Description

Title of the invention: Ship including a tank

Technical field

[1] The invention relates to the field of ships that include tanks and in particular sealed and thermally insulating membrane tanks. The invention relates in particular to the field of ships including sealed and thermally insulating tanks for the storage and/or the transport of liquefied gas at low temperature, such as tanks for the transport of liquefied petroleum gas (LPG), for example at a temperature between -50°C and 0°C inclusive, or for the transport of liquefied natural gas (LNG) at approximately -162°C at atmospheric pressure. These tanks may be installed on land or on a floating structure. The tank may be intended for the transport of liquefied gas or to receive liquefied gas serving as fuel for the propulsion of the ship.

Technological background

[2] Known from the prior art are so-called double-hull ships, namely ships including an inner hull and an outer hull. These ships can contain one or more tanks containing fuel whether for its transport or for use as fuel for the propulsion of the ship. These tanks are disposed in and fixed to the inner hull. These tanks may for example be sealed and thermally insulating membrane tanks for the storage of a liquefied gas. In this case the walls of this kind of tank include a structure consisting of multiple layers stacked in a direction of thickness and including at least one sealing membrane and at least one thermally insulating barrier situated between the inner hull and the sealing membrane.

[3] For correct functioning of these tanks, traversing elements pass through a plurality of orifices produced in the inner hull and in the tank walls. These traversing elements may for example be loading/offloading pipes or a sump structure.

[4] The inner hull includes on its external surface an array of stiffeners for stiffening the structure in order to withstand in particular the pressure of the fluid contained in the tank or tanks. This array of stiffeners is interrupted all around orifices produced in the inner hull, for example by interrupting or by vitiating the stiffeners of said array all around the orifice.

[5] Now, it has been found that the beam of a ship that includes such tanks is caused to flex in the longitudinal direction of the ship because of various factors. Indeed, the flexing of the ship beam is caused for example by the passage of the hull from its dry dock state to its floating state or by variations in the temperature of the hull between the temperature

during its production and the temperature during its use, or again by the forces exerted on the ship by the swell.

Summary

[6] The invention starts from the hypothesis that during these flexing phenomena the inner hull is subjected to high mechanical loads that come to be concentrated at the level of the orifices produced in the latter. These stress concentrations may generate deformation of said orifice, known as "ovalization" in the case of a circular orifice, which may damage the inner hull and the tank.

[7] One idea behind the invention is to limit the risk of deformation of an orifice produced in the inner hull that may damage the latter.

[8] In accordance with one embodiment, the invention provides a ship including a metal inner hull having an internal surface and an external surface, an outer hull disposed outside the inner hull facing the external surface, and at least one tank disposed in the inner hull and supported against the internal surface of the inner hull, the tank including at least one tank wall, the inner hull including a plurality of hull plates welded to one another,

the ship including at least one traversing element passing through an opening produced in the inner hull and in the wall of the tank, at least one hull plate bordering said opening;

in which the ship includes at least one metal plate including at least one orifice through which the traversing element passes, the metal plate having a thickness greater than the thickness of said at least one hull plate bordering the opening, the metal plate being welded to said at least one hull plate bordering the opening, the metal plate extending around the opening (3).

[9] Thanks to these features, because its thickness is greater than the inner hull the metal plate of the ship enables stiffening of the structure all around the orifice in order to limit its deformation upon flexing of the beam of the ship.

[10] Embodiments of a ship of this kind may have one or more of the following features.

[11] The thickness of the metal plate and of the hull plates is measured in a direction orthogonal to the external surface of the inner hull.

[12] In accordance with one embodiment, the ship includes a plurality of traversing elements passing through said opening produced in the inner hull and in said tank wall, the metal plate including an orifice for each traversing element.

[13] In accordance with one embodiment, the ship includes a plurality of traversing elements passing through a plurality of openings produced in the inner hull and in said tank wall, and the ship including a plurality of metal plates each including at least one orifice through which one of the traversing elements passes, the metal plates being spaced from one another by at least one hull plate.

[14] In accordance with one embodiment, the thickness of the metal plate is greater than or equal to 1.2 times the thickness of the at least one hull plate bordering the opening.

[15] The metal plate is therefore sufficiently thick to diffuse stresses and to stiffen the structure all around the orifice without this making unduly complicated the operation of welding between the two elements and limiting the deformations linked to welding.

[16] In accordance with one embodiment, the metal plate is made of stainless steel and the hull plates are made of carbon steel.

[17] In accordance with one embodiment, the orifice is circular and the traversing element has a circular section.

[18] In accordance with one embodiment, the ship includes a first array of stiffeners welded to an external surface of the metal plate and a second array of stiffeners welded to the external surface of the inner hull; and
the first array of stiffeners includes internal stiffeners and external stiffeners, the external stiffeners being arranged so as to form a stiffener frame all around the internal stiffeners, stiffeners of the second array of stiffeners being welded to the external stiffeners.

[19] Accordingly, just like the thickness of the metal plate, the first array of stiffeners enables stiffening of the structure all around the orifice so as to limit any deformation thereof caused for example by flexing of the ship beam. Moreover, the first array of stiffeners assures mechanical continuity with the second array of stiffeners.

[20] In accordance with one embodiment, each external stiffener is made in the form of a plate.

[21] In accordance with one embodiment, the stiffeners of the first array of stiffeners are made of stainless steel and the stiffeners of the second array of stiffeners are made of carbon steel.

[22] In accordance with one embodiment, the internal stiffeners are regularly distributed all around the traversing element.

[23] Here by "regularly distributed" is meant spaced from one another at a constant pitch, here a constant angular pitch.

[24] In accordance with one embodiment, the internal stiffeners are distributed irregularly all around the traversing element.

[25] Here by "distributed irregularly" is meant spaced from one another at a variable pitch, here a variable angular pitch.

[26] In accordance with one embodiment, the second array of stiffeners includes primary stiffeners and secondary stiffeners, each primary stiffener being formed essentially in a plane orthogonal to the external surface of the inner hull and being welded on the one hand to the inner hull and on the other hand to the outer hull, and each secondary stiffener being formed essentially in a plane orthogonal to the external surface of the inner hull and being welded to the inner hull and disposed at a distance from the outer hull.

[27] In accordance with one embodiment, the tank wall is a ceiling wall of the tank and the traversing element is a pipe.

[28] In accordance with one embodiment, the internal stiffeners are welded on the one hand to the metal plate and on the other hand to the external stiffeners.

[29] In accordance with one embodiment, the internal stiffeners are produced in gusset plate form and have a thickness increasing from the pipe toward the external stiffeners.

[30] The thickness of the stiffeners is measured in a direction orthogonal to the external surface of the inner hull.

[31] In accordance with one embodiment, the increase in the thickness of the internal stiffeners is linear, quadratic or exponential, until a thickness is reached equal to the distance between the metal plate and the outer hull.

[32] The thickness of the internal stiffeners is measured in the same manner as for the metal plate, that is to say in a direction orthogonal to the external surface of the inner hull.

[33] In accordance with one embodiment, the first array of stiffeners includes at least three internal stiffeners, preferably eight internal stiffeners, that are preferably regularly distributed all around the orifice.

[34] In accordance with one embodiment, each internal stiffener is fixed to a portion of an external stiffener, a stiffener of the second array of stiffeners being fixed to the same said portion of external stiffener.

[35] In accordance with one embodiment, the ceiling wall includes a thermally insulating barrier supported by the inner hull and a sealing membrane supported by the thermally insulating barrier, the thermally insulating barrier and the sealing membrane being

interrupted at a distance from the pipe, the sealing membrane being fixed to the metal plate by means of a connecting ring all around the pipe, the connecting ring including a portion projecting from the external surface of the metal plate so as to form a circular stiffener.

[36] In accordance with one embodiment, at least one end of the internal stiffeners is welded to the circular stiffener.

[37] In accordance with one embodiment, the external stiffeners are formed in a plane orthogonal to the external surface of the inner hull, the external stiffeners being welded on the one hand to the metal plate and on the other hand to the outer hull.

[38] In accordance with one embodiment, the internal stiffeners have a lower surface in contact with the metal plate, said surface extending from the circular stiffener as far as the external frame.

[39] In accordance with one embodiment, the internal stiffeners have a lateral surface in contact with one of the external stiffeners, said surface extending from the metal plate as far as the outer hull.

[40] In accordance with one embodiment, the tank wall is a bottom wall of the tank and the traversing element is a sump structure or a support foot for a loading/offloading mast.

[41] In accordance with one embodiment, the stiffener frame is an external stiffener frame, the internal stiffener frames includes a first stiffener group and a second stiffener group, the first stiffener group forming an internal stiffener frame all around the orifice and inside the external frame of the stiffener, the internal frame of the stiffener being welded to the external frame of the stiffener, the second stiffener group including at least two junction stiffeners, the junction stiffeners being on the one hand welded to the sump structure and on the other hand welded to the internal frame of the stiffener.

[42] In accordance with one embodiment, the stiffener frame is an external stiffener frame, the internal stiffeners include a first stiffener group, a second stiffener group and a third stiffener group, the first stiffener group forming a first stiffener frame all around the orifice and inside the external stiffener frame, the first stiffener frame being welded to the external stiffener frame, the second stiffener group forming a second stiffener frame all around the orifice and inside the first stiffener frame, the second stiffener frame being welded to the first stiffener frame, the third stiffener group including at least two junction stiffeners, the junction stiffeners being on the one hand welded to the sump structure and on the other hand welded to the second frame of the stiffener.

[43] In accordance with one embodiment, the junction stiffeners are regularly distributed all around the sump structure.

[44] In accordance with one embodiment, the third group of stiffeners includes four junction stiffeners.

[45] In accordance with one embodiment, the sump structure includes a sump bottom and the ship includes two sump stiffeners, the sump stiffeners being welded to an external surface of the sump bottom.

[46] In accordance with one embodiment, the sump stiffeners cross at the centre of the sump bottom and are oriented at 90° to one another.

[47] In accordance with one embodiment, each sump stiffener is oriented at 45° relative to one of the junction stiffeners.

[48] In accordance with one embodiment, the tank is a sealed and thermally insulating membrane tank intended for the storage of a liquefied gas.

[49] In accordance with one embodiment, the tank wall includes a multilayer structure formed in a direction of thickness from the exterior to the interior of the tank of a secondary thermally insulating barrier supported by the inner hull, a secondary sealing membrane supported by the secondary thermally insulating barrier, a primary thermally insulating barrier supported by the secondary sealing membrane, and a primary sealing membrane supported by the primary thermally insulating barrier and intended to be in contact with the liquefied gas.

[50] In accordance with one embodiment, the invention also provides a transfer system for a cold liquid product, the system including the aforementioned ship, insulated pipes arranged in such a manner as to connect the tank installed in the inner hull of the ship to a floating or terrestrial storage installation and a pump for driving a flow of cold liquid product through the insulated pipes from or to the floating or terrestrial storage installation to or form the tank of the ship.

[51] In accordance with one embodiment, the invention also provides a method for loading or offloading this kind of ship, in which a cold liquid product is routed through insulated pipes from or to a floating or terrestrial storage installation to or from the tank of the ship.

Brief description of the figures

[52] The invention will be better understood and other objects, details, features and advantages thereof will become more clearly apparent in the course of the following

description of a plurality of particular embodiments of the invention, given by way of non-limiting illustration only, with reference to the appended drawings.

[53] [Fig. 1] Figure 1 represents a cutaway side view of a double-hull ship including a plurality of tanks.

[54] [Fig. 2] Figure 2 is a perspective view of the detail II from Figure 1, the inner hull of the ship being traversed by two pipes.

[55] [Fig. 3] Figure 3 is a schematic view from above of the detail II in figure 1, the inner hull of the ship being traversed by a pipe.

[56] [Fig. 4] Figure 4 is a schematic view in section of the detail IV in Figure 1, a sump structure traversing the inner hull.

[57] [Fig. 5] Figure 5 is a schematic view from below of the detail IV from Figure 1.

[58] [Fig. 6] Figure 6 is a schematic cutaway representation of a methane tanker ship including a plurality of tanks and of a terminal for loading/offloading that tank.

Description of embodiments

[59] In the following description there will be described a ship 70 including an inner hull 1, an outer hull 2 and a plurality of storage tanks 71.

[60] Figure 1 more particularly represents a methane tanker ship 70 for the storage and the transport of liquefied gas. However, the invention is not limited to this type of ship and concerns any ship 70 with double hull 1, 2 equipped with at least one tank containing a fuel whether that be for its transport or for its use as fuel.

[61] Thus the ship 70 represented in Figure 1 includes four tanks disposed in and fixed to the inner hull 1. The inner hull 1 is produced by assembling a plurality of hull plates 16 to one another. For the proper functioning of these tanks openings 3 are provided through the inner hull 1 in order to pass equipment of the tank through them. Traversing elements, such as for example a sump structure 9 represented in particular in Figures 4 and 5 or a pipe 20 represented in particular in Figures 2 and 3 are therefore disposed inside these openings 3 in the inner hull 1.

[62] Referring to Figure 2, it is seen that the ship 70 includes a metal plate 30 in order to make the connection between the traversing element 9, 20 and the inner hull 1 at the level of the opening 3. The metal plate 30 is therefore welded to the hull plates all around the opening 3 and includes an orifice 31 through which the traversing element 9, 20 passes. The traversing element 9, 20 is fixed to the metal plate 30 all around the orifice

31. The metal plate 30 is plane and disposed substantially in the plane of the hull plates of the inner hull 1 bordering the opening 3.

[63] As described hereinabove, it is advantageous to stiffen the structure formed by the inner hull 1 and the metal plate 30 at the level of the orifices 31 in order to limit deformation of the orifice 31.

[64] To this end, the thickness of the metal plate 30 is increased compared to the thickness of the hull plates 16 of the inner hull 1 bordering the opening 3. For example, the thickness of the metal plate 30 is therefore 1.5 times greater than the thickness of the hull plates 16 bordering the opening 3. In order further to increase the stiffness of the metal plate 30 without this excessively increasing the thickness of the metal plate 30, a first stiffener array 32 is welded to the metal plate 30. The first stiffener array 32 will be described in more detail hereinafter in accordance with a plurality of embodiments according to the type of traversing element.

[65] The inner hull 1 includes on its external surface a second stiffener array 17, as can be seen in Figure 2 in particular. The second stiffener array enables stiffening of the inner hull 1 so as in particular to withstand the pressure of the fluid contained in the tank. The second stiffener array 17 includes primary stiffeners 18 and secondary stiffeners 19 alternating with one another. The primary stiffeners 18 and the secondary stiffeners 19 are developed in a first series in the longitudinal direction of the ship and equally in a second series in the transverse direction of the ship in the case of the upper and lower walls of the inner hull 1.

[66] In another embodiment, the primary stiffeners 18 are developed in the longitudinal direction and the secondary stiffeners 19 are developed in the transverse direction.

[67] Each primary stiffener 18 is formed in a plane orthogonal to the external surface of the inner hull 1 and is welded on the one hand to the inner hull 1 and on the other hand to the outer hull 2 so as to form the junction between the hulls 1, 2. Each of the secondary stiffeners 19 is equally in a plane orthogonal to the external surface of the inner hull 1, but they are smaller than the primary stiffeners 18 and are therefore welded only to the inner hull 1 and consequently disposed at a distance from the outer hull 2. The primary stiffeners 18 are in the form of plates and are advantageously provided with orifices in order to enable free circulation of operatives or of air present in the space between the inner hull 1 and the outer hull 2.

[68] Figures 2 and 3 represent embodiments in which the traversing element is a pipe 20 that passes through the upper wall of the inner hull 1 and the sealing wall of the tank 71,

Figure 2 being a particular instance in which two pipes 20 close to one another pass through the inner hull 1.

[69] In the embodiments from Figures 2 and 3 the ceiling wall 4 includes a multilayer structure, not represented, including at least one thermally insulating barrier supported by the internal surface of the inner hull 1 and at least one sealing membrane supported by the thermally insulating barrier. The thermally insulating barrier and the sealing membrane are interrupted at a distance from the pipe 20. The sealing membrane is fixed to the metal plate 30 by means of a connecting ring (not represented) all around the pipe 20. The connecting ring includes a portion projecting from the external surface of the metal plate 30 so as to form a circular stiffener 21 formed all around the pipe 20 at a distance from the latter. The circular stiffener 21 enables stiffening of the sealing membrane fixing zone in order to prevent the metal plate 30 flexing in this zone because of the stresses exerted by the sealing membrane.

[70] In Figures 2 and 3 there is represented the arrangement of the first stiffener array 32 formed on the external surface of the metal plate 30 in the case of one pipe 20. The first stiffener array 32 includes internal stiffeners 34 and external stiffeners 33. The external stiffeners 33 are produced in the form of plates and arranged so as to form a stiffener frame all around the internal stiffeners 34. The external stiffeners 33 are disposed in a plane orthogonal to the external surface of the upper wall of the inner hull 1. The external stiffeners 33 are welded on the one hand to the metal plate 30 and on the other hand to the outer hull 2. Moreover, stiffeners of the second array of stiffeners 17 are welded to the external stiffeners 33. In the embodiments represented primary stiffeners 18 of the second stiffener array 17 are fixed in line with the external stiffeners 33.

[71] As represented in Figures 2 and 3 there are eight internal stiffeners 34 regularly distributed all around the pipe 20. In fact, in this example the internal stiffeners 34 are oriented radially relative to the axis of the pipe 20 and distributed every 45°, with the reference being the axis of the pipe 20, as can be seen in Figure 3. However, the number of internal stiffeners 34 may vary in particular according to the diameter of the pipe 20 so that their number may be lower or higher, provided that they are regularly distributed all around the pipe 20.

[72] The internal stiffeners 34 are gusset plate shape and are welded to one of the external stiffeners 33, to the metal plate 30 and to the circular stiffener 21. The internal stiffeners 34 therefore a lower surface in contact with and welded to the metal plate 30. This upper surface extends from the circular stiffener 21 as far as the external stiffener 33. Moreover, the internal stiffeners 34 have a lateral surface in contact with and welded

to the external stiffeners 33. This lateral surface extends from the metal plate 30 as far as the outer hull 2. Thus in this configuration two internal stiffeners 34 are welded to each external stiffener 33. Each internal stiffener 34 is therefore fixed to a portion of an external stiffener 33 and a stiffener of the second series of stiffeners 17 is fixed at the level of this portion of the external stiffener 33 so as to be situated in line with the internal stiffener 34, as represented in Figure 3.

[73] This arrangement of the circular stiffener 21, the internal stiffeners 34, the external stiffeners 33 and the second stiffener array 17 enables continuity of the mechanical absorbing of forces and a homogeneous distribution of those forces to be assured in order to limit the deformation of the orifice 31 of the metal plate 30.

[74] The internal stiffeners 34 have a thickness increasing from the circular stiffener 21 toward the external stiffener 33 in order for optimum absorbing of the forces exerted around the orifice 31 of the metal plate 30 and transfer thereof in a homogeneous manner from the circular stiffener 21 to the external stiffeners 33. In the embodiment represented this increase is exponential and starts from a value less than the height of the circular stiffener 21 to reach a thickness equal to the distance between the metal plate 30 and the outer hull 2.

[75] In the particular case of Figure 2 in which two pipes 20 close to one another pass through the inner hull 1, the first stiffener array 32 of the first pipe 20 and the first stiffener array 32 of the second pipe 20 share the same external stiffener 33. Thus in Figure 2 two pipes 20 pass through the same opening 3 so that only one metal plate 30 is necessary. This metal plate 30 is therefore provided with two orifices 31 and two first stiffener arrays 32 are fixed thereto. As represented in Figure 2, the metal plate 30 can have a rectangular shape, this shape being able to vary according to the number of traversing elements 9, 20. For example, in the case of three traversing elements 9, 20 passing through the same metal plate 30, the latter may have an L shape.

[76] In the situation, not represented, where the two or more traversing elements 9, 20 are far apart and it is necessary to have a plurality of openings 3 in the inner hull 1 and in the tank wall 4, a metal plate 30 is provided for each of the openings 3. Each of these metal plates 30 is equally provided with the necessary number of orifices 31 according to the number of traversing elements 9,20 passing through said opening 3.

[77] Figures 4 and 5 represent an embodiment in which the traversing element is a sump structure 9 that passes through the bottom wall of the tank and the lower wall of the inner hull 1.

[78] In Figure 4 there has been diagrammatically represented the multilayer structure of the bottom wall 4 of the tank in the situation where the tank is a sealed and thermally insulating membrane tank for the storage of liquefied gas. Thus in this embodiment the walls 4 of the tank are formed by a multilayer structure fixed to supporting walls of the inner hull 1 and including two sealed membranes 5, 7 alternating with two thermally insulating barriers 6, 8. For example, such membrane tanks are described in particular in the patent applications WO14057221, FR2691520 and FR2877638 respectively relating to the Mark V ©, Mark III © and NO96 © products developed by the applicant.

[79] The tank wall 4 is mounted on the inner hull 1 of a double-hull ship 70. The tank wall 4 has a multilayer structure successively including a secondary thermal insulation barrier 8 fixed to the inner hull 1, a secondary sealing membrane 7 supported by the secondary thermal insulation barrier 8, a primary thermal insulation barrier 6 covering the secondary sealing membrane 7 and a primary sealing membrane 5 supported by the primary thermal insulation barrier 6.

[80] The sump structure 9 includes a first container 10 in communication with the interior of the tank and a second container 11 containing the first container 10. The first container 10 is connected in a continuous manner to the primary sealing membrane 5, which it therefore completes in sealed manner. Similarly, the second recipient 11 is connected in a continuous manner to the secondary sealing membrane 7, which it therefore completes in sealed manner. The connection between the first container 10 and the primary sealing membrane 5 is made by means of a first flange 13 while the connection between the second container and the secondary sealing membrane 7 is made by means of a second flange 14.

[81] The sump structure 9 is equally provided with a rigid container 12 that comes to be fixed all around the metal plate 30 at the level of the orifice 31. The first and second containers 10, 11 are situated inside the rigid container 12. The rigid container 12, the first container 10 and the second container 11 are for example coaxial cylindrical containers as represented in Figure 4. The second container 11 is fixed by means of fixing flanges 15 to the metal plate 30. The fixing flanges 15 may advantageously have a degree of freedom of movement in translation corresponding to a radial direction of the second container 11 so as to allow thermal contraction and expansion thereof.

[82] In the embodiment from Figures 4 and 5, and in the same manner as for the embodiments from Figures 2 and 3, the first stiffener array 32 includes internal stiffeners 35, 36, 37 and external stiffeners 33. The external stiffeners 33 are produced in the form of plates and arranged so as to form an external stiffener frame all around the internal

stiffeners 35, 36, 37. The external stiffeners 33 are disposed in a plane orthogonal to the external surface of the upper wall of the inner hull 1. The external stiffeners 33 are welded on the one hand to the metal plate 30 and on the other hand to the outer hull 2. Moreover, stiffeners of the second array of stiffeners 17 are welded to the external stiffeners 33. In the embodiment represented primary stiffeners 18 of the second stiffener array 17 are fixed in line with the external stiffeners 33. Thus the external stiffeners 33 are arranged in the same manner as in the embodiments from Figures 2 and 3. However, the arrangement of the primary stiffeners 35, 36, 37 in the embodiment from Figures 4 and 5 is different.

[83] As illustrated in Figure 5 in particular, the internal stiffeners 35, 36, 37 include a first stiffener group 35, a second stiffener group 36 and a third stiffener group 37. The first stiffener group 35 forms a first stiffener frame 35 all around the orifice 31 and inside the external stiffener frame 33. The first stiffener frame 35 is welded to the external stiffener frame 33 in line with the stiffeners 35 so as to come to be fixed to the external stiffeners 33. The second stiffener group 36 equally forms a second stiffener frame 36 all around the orifice 31 and inside the first stiffener frame 35. In the same manner as the first frame 35, the second stiffener frame 36 is welded to the first stiffener frame 35 in line with the stiffeners 36.

[84] Finally, the third stiffener group 37 includes two junction stiffeners 37. The junction stiffeners 37 are on the one hand welded to the rigid container 12 of the sump structure 9 and on the other hand welded to the second stiffener frame 36. The junction stiffeners 37 are situated on respective opposite sides of the rigid container 12. In the same manner as for the internal stiffeners 34 from Figure 2, the junction stiffeners 37 may advantageously have a thickness increasing from the rigid container 12 toward the second stiffener frame 36 in order for optimum absorbing of the forces exerted around the orifice 31 of the metal plate 30 and to transfer them homogeneously from the rigid container 12 as far as the external stiffeners 33 via the various groups of internal stiffeners 35, 36, 37.

[85] The sump structure 9 includes a sump bottom 38 to which are welded two sump stiffeners 39. The sump stiffeners 39 are welded to an external surface of the sump bottom 38. The sump stiffeners 39 are disposed in a plane orthogonal to the external surface of the sump bottom 38. In the embodiment represented in Figure 5 the sump stiffeners 39 cross at the centre of the sump bottom 38 and are oriented at 90° relative to one another. Moreover, each sump stiffener 39 is oriented at 45° relative to the junction stiffeners 37.

[86] Referring to figure 6, a cutaway of a methane tanker ship 70 shows a sealed and insulated tank 71 of prismatic general shape mounted in the double hull 72 of the ship. The double hull 72 includes an inner hull 1 and an outer hull 2. The wall of the tank 71 includes a primary sealed barrier intended to be in contact with the LNG contained in the tank, a secondary sealed barrier arranged between the primary sealed barrier and the double hull 72 of the ship, and two insulating barriers respectively arranged between the primary sealed barrier and the secondary sealed barrier and between the secondary sealed barrier and the double hull 72.

[87] In a manner known in itself loading/offloading pipes 73 disposed on the top deck of the ship may be connected by means of appropriate connectors to a maritime or harbour terminal to transfer a cargo of LNG from or to the tank 71.

[88] Figure 6 shows an example of a maritime terminal including a loading and offloading station 75, an underwater pipe 76 and a terrestrial installation 77. The loading and offloading station 75 is a fixed off-shore installation including a mobile arm 74 and a tower 78 that supports the mobile arm 74. The mobile arm 74 carries a bundle of insulated flexible tubes 79 that can be connected to the loading/offloading pipes 73. The orientable mobile arm 74 adapts to all methane tanker loading gauges. A connecting pipe that is not shown extends inside the tower 78. The loading and offloading station 75 enables loading and offloading of the methane tanker 70 from or to the terrestrial installation 77. The latter includes liquefied gas storage tanks 80 and connecting pipes 81 connected via the underwater pipe 76 to the loading or offloading station 75. The underwater pipe 76 enables transfer of the liquefied gas between the loading or offloading station 75 and the terrestrial installation 77 over a great distance, for example 5 km, which enables the methane tanker ship 70 to remain at a great distance from the coast during loading and offloading operations.

[89] Pumps onboard the ship 70 and/or pumps equipping the terrestrial installation 77 and/or pumps equipping the loading and offloading station 75 are used to generate the pressure necessary to transfer the liquefied gas.

[90] Although the invention has been described in connection with a plurality of particular embodiments, it is obvious that it is in no way limited to them and that it encompasses all technical equivalents and combinations of the means described if the latter fall within the scope of the invention defined by the claims.

[91] The use of the verb "to include" or "to comprise" and conjugate forms thereof do not exclude the presence of elements or other steps other than those stated in a claim.

[92] In the claims, any reference sign between parentheses should not be interpreted as a limitation of the claim.

Claims

[Claim 1] Ship (70) including a metal inner hull (1) having an internal surface and an external surface, an outer hull (2) disposed outside the inner hull (1) facing the external surface, and at least one tank (71) disposed in the inner hull (1) and supported against the internal surface of the inner hull (1), the tank including at least one tank wall (4), the inner hull (1) including a plurality of hull plates (16) welded to one another,

the ship (70) including at least one traversing element (9, 20) passing through an opening (3) produced in the inner hull (1) and in the wall (4) of the tank, at least one hull plate (16) bordering said opening (3);

in which the ship (70) includes at least one metal plate (30) including at least one orifice (31) through which the traversing element (9, 20) passes, the metal plate (30) having a thickness greater than the thickness of said at least one hull plate (16) bordering the opening (3), the metal plate (30) being welded to said at least one hull plate (16) bordering the opening (3), the metal plate (30) extending around the opening (3).

[Claim 2] Ship (70) according to Claim 1, in which the thickness of the metal plate (30) is greater than or equal to 1.2 times the thickness of the at least one hull plate (16) bordering the opening (3).

[Claim 3] Ship (70) according to Claim 1 or Claim 2, in which the metal plate (30) is made of stainless steel and the hull plates (16) are made of carbon steel.

[Claim 4] Ship (70) according to any one of Claims 1 to 3, in which the orifice (31) is circular and the traversing element (9, 20) has a circular section.

[Claim 5] Ship (70) according to any one of Claims 1 to 4, in which the ship (70) includes a first array of stiffeners (32) welded to an external surface of the metal plate (30) and a second array of stiffeners (17) welded to the external surface of the inner hull (1); and

in which the first array of stiffeners (32) includes internal stiffeners (34, 35, 36, 37) and external stiffeners (33), the external stiffeners (33) being arranged so as to form a stiffener frame all around the internal stiffeners (34, 35, 36, 37), stiffeners of the second array of stiffeners (17) being welded to the external stiffeners (33).

[Claim 6] Ship (70) according to Claim 5, in which the stiffeners of the first array of stiffeners (32) are made of stainless steel and the stiffeners of the second array of stiffeners (17) are made of carbon steel.

[Claim 7] Ship (70) according to Claim 5 or Claim 6, in which the internal stiffeners (34, 35, 36, 37) are regularly distributed all around the traversing element (9, 20).

[Claim 8] Ship according to Claim 5 or Claim 6, in which the internal stiffeners (34, 35, 36, 37) are irregularly distributed all around the traversing element (9, 20).

[Claim 9] Ship (70) according to any one of Claims 5 to 8, in which the second array of stiffeners (17) includes primary stiffeners (18) and secondary stiffeners (19), each primary stiffener (18) being formed essentially in a plane orthogonal to the external surface of the inner hull (1) and being welded on the one hand to the inner hull (1) and on the other hand to the outer hull (2), and each secondary stiffener (19) being formed essentially in a plane orthogonal to the external surface of the inner hull (1) and being welded to the inner hull (1) and disposed at a distance from the outer hull (2).

[Claim 10] Ship (70) according to any one of Claims 5 to 9, in which the internal stiffeners (34) are welded on the one hand to the metal plate (30) and on the other hand to the external stiffeners (33).

[Claim 11] Ship (70) according to any one of Claims 5 to 10, in which the internal stiffeners (34) are made in gusset plate form and have a thickness increasing from the traversing element (20) toward the external stiffeners (33).

[Claim 12] Ship (70) according to any one of Claims 5 to 11, in which the first array of stiffeners (32) includes at least three internal stiffeners (34) regularly distributed all around the orifice (31).

[Claim 13] Ship (70) according to any one of Claims 5 to 12, in which each internal stiffener (34) is fixed to a portion of an external stiffener (33), a stiffener of the second array of stiffeners (17) being fixed to the same said portion of external stiffener (33).

[Claim 14] Ship (70) according to any one of Claims 1 to 13, in which the tank wall (4) is a ceiling wall of the tank and the traversing element is a pipe (20).

[Claim 15] Ship (70) according to Claim 14, in which the ceiling wall (4) includes a thermally insulating barrier (8) supported by the inner hull (1) and a sealing membrane (7) supported by the thermally insulating barrier (8), the thermally insulating barrier (8) and the sealing membrane (7) being interrupted at a distance from the pipe (20), the sealing membrane being fixed to the metal plate (30) by means of a connecting ring all around the pipe (20), the connecting ring including a portion projecting from the external surface of the metal plate (30) so as to form a circular stiffener (21).

[Claim 16] Ship (70) according to Claim 15 prise in combination with any one of Claims 5 to 13, in which at least one end of the internal stiffeners (34) is welded to the circular stiffener (21).

[Claim 17] Ship (70) according to any one of Claims 1 to 13, in which the tank wall (4) is a bottom wall of the tank and the traversing element is a sump structure (9).

[Claim 18] Ship (70) according to any one of Claims 1 to 17, in which the tank (71) is a sealed and internally insulating membrane tank intended for the storage of a liquefied gas.

[Claim 19] Transfer system for a cold liquid product, the system including a ship (70) according to any one of Claims 1 to 18, insulated pipes (73, 79, 76, 81) arranged in such a manner as to connect the tank (71) installed in the inner hull (1) of the ship (70) to a floating or terrestrial storage installation (77) and a pump for driving a flow of cold liquid product through the insulated pipes from or to the floating or terrestrial storage installation to or form the tank of the ship (70).

[Claim 20] Method for loading or offloading a ship (70) according to any one of Claims 1 to 18, in which a cold liquid product is routed through insulated pipes (73, 79, 76, 81) from or to a floating or terrestrial storage installation (77) to or from the tank (71) of the ship.