [0017]; fig. 1 & WO 2007/062770 A2 & DE 102005057451 A1 & CN 101321662 A & KR 10-2008-0093980 A	3, 11
Y	JP 7-156860 A (Ishikawajima-Harima Heavy Industries Co., Ltd.), 20 June 1995 (20.06.1995), paragraphs [0014] to [0016], [0019] to [0020]; fig. 1 to 4 (Family: none)	4-9

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000177681 A [0005]
- JP S595492 U [0005]