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(54) **UPPER STRUCTURE OF CARGO TANK IN LNGC**

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Description

Technical Field

[0001] The present invention relates to an upper structure of a cargo tank in an LNGC, and more particularly to an upper structure of a cargo tank in an LNGC capable of increasing the longitudinal strength of a hull while minimizing the sloshing load in the interior of the cargo tank and of allowing easy installation of various equipment and passages.

Background Art

[0002] In general, natural gas is carried by a liquefied natural gas carrier (hereinafter, referred to as LNGC) because of the transportation cost thereof. Meanwhile, since more natural gas can be carried at once by carrying the natural gas in a liquefied state than in a gaseous state, the natural gas is liquefied at an ultra-low temperature to be carried. The natural gas liquefied for the above-mentioned purpose is called liquefied natural gas.

[0003] When liquefied natural gas is carried by an LNGC, a sloshing load problem critically influencing a hull occurs in a cargo tank in the LNGC. Sloshing is a phenomenon in which the free surface of a fluid in a tank is fluctuated by the vibration of the tank such that the fluid impacts on wall surfaces of the tank.

[0004] A need for an improved cargo tank structure of an LNGC capable of minimizing the sloshing phenomenon has been requested because the sloshing load can critically influence the structural stability of the hull of the LNGC.

[0005] FIG. 1 is a concept view illustrating a conventional cargo tank in an LNGC. Such a cargo tank is also known from US 7137345. Referring to FIG. 1, the transverse cross-section of a membrane type cargo tank is schematically illustrated. First, referring to FIG. 1, there is provided a double plate type cargo tank including a double bottom plate 3 forming the bottom of the cargo tank, double inclined sections 5 obliquely extending toward the outer upper side of the double bottom plate 3, inner side plates 7 and outer side plates 9 vertically extending upward from the double inclined sections 5 to form the side walls of the cargo tank, inner inclined plates 11 and outer inclined plates 13 obliquely extending toward the inner upper sides of the inner side plates 7 and the outer side plate 9 respectively, and an upper structure A connected to the inner inclined plates 11 and the outer inclined plates 13.

[0006] FIG. 2 is a concept view illustrating the upper structure of the conventional cargo tank of the LNGC of FIG. 1. Referring to FIG. 2, the upper structure of the cargo tank includes a conventional inner deck 15 horizontally connected to both ends of the inner inclined plates 11 and a trunk deck 17 spaced upwardly apart from the conventional inner deck 15 and horizontally connected to both ends of the outer inclined plates 13.

[0007] In the conventional upper structure of the cargo tank in the LNGC, a sole method for reducing the sloshing load is to restrict the size (e.g. width or length) of the cargo tank. However, according to this method, it is necessary to increase the number of cargo tanks in order to carry more liquefied natural gas.

[0008] Meanwhile, various pipes, pipe supports, cables, cableways, and passages 60 are conventionally installed between the inner inclined plate 11 and the outer inclined plate 13 of the cargo tank. Since the installation spaces are generally narrow and inclined, various support members 62 are inconveniently required to the upper structure of the cargo tank.

[0009] Moreover, the trunk deck 17 formed in the conventional cargo tank of the LNGC does not have a sufficient upper area, so necessary pipes need to be arranged in a multilayer structure. Accordingly, there are many difficulties in performing works such as maintenance, repair, a sealing test (e.g. hydro test), etc.

[0010] The conventional cargo tank in an LNGC also has a problem in the longitudinal strength of the hull thereof. FIG. 3 is an arrangement view illustrating the position of a liquid dome opening installed in the conventional upper structure of the cargo tank in the LNGC. Referring to FIG. 3, a liquid dome opening 50 is disposed on the conventional trunk deck. Here, the liquid dome opening 50 is equipment functioning as a sort of an entrance for cargo for supplying liquefied natural gas into the cargo tank or withdrawing the liquefied natural gas from the cargo tank. Various pipes are installed in the liquid dome opening 50.

[0011] A center girder is installed on the longitudinal center line of the trunk deck 17 and side girders are disposed in parallel to each other and are spaced apart from the center line to the right and left sides. The center girder and the side girders are reinforcing members for maintaining the longitudinal strength of the hull.

[0012] However, the liquid dome opening 50 disposed in the conventional trunk deck 17 intrudes into a portion of the center girder, which causes a problem in the longitudinal strength of the hull.

Disclosure of Invention

Technical Problem

[0013] Therefore, the present invention has been made in view of the above problems, and it is an aspect of the present invention to provide an upper structure of a cargo tank in an LNGC capable of reducing a sloshing load that can be generated in the interior of the cargo tank, of easily installing various equipments and passages, and of maintaining the continuity of a center girder installed on a trunk deck.

Technical Solution

[0014] In order to achieve the aspect, there is provided

an upper structure of a cargo tank in an LNGC comprising: an inner deck, both ends of which are connected to the upper ends of inner inclined plates extending from inner side plates respectively; a trunk deck spaced apart from the inner deck above the inner deck and extending further to the right and to the left than the inner deck by a predetermined length respectively; trunk inclined section, ends of which are connected to both ends of the trunk deck and the other ends of which are located on right and left horizontal extension lines of the inner deck; and inner deck extensions extending from both ends of the inner deck to the trunk inclined sections respectively.

[0015] Preferably, the inner deck, the trunk deck, the trunk inclined sections, and the inner deck extensions form a rectangular box-shaped structure.

[0016] Preferably, the width of the inner deck is reduced to a minimal requirement range required by pipes and cargo systems that can be mounted to the upper and lower surfaces of the inner deck or can penetrate the inner deck.

[0017] Preferably, the inclination angle of the trunk inclined sections may be ninety degrees downward with respect to the trunk deck.

[0018] Then, passage assemblies including pipes, pipe supports, cables, cableways, and passages may be positioned on the upper surface of the inner deck extensions respectively without using any separate support member.

[0019] Preferably, a liquid dome opening may be deviated from the longitudinal center line and may be eccentrically disposed on the upper surface of the trunk deck. The arrangement can maintain the continuity of the center girder installed on the longitudinal center line of the trunk deck, thereby enhancing the longitudinal strength of the hull.

Advantageous Effects

[0020] In the upper structure of the cargo tank in the LNGC according to the embodiment of the present invention, as the width of the inner deck is reduced to the minimal requirement range, the sloshing load in the cargo tank can be minimized. Further, due to the geometric characteristics of the rectangular box-shaped structure, the uppermost area of the trunk deck and the lower space of the horizontal trunk deck is so sufficient that various equipments such as the passage assembly including the pipes, the cables, and the passages can be easily disposed. Furthermore, the liquid dome opening is deviated from the center girder so that the longitudinal strength of the hull can be enhanced.

[0021] In addition, in the upper structure of the cargo tank in the LNGC according to the embodiment of the present invention, since the passage assemblies can be simply positioned on the upper surfaces of the inner deck extensions, the separate support members installed in the conventional inclined spaces are unnecessary and the steel grating (about 200 M) used as the bottom sur-

face of the passage is also unnecessary, thereby reducing the ship construction cost by shortening the work time and reducing the work cost.

[0022] Moreover, in the upper structure of the cargo tank in the LNGC according to the embodiment of the present invention, the wide uppermost area of the trunk deck as compared with the conventional one allows the arrangement of the pipes in a single layer structure, thereby providing a convenience in performing installation, maintenance, and repair of the pipes as well as various tests (e.g. hydro test).

Brief Description of the Drawings

[0023] The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a concept view illustrating a conventional cargo tank in an LNGC;

FIG. 2 is a concept view illustrating an upper structure of the conventional cargo tank in the LNGC of FIG. 1;

FIG. 3 is an arrangement view illustrating the position of a liquid dome opening installed in the upper structure of the cargo tank in the LNGC of FIG. 1;

FIG. 4 is a concept view illustrating an upper structure of a cargo tank in an LNGC according to an embodiment of the present invention;

FIG. 5 is an arrangement view illustrating the position of a liquid dome opening installed in the upper structure of the cargo tank in the LNGC of FIG. 4; and

FIG. 6 is a concept view for comparing the width of an inner deck of the upper structure of the cargo tank in the LNGC according to the present invention with that of an inner deck of the conventional upper structure of the cargo tank in the LNGC of FIG. 1.

Best Mode for Carrying Out the Invention

[0024] Hereinafter, a preferred embodiment of the present invention will be described in detail with reference to the accompanying drawings.

[0025] FIG. 4 is a concept view illustrating an upper structure of a cargo tank in an LNGC according to an embodiment of the present invention. FIG. 5 is a view illustrating the position of a liquid dome opening installed in the upper structure of the cargo tank in the LNGC of FIG. 4.

[0026] In FIGS. 4 and 5, the upper structure of a cargo tank in an LNGC is illustrated but the middle and lower structure of the membrane type cargo tank illustrated in FIG. 1 is not illustrated, the middle and lower structure including a double bottom plate 3 forming the bottom of the cargo tank, double inclined sections 5 obliquely extending toward the outer upper side of the double bottom

plates 3, inner side plates 7 and outer side plates 9 vertically extending upward from the double inclined sections 5 to form the side walls of the cargo tank.

[0027] An inner deck 108 according to the embodiment of the present invention is connected to ends of inner inclined plates 11 extending from the inner side plates 7 and a trunk deck 102 extending further to the right and to the left than the inner deck 108 is located above the inner deck 108. Inclined trunk sections 104 obliquely extend from the right and left ends of the trunk deck 102 to a horizontal extension line of the inner deck 108.

[0028] In the embodiment of the present invention, the inclined trunk sections 104 are inclined by ninety degrees with respect to the trunk deck 102. Accordingly, knuckle point 114 is formed at each of both ends of the inclined trunk sections 104 such that a space for equipment is easily secured. As long as the inclination angle of the inclined trunk section 104 is larger than that of the inner inclined plates 11 or the outer inclined plates 13, it can be variously determined.

[0029] Further, inner deck extensions 106 horizontally extend from both ends of the inner deck 108 to the lower ends of the inclined trunk section 104. In the embodiment of the present invention, the trunk deck 102, the inclined trunk section 104, the inner deck extensions 106, and the inner deck 108 are connected to each other to form the upper structure of the cargo tank in the shape of a rectangular box. The rectangular box-shaped upper structure of the cargo tank is connected to the upper ends of the inner inclined plates 11 and the outer inclined plates 13.

[0030] Here, it is preferable that the width of the inner deck 108 is reduced to a minimally required width range (also, referred to as "minimal requirement range") required by pipes and cargo systems that can be mounted on the upper and lower surfaces of the inner deck 108 or passing through the inner deck 108, in order to minimize the sloshing load by reducing the free surface of the liquefied natural gas in the cargo tank. FIG. 6 is a concept view for comparing the width of an inner deck of the upper structure of the cargo tank in the LNGC according to the present invention with that of an inner deck of the conventional upper structure of the cargo tank. Referring to FIG. 6, assuming that the conventional trunk deck 17 and the trunk deck 102 according to the present invention have the same width, it can be seen that the width $W1$ ($W1 = W2 + 2 \times W3$) of the conventional inner deck 15 is larger than the width Ws of the inner deck of the embodiment of the present invention. That is, according to the present invention, the free surface of the liquefied natural gas in the cargo tank is reduced such that the sloshing load is minimized.

[0031] Passage assemblies 110 are positioned on the flat upper surface of the inner deck extensions respectively. The passage assemblies 110 refer to passage structures including pipes, pipe supports for supporting the pipes, cables, cableways for arranging the cables, and passages through which workers pass.

[0032] The upper structure of the cargo tank according to the embodiment of the present invention has a wide interior space as compared with the conventional upper structure of the cargo tank illustrated in FIG. 2. Further, as a flat bottom surface is provided in the interior space, the passage assemblies 110 can be easily positioned even without using the conventional support members 62. Moreover, since the upper surfaces of the inner deck extensions 106 are flat, steel gratings that have been used as the bottom surface of the passage may not need to be manufactured.

[0033] Due to the geometric characteristics of the rectangular box-shaped structure to which the inner deck extensions 106 are added, the trunk deck 102 according to the embodiment of the present invention has a wide uppermost area as compared with the conventional trunk deck 17 illustrated in FIG. 2. In other words, the widthwise length of the trunk deck 102 is the sum of the widthwise length of the inner deck 108 and the widthwise lengths of the two inner deck extensions 106. Accordingly, the pipes can be arranged not in the conventional multilayer structure 70 illustrated in FIG. 2 but in a single structure 112. The arrangement provides a convenience in performing maintenance and repair of the pipes and a sealing test work such as a hydro test.

[0034] In addition, the uppermost areas of the trunk deck 102 according to the embodiment of the present invention are expanded as compared with the conventional one, as a result the liquid dome opening 50 can be optimally disposed on the trunk deck 102. Here, the liquid dome opening 50 is equipment functioning as a sort of an entrance for cargo for supplying liquefied natural gas into the cargo tank or withdrawing the liquefied natural gas from the cargo tank.

[0035] A plurality of reinforcing members referred to girders can be used in the trunk deck 102 for the purpose of maintaining the longitudinal strength of the hull. The girders include a center girder and side girders. The center girder is installed on the longitudinal center line of the trunk deck 102 and the side girders are disposed in parallel to each other on both sides of the center girder. The center girder and the side girders are members for enhancing the longitudinal strength of the hull.

[0036] The uppermost area of the conventional trunk deck 17 illustrated in FIGS. 2 and 3 is so narrow that the liquid dome opening 50 must intrude into the center girder of the trunk deck 17. Because of the arrangement, the continuity of the center girder is partially interrupted and the longitudinal strength of the hull decreases. However, since the trunk deck 102 according to the embodiment of the present invention that is illustrated in FIGS. 4 and 5 has a wider uppermost area as compared with the conventional trunk deck 17, the liquid dome opening 50 can be arranged not to intrude the longitudinal center line and can be disposed between the center girder and one of the side girders. This arrangement maintains the continuity of the center girder, thereby increasing the longitudinal strength of the hull. Additionally, it also increases

the torsional rigidity of the hull.

[0037] As mentioned above, in the upper structure of the cargo tank in the LNGC according to the embodiment of the present invention, as the width of the inner deck is reduced to the minimal requirement range, the sloshing load in the cargo tank can be minimized. Further, due to the geometric characteristics of the rectangular box-shaped structure, the uppermost area of the trunk deck and the lower space of the horizontal trunk deck is so sufficient that various equipments such as the passage assembly including the pipes, the cables, and the passages can be easily disposed. Furthermore, the liquid dome opening is deviated from the center girder so that the longitudinal strength of the hull can be enhanced.

[0038] In addition, in the upper structure of the cargo tank in the LNGC according to the embodiment of the present invention, since the passage assemblies can be simply positioned on the upper surfaces of the inner deck extensions, the separate support members installed in the conventional inclined spaces are unnecessary and the steel grating (about 200 M) used as the bottom surface of the passage is also unnecessary, thereby reducing the ship construction cost by shortening the work time and reducing the work cost.

[0039] Moreover, in the upper structure of the cargo tank in the LNGC according to the embodiment of the present invention, the wide uppermost area of the trunk deck as compared with the conventional one allows the arrangement of the pipes in a single layer structure, thereby providing a convenience in performing installation, maintenance, and repair of the pipes as well as various tests (e.g. hydro test).

[0040] Although the preferred embodiment of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

Claims

1. An upper structure of a cargo tank in an LNGC comprising:

an inner deck (108), both ends of which are connected to the upper ends of inner inclined plates (11) extending from inner side plates respectively;

a trunk deck (102) spaced apart from the inner deck (108) above the inner deck (108) and extending further to the right and to the left than the inner deck by a predetermined length respectively;

trunk inclined sections (104), ends of which are connected to both ends of the trunk deck and the other ends of which are located on right and left horizontal extension lines of the inner deck;

and

inner deck extensions (106) extending from both ends of the inner deck (108) to the trunk inclined sections (104) respectively.

2. The upper structure of the cargo tank according to claim 1, wherein the inner deck (108), the trunk deck (102), the trunk inclined sections (104), and the inner deck extensions (106) form a rectangular box-shaped structure.
3. The upper structure of the cargo tank according to claim 1, wherein the width of the inner deck (108) is reduced to a minimal requirement range required by pipes and cargo systems that can be mounted to the upper and lower surfaces of the inner deck (108) or can penetrate the inner deck (108).
4. The upper structure of the cargo tank according to claim 1, wherein the inclination angle of the trunk inclined sections (104) is ninety degrees downward with respect to the trunk deck (102).
5. The upper structure of the cargo tank according to claim 1, wherein passage assemblies including pipes, pipe supports, cables cableways, and passages are positioned on the upper surface of the inner deck (108) extensions respectively without using any separate support member.
6. The upper structure of the cargo tank according to one of claims 1 to 5, wherein a liquid dome opening (50) is deviated from the longitudinal center line and is eccentrically disposed on the upper surface of the trunk deck (102).
7. A LNGC comprising the upper structure of the cargo tank according to one of claims 1 to 5.

Patentansprüche

1. Eine oberer Struktur eines Ladetanks in einem LNGC, aufweisend:

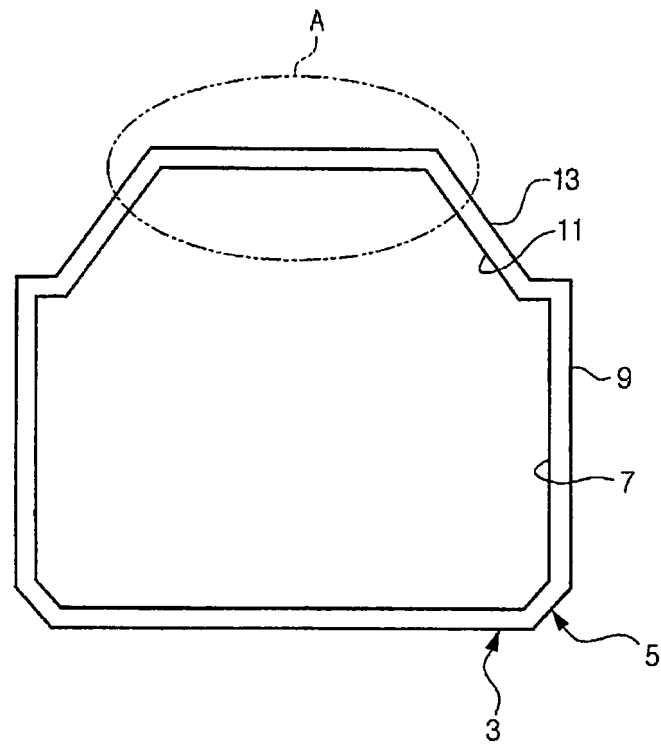
ein Innendeck (108), dessen beide Enden mit den oberen Enden von inneren geneigten Platten (11) verbunden sind, welche sich von inneren Seitenplatten aus erstrecken,

ein Raumdeck (102), welches oberhalb des Innendecks (108) im Abstand zu dem Innendeck (108) angeordnet ist und welches sich um eine vorbestimmte Länge weiter nach rechts bzw. nach links erstreckt als das Innendeck,

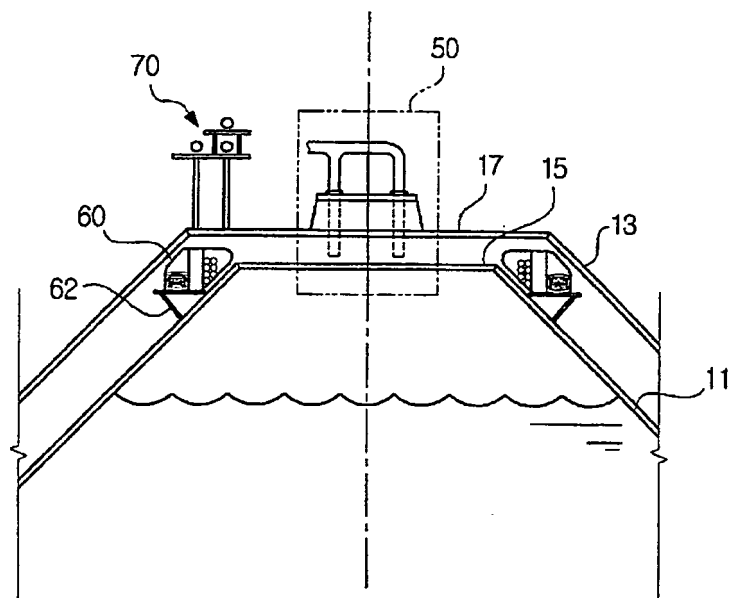
geneigte Raumabschnitte (104), von denen Enden mit den beiden Enden des Raumdecks verbunden sind und deren andere Enden an einer rechten bzw. einer linken horizontalen Verlän-

- gerungslinie des Innendecks angeordnet sind, und
Innendeckverlängerungen (106), welche sich von den beiden Enden des Innendecks (108) aus zu den jeweilig geneigten Raumabschnitten (104) hin erstrecken. 5
2. Die obere Struktur des Ladetanks gemäß Anspruch 1, wobei das Innendeck (108), das Raumdeck (102), die geneigten Raumabschnitte (104) und die Innendeckverlängerungen (106) eine Struktur bilden, welche die Form eines rechteckigen Kastens hat. 10
3. Die obere Struktur des Ladetanks gemäß Anspruch 1, wobei die Breite des Innendecks (108) auf einen minimalen Anforderungsbereich reduziert ist, welcher von Rohren und Frachtsystemen benötigt wird, welche an der oberen und der unteren Fläche des Innendecks (108) angebracht sein können oder welche das Innendeck (108) durchdringen können. 15
4. Die obere Struktur des Ladetanks gemäß Anspruch 1, wobei der Neigungswinkel der geneigten Raumabschnitte (104) neunzig Grad nach unten bezüglich des Raumdecks (102) beträgt. 25
5. Die obere Struktur des Ladetanks gemäß Anspruch 1, wobei Durchgangseinrichtungen, welche Rohre, Rohrträger, Kabel, Kabelgänge und Durchgänge aufweisen, an der oberen Fläche einer jeweiligen Innendeck-(108) -Verlängerung ohne Verwendung irgendeines separaten Stützelements angeordnet sind. 30
6. Die obere Struktur des Ladetanks gemäß einem der Ansprüche 1 bis 5, wobei eine Flüssigkeitsdomöffnung (50) von der längsverlaufenden Zentrumslinie abweicht und exzentrisch an der oberen Fläche des Raumdecks (102) angeordnet ist. 35
7. Ein LNGC, aufweisend die obere Struktur des Ladetanks gemäß einem der Ansprüche 1 bis 5. 40
- Revendications** 45
1. Structure supérieure d'une citerne à cargaison dans un LNGC comprenant :
- un pont intérieur (108), dont les deux extrémités sont reliées aux extrémités supérieures de plaques intérieures inclinées (11) s'étendant, respectivement, à partir de plaques latérales intérieures ;
un trunk-deck (102) espacé du pont intérieur (108) au-dessus du pont intérieur (108) et s'étendant, respectivement, plus loin vers la droite et vers la gauche que le pont intérieur 50
- d'une longueur prédéterminée ;
des sections inclinées de trunk (104), dont les extrémités sont reliées aux deux extrémités du trunk et dont les autres extrémités se situent sur des lignes d'extension horizontales droites et gauches du pont intérieur ; et
des extensions de pont intérieur (106) s'étendant, respectivement, à partir des deux extrémités du pont intérieur (108) vers les sections inclinées de trunk (104). 55
2. Structure supérieure de la citerne à cargaison selon la revendication 1, dans laquelle le pont intérieur (108), le trunk-deck (102), les sections inclinées de trunk (104), et les extensions de pont intérieur (106) forment une structure qui présente une forme de boîte rectangulaire.
3. Structure supérieure de la citerne à cargaison selon la revendication 1, dans laquelle la largeur du pont intérieur (108) est réduite au minimum de la plage de besoin requis par les canalisations et les dispositifs de chargement qui peuvent être montés sur les surfaces supérieure et inférieure du pont intérieur (108) ou qui peuvent pénétrer dans le pont intérieur (108).
4. Structure supérieure de la citerne à cargaison selon la revendication 1, dans laquelle l'angle d'inclinaison des sections inclinées de trunk (104) est égal à quatre-vingt-dix degrés vers le bas par rapport au trunk-deck (102).
5. Structure supérieure de la citerne à cargaison selon la revendication 1, dans laquelle des ensembles de passages incluant des canalisations, des supports de canalisations, des câbles, des chemins de câbles et des passages, sont positionnés sur la surface supérieure des extensions du pont intérieur (108), respectivement, sans utiliser des éléments de support séparés.
6. Structure supérieure de la citerne à cargaison selon l'une quelconque des revendications 1 à 5, dans laquelle une ouverture en dôme destinée au passage d'un liquide (50) est déviée de la ligne centrale longitudinale et est disposée de manière excentrique sur la surface supérieure du trunk-deck (102).
7. LNGC comprenant la structure supérieure de la citerne à cargaison selon l'une quelconque des revendications 1 à 5.

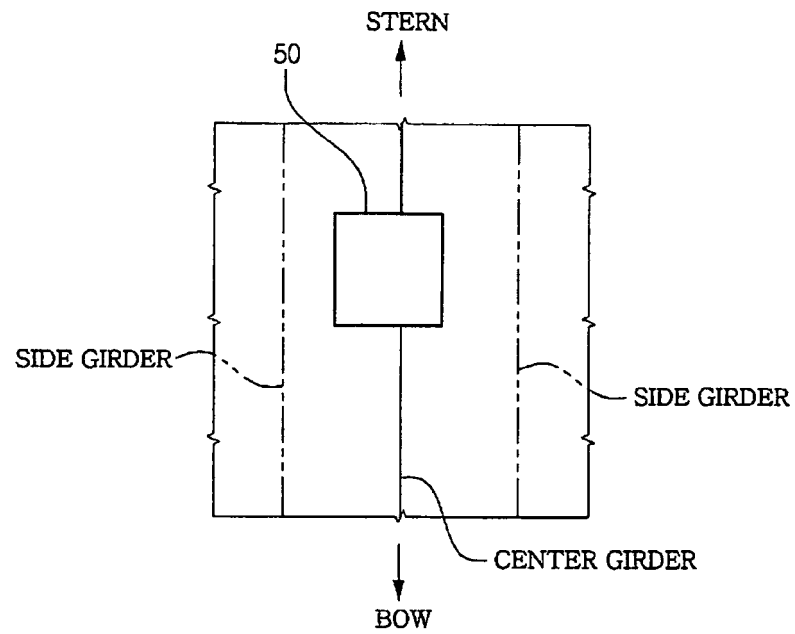
[Fig. 1]



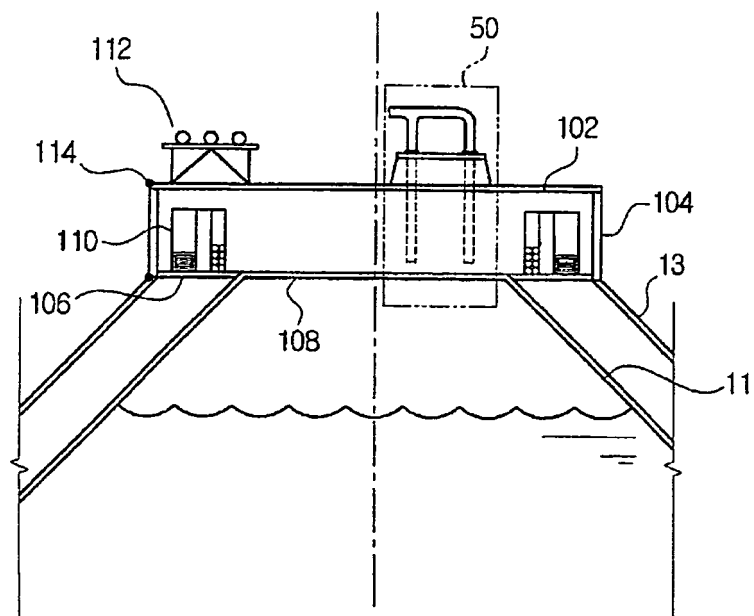
[Fig. 2]



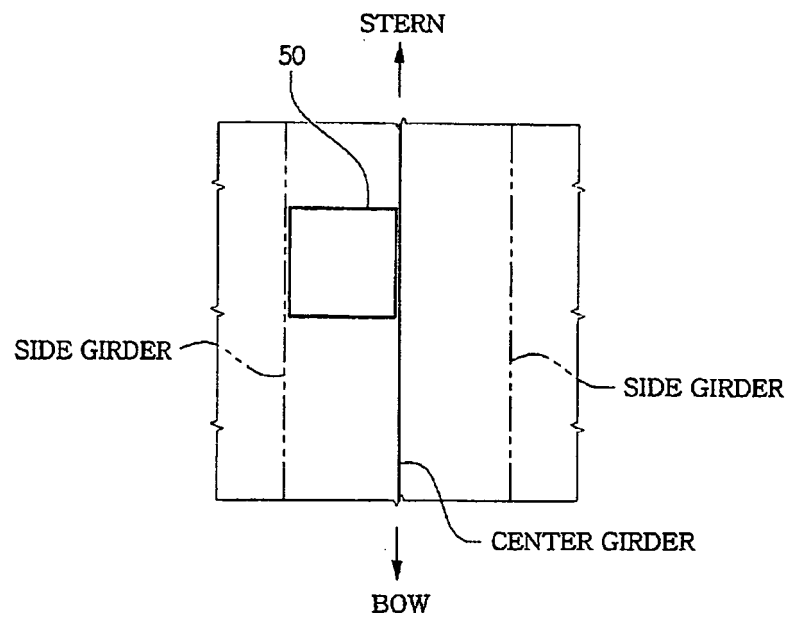
[Fig. 3]



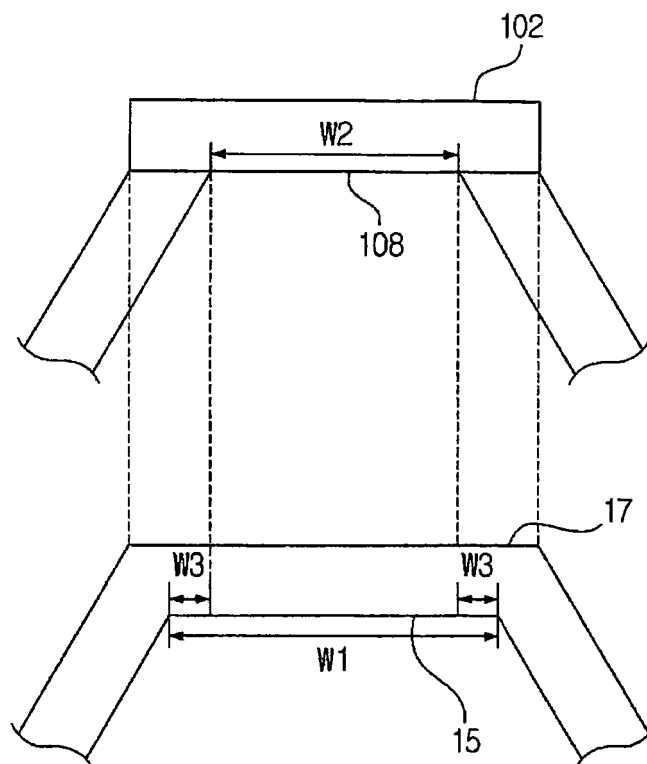
[Fig. 4]



[Fig. 5]



[Fig. 6]



REFERENCES CITED IN THE DESCRIPTION

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