

Description

Title of the invention: Sealed and thermally insulated tank

Technical field

[0001] The invention relates to the field of sealed and thermally insulated tanks with
5 membranes. In particular, the invention relates to the field of sealed and thermally
insulated tanks for storing and/or transporting liquefied gas at low temperatures, such as
tanks for transporting Liquefied Petroleum Gas (also known as LPG) at a temperature of
between -50°C and 0°C for example, or for transporting Liquefied Natural Gas (LNG) at
10 approximately -162°C at atmospheric pressure. These tanks can be installed onshore or
on a floating structure. In the case of a floating structure, the tank may be designed to
transport liquefied gas or to receive liquefied gas used as fuel for propelling the floating
structure.

Technical background

[0002] It is known from document WO 2011/157915 A1 that sealed and thermally insulated
15 tanks for storing and/or transporting liquefied gas comprise at least one sealing membrane
which is in contact with the liquefied gas. These tanks can be provided with a
loading/offloading tower or, more simply, with loading and offloading lines running through
the ceiling wall of the tank in order to reach the internal space of the tank in order to load
or offload liquefied gas to or from the tank.

20 [0003] In the case of a loading/offloading tower, this includes a structure formed of a plurality
of masts connected to each other at a lower end by means of a base. The
loading/offloading tower also has a guide device which is fixed to the lower face of the
base and which cooperates with a support foot which passes through the bottom wall of
the tank and is fixed to the load-bearing structure.

25 [0004] Pumps, particularly offloading pumps, are attached inside the tank to the
loading/offloading tower, to the loading and offloading lines or to the support foot. In order
to limit the volume of liquid that cannot be offloaded from the tank, the lower end of the
offloading pump is located as close as possible to the sealing membrane at a predefined
distance, of the order of a few centimetres.

30 [0005] Furthermore, in WO 2011/157915 A1, the sealing membrane in contact with the
liquefied gas is a corrugated metal sealing membrane having a first series of parallel
corrugations in a first direction and a second series of parallel corrugations in a second
direction.

[0006] In document WO 2023/094330 A1, it was proposed to have an area on the sealing membrane without one of the series of corrugations in line with the offloading pump, the absence of the corrugations of this series of corrugations in this region enabling the spacing between the sealing membrane and the internal element to be adjusted, in order to optimize the volume pumped.

[0007] However, the design of the sealing membrane in document WO 2023/094330 A1 leads to the manufacture of corrugated metal sheets on which a corrugation of this series of corrugations remains. Such corrugated metal sheets are difficult and expensive to manufacture.

10 Summary

[0008] One idea behind the invention is to ensure that the sealing membrane can be manufactured simply and inexpensively, thanks to the arrangement of corrugated metal sheets.

[0009] According to one embodiment, the invention provides a sealed and thermally insulated tank incorporated in a load-bearing structure including a load-bearing wall, said tank including a tank wall fixed to the load-bearing wall of the load-bearing structure, wherein the tank wall includes, in a thickness direction from the outside to the inside of the tank, a thermally insulating barrier and a sealing membrane supported by the thermally insulating barrier and intended to be in contact with a fluid contained in the tank,

the sealing membrane including a plurality of membrane portions that are juxtaposed and welded to each other, the plurality of membrane portions comprising at least one regular membrane portion, the regular membrane portion having a series of parallel first corrugations extending in a first direction and spaced apart by a first wave pitch in a second direction, the second direction being orthogonal to the first direction, and a series of parallel second corrugations extending in the second direction and spaced apart by a second wave pitch in the first direction,

the tank including a through-element passing through the tank wall,

the through-element being centred on the intersection between a first directrix extending in the first direction and located between directrices of two of said first corrugations and a second directrix extending in the second direction and located between a first and a second of said second corrugations,

the second directrix dividing the plane of the load-bearing wall into a first half-plane and a second half-plane, the first of said second corrugations being located in the first half-plane and the second of said second corrugations being located in the second half-plane,

the plurality of membrane portions being interrupted at a polygonal window surrounding

the through-element to allow the through-element to pass, the window interrupting the directrices of said two first corrugations and interrupting the directrices of the first of said second corrugations and the second of said second corrugations,

the sealing membrane comprising at least one closure plate sealingly connecting the plurality of membrane portions to the through-element,

the plurality of membrane portions comprising, around the window, a plurality of corrugated metal sheets, the corrugated metal sheets having sides parallel to the first direction and the second direction respectively, the plurality of corrugated metal sheets comprising, in the second half-plane:

- a first rectangular metal sheet having a width greater than or equal to 4 times the first wave pitch in the second direction, the first rectangular metal sheet being disposed on the first directrix and symmetrically with respect to the first directrix, the first rectangular metal sheet including a first indented edge facing the through-element,

- two second singular rectangular metal sheets having a width greater than or equal to 2 times the first wave pitch in the second direction and a length of 1 times the second wave pitch in the first direction, and

- two third singular rectangular metal sheets having a width greater than or equal to 3 times the first wave pitch in the second direction and a length of 1 times the second wave pitch in the first direction, and symmetrical to each other with respect to the first directrix,

the second singular rectangular metal sheets being disposed on either side of the window and each welded to the first rectangular metal sheet,

the third singular rectangular metal sheets being disposed on either side of the first metal sheet and each welded to one of the second singular rectangular metal sheets and to the first rectangular metal sheet,

wherein the first rectangular metal sheet extends said two first corrugations as far as the at least one closure plate,

wherein the first rectangular metal sheet, the second singular rectangular metal sheets and the third singular rectangular metal sheets extend others of said first corrugations on either side of the window,

wherein the second of said second corrugations is absent from the second singular rectangular metal sheets, and a third of said second corrugations is absent from the third singular rectangular metal sheets.

[0010] Through these features, it is possible to obtain two regions of the sealing membrane adjacent to the through-element and devoid of second corrugations. An internal element, such as an offloading pump, can therefore be disposed in line with and at a distance from each of these regions in an internal space of the tank. The absence of the second

corrugations makes it possible to adapt the spacing between the sealing membrane and the offloading pump in order to optimize the volume of cargo that can be pumped, as described in document WO 2023/094330 A1.

[0011] In addition, because of their dimensions in the first direction, the second singular rectangular metal sheets and the third singular rectangular metal sheets are entirely devoid of second corrugations. As a result, either a corrugated metal sheet is provided with second corrugations spaced at the second wave pitch along its entire length in the first direction, or a corrugated metal sheet is entirely devoid of second corrugations. This is advantageous from an economic and industrial point of view, as it is difficult and costly to manufacture corrugated metal sheets with the second corrugations along only part of their length in the first direction.

[0012] In summary, the sealed and thermally insulated tank allows the spacing between the sealing membrane and an internal element such as an offloading pump to be adapted, while ensuring that the sealing membrane can be manufactured simply and at a moderate cost.

[0013] According to some embodiments, such a sealed and thermally insulated tank can include one or more of the following features.

[0014] According to one embodiment, the first wave pitch and the second wave pitch are equal.

[0015] According to one embodiment, the first rectangular metal sheet has a width of $N1$ times the first wave pitch in the second direction, where $N1$ is an integer greater than or equal to 4. Preferably, $N1$ is an even integer, which allows the first rectangular metal sheet both to be disposed symmetrically with respect to the first directrix and to extend the first corrugations on either side of the window, without the need to offset these first corrugations in the first half-plane. More preferably, $N1 = 4$.

[0016] According to one embodiment, the first rectangular metal sheet has a length of $M1$ times the second wave pitch in the first direction, where $M1$ is a non-zero integer.

[0017] According to one embodiment, the third singular rectangular metal sheets have a width of $N3$ times the first wave pitch in the second direction, where $N3$ is an integer greater than or equal to 3.

[0018] By providing that the sheets have dimensions equal to integer multiples of the first wave pitch and the second wave pitch, the sheets can be manufactured at a moderate cost.

[0019] According to one embodiment, the two second singular rectangular metal sheets have a width of between 2 times and 4 times the first wave pitch in the second direction, and $N3 = 3$.

[0020] Thus, the second singular rectangular metal sheets and the third singular rectangular metal sheets are small in size in the first direction and the second direction, so that they retain sufficient adaptability to thermal contraction/expansion despite the absence of the second corrugations.

[0021] According to one embodiment, the first directrix is equidistant from the directrices of said two first corrugations.

[0022] According to one embodiment, the second directrix is equidistant from the directrices of said two second corrugations.

[0023] According to one embodiment, an edge of the second singular rectangular metal sheets parallel to the second direction and an edge of the third singular rectangular metal sheets parallel to the second direction delimit a first overlap region, said first overlap region being anchored to the thermally insulating barrier over only part of its length.

[0024] According to one embodiment, an inner surface of the thermally insulating barrier forms a support surface for the sealing membrane and carries metal anchoring plates intended to be welded to the membrane portions in order to hold said plurality of membrane portions against said support surface, and the metal anchoring plates comprise first metal anchoring plates located in the second half-plane in line with the first overlap region, the first overlap region being welded to the first metal anchoring plates.

[0025] According to one embodiment, the thermally insulating barrier comprises a plurality of juxtaposed insulating panels each having an inner face which forms the support surface for the sealing membrane, the insulating panels having rectangular parallelepiped shapes with sides parallel to the first direction and the second direction respectively of the plane of the load-bearing wall and with projected dimensions in the plane of the load-bearing wall that are substantially equal to integer multiples of the first wave pitch in the second direction and to integer multiples of the second wave pitch in the first direction.

[0026] The first metal anchoring plates are used to anchor the second singular rectangular metal sheets and the third singular rectangular metal sheets to the thermally insulating barrier by welding, without risking damage to the insulating panels. The absence of second corrugations by means of the second singular rectangular metal sheets and the third singular rectangular metal sheets with length in the first direction of 1 times the second wave pitch, poses no difficulty with regard to the manufacture of the tank.

[0027] According to one embodiment, the metal anchoring plates comprise second metal anchoring plates located in the second half-plane, one edge of the first rectangular metal sheet parallel to the second direction and opposite the first indented edge of the first rectangular metal sheet in the first direction being welded to the second metal anchoring plates.

[0028] According to one embodiment, the plurality of corrugated metal sheets comprises, in the first half-plane, an indented rectangular metal sheet having a width greater than or equal to 6 times the first wave pitch in the second direction and a length greater than or equal to 3 times the second wave pitch in the first direction, the indented rectangular metal sheet having an indented edge facing the through-element, the second singular rectangular metal sheets are each welded to the indented rectangular metal sheet, and the indented rectangular metal sheet extends said two first corrugations and the first of said second corrugations as far as the at least one closure plate, and extends the others of said first corrugations on either side of the window.

[0029] In one embodiment, the indented rectangular metal sheet has a width of N_4 times the first wave pitch in the second direction, where N_4 is an integer greater than or equal to 6.

[0030] According to one embodiment, the indented rectangular metal sheet has a length of M_4 times the second wave pitch in the first direction, where M_4 is an integer greater than or equal to 3.

[0031] Preferably, $N_4 = 6$ or 7 and $M_4 = 3$, which makes it possible to manufacture the indented rectangular metal sheet without excessive extra cost.

[0032] According to one embodiment, an edge of the indented rectangular metal sheet parallel to the second direction and an edge of the second singular rectangular metal sheets parallel to the second direction delimit a second overlap region, the second overlap region being anchored to the thermally insulating barrier over part of its length.

[0033] In one embodiment, the metal anchoring plates further comprise third metal anchoring plates disposed on the second directrix, the second overlap region being welded to the third metal anchoring plates.

[0034] According to one embodiment, the first rectangular metal sheet has a length of 2 times the second wave pitch in the first direction (in other words, $M_1 = 2$) and includes a corrugation portion extending said third of said second corrugations between the two third singular rectangular metal sheets, each third singular rectangular metal sheet being sealingly connected to the corrugation portion.

[0035] According to one embodiment, the first rectangular metal sheet is a first singular rectangular metal sheet, said third of said second corrugations being absent from the first singular rectangular metal sheet.

5 [0036] According to one embodiment, the first singular rectangular metal sheet has a length of 1 times the second wave pitch in the first direction (in other words, $M1 = 1$).

[0037] According to one embodiment, the second singular rectangular metal sheets each comprise a second indented edge facing the through-element and extending the first indented edge of the first rectangular metal sheet.

10 [0038] According to one embodiment, the first singular rectangular metal sheet has a length of 2 times the second wave pitch in the first direction (in other words, $M1 = 2$) and is welded to each of the second singular rectangular metal sheets at a distance from the window.

[0039] According to one embodiment, the first corrugations have a height in the thickness direction of the tank wall which is less than a height in the thickness direction of the tank wall of the second corrugations.

15 [0040] According to one embodiment, the sealing membrane comprises a first closure plate in the first half-plane and a second closure plate in the second half-plane, the first closure plate and the second closure plate surrounding the through-element. According to one embodiment, in this case, the first indented edge of the first rectangular metal sheet is welded in a sealed manner to the second closure plate, and the second indented edge of
20 the indented rectangular metal sheet is welded in a sealed manner to the first closure plate. The indented rectangular metal sheet can extend said two first corrugations and the first of said two second corrugations to first end pieces sealingly connected to the first closure plate. The first rectangular metal sheet can extend said two first corrugations as far as second end pieces sealingly connected to the second closure plate.

25 [0041] According to one embodiment, the tank comprises an internal space bounded by the sealing membrane, the tank including an internal element located in the internal space of the tank,
the internal element being located in line with and spaced apart in the thickness direction of the tank wall from one said second singular rectangular metal sheet and one said third
30 singular rectangular metal sheet adjacent to said second singular rectangular metal sheet.

[0042] According to one embodiment, the tank comprises a loading/offloading tower and an offloading pump attached to the loading/offloading tower, the through-element being a support foot for the loading/offloading tower that the tank includes.

[0043] According to one embodiment, the loading/offloading tower comprises a plurality of masts connected at a lower end to one another by means of a base, the base including a guide device cooperating with the support foot, the support foot being configured to ensure vertical translational guidance of the loading/offloading tower.

5 [0044] According to one embodiment, the internal element located in line with and spaced apart in the thickness direction of the tank wall from one said second singular rectangular metal sheet and one said third singular rectangular metal sheet adjacent to said second singular rectangular metal sheet is formed by the offloading pump.

10 [0045] As mentioned above, the absence of second corrugations on the second singular rectangular metal sheets and the third singular rectangular metal sheets enables the spacing between the sealing membrane and the offloading pump to be adjusted in order to optimize the volume of cargo that can be pumped.

[0046] According to one embodiment, the internal element is connected to the support foot.

15 [0047] The corrugated metal sheets can be made in several ways. According to one embodiment, a said corrugated metal sheet is formed in one piece, for example by folding an initially flat metal panel. According to another embodiment, a said corrugated metal sheet is made up of a plurality of parts welded together.

20 [0048] According to one embodiment, one or more or each of the corrugated metal sheets selected from: the first rectangular metal sheet, the two second rectangular metal sheets and the two third rectangular metal sheets, includes a plurality of parts welded together.

25 [0049] In one embodiment, the liquefied gas is LNG, i.e. a mixture with a high methane content stored at a temperature of approximately -162°C at atmospheric pressure. Other liquefied gases can also be considered, in particular ethane, propane, butane or ethylene. Liquefied gases can also be stored under pressure, for example at a gauge pressure of between 2 and 20 bar, and in particular at a gauge pressure of around 2 bar. The tank can be produced according to various techniques, in particular in the form of a tank with integrated membrane or a self-supporting tank.

30 [0050] Such a tank may form part of an onshore storage facility, for example for storing LNG, or be installed in a floating, coastal or deep-water structure, in particular an LNG carrier, a floating storage and regasification unit (FSRU), a floating production storage and offloading (FPSO) unit and others. Such a tank can also be used as a fuel tank in any type of ship.

[0051] According to one embodiment, a ship for transporting a liquefied gas includes a double hull and an aforementioned tank disposed in the double hull.

[0052] According to one embodiment, the invention also provides a transfer system for a liquefied gas, the system including the aforementioned ship, insulated pipes arranged to connect the tank of the ship to a floating or onshore storage facility, and a pump for driving a flow of liquefied gas through the insulated pipes from or to the floating or onshore storage facility, to or from the tank of the ship.

[0053] According to one embodiment, the invention also provides a method for loading or offloading such a ship, wherein a liquefied gas is conveyed through insulated pipes from or to a floating or onshore storage facility, to or from the tank of the ship.

Brief description of the figures

[0054] The invention will be better understood and other objectives, details, features and advantages of the invention will appear more clearly in the course of the following description of several particular embodiments of the invention, given by way of illustration only and non-limiting, with reference to the accompanying drawings.

[0055] [Fig. 1] Figure 1 shows a partial schematic cross-section of a sealed and thermally insulated tank in the region of a support foot.

[0056] [Fig. 2] Figure 2 is a view of detail II of Figure 1.

[0057] [Fig. 3] Figure 3 is a partial top view of a bottom wall at a support foot according to a first embodiment.

[0058] [Fig. 4] Figure 4 is a partial top view of a thermally insulating barrier disposed beneath the sealing membrane visible in Figure 3.

[0059] [Fig. 5] Figure 5 is a partial top view of a bottom wall at a support foot according to a second embodiment.

[0060] [Fig. 6] Figure 6 is a partial top view of a thermally insulating barrier disposed beneath the sealing membrane visible in Figure 5.

[0061] [Fig. 7] Figure 7 is a partial top view of a bottom wall at a support foot according to a third embodiment.

[0062] [Fig. 8] Figure 8 is a partial top view of a thermally insulating barrier disposed beneath the sealing membrane visible in Figure 7.

[0063] [Fig. 9] Figure 9 is a sketch-like schematic representation of an LNG carrier and a terminal for loading/offloading this tank.

Description of the embodiments

- [0064] Figure 1 shows part of a sealed and thermally insulated tank 71 for storing and/or transporting liquefied gas, consisting of a bottom wall 1 fixed to the inner surface of a load-bearing structure 2. The load-bearing structure 2 is, for example, the inner hull of a double-hulled ship or a structure located onshore. In order to contain a cold liquid such as LNG, the tank walls include at least one sealing membrane 4 and at least one thermally insulating barrier 3 located between the sealing membrane 4 and the load-bearing structure 2. As a safety measure, a secondary sealing membrane and a secondary thermally insulating barrier (not shown) can be provided between the load-bearing structure and the thermally insulating barrier 3, which is referred to as primary in this case.
- [0065] The liquefied gas to be stored in the tank 71 may be, in particular, liquefied natural gas (LNG), i.e. a gaseous mixture including mainly methane and one or more other hydrocarbons. The liquefied gas can also be ethane or liquefied petroleum gas (LPG), i.e. a mixture of hydrocarbons produced by refining petroleum, including mostly propane and butane.
- [0066] The tank 71 can be produced in various well-known geometries, for example a prismatic geometry in the hull of a ship or a cylindrical geometry onshore or elsewhere. Furthermore, there are many methods available for producing thermally insulating barriers and sealing membranes, for example from prefabricated elements.
- [0067] In the bottom wall 1 of the tank, an elongated rigid element is shown, constituting a support foot 5, which extends through the thermally insulating barrier 3 and the sealing membrane 4, so that one part of the support foot 5 abuts against the load-bearing structure 2 and another part projects into the tank at a distance from the sealing membrane 4. The support foot 5 can be used, for example, to support a piece of equipment 7 before being immersed in the tank. For example, in order to support an offloading pump 7, a loading/offloading tower 6 can be disposed in the tank as shown schematically in Figure 1. Instead of a loading/offloading tower 6, the tank 71 can include loading and offloading lines that are not connected to one another and are guided by the support foot 5.
- [0068] In the case of a loading/offloading tower 6, this includes a structure formed from a plurality of masts connected to each other at a lower end by means of a base. The loading/offloading tower 6 also includes a guide device that is fixed to the lower face of the base and which cooperates with the support foot 5.
- [0069] The support foot 5 is designed to guide the loading/offloading tower 6 (or only the loading and offloading lines) in vertical translation, the offloading pump 7 being fixed to the loading/offloading tower 6 or directly to the support foot 5.

[0070] Here, the support foot 5 is circular in cross-section, with a frustoconical lower part 8 which connects at its smaller-diameter end to a cylindrical upper part 9. The larger-diameter base of the frustoconical part 8 rests against the load-bearing structure 2. The frustoconical part 8 extends through the thickness of the bottom wall 1 and beyond the sealing membrane 4.

[0071] In a manner not shown in Figure 1 and Figure 2, the thermal insulating barrier 3 comprises a plurality of rectangular parallelepiped insulating blocks juxtaposed with one another. These insulating blocks are described in more detail below.

[0072] With reference to Figure 2 and Figure 3, the sealing membrane 4 comprises a plurality of corrugated metal sheets. The corrugated metal sheets have an inner face intended to be in contact with the fluid contained in the tank. The corrugated metal sheets can be made, in particular, of stainless steel or of an iron-nickel alloy called Invar®, and are welded together in the overlap regions. The welds are lap welds. Corrugated metal sheets can be designed in a variety of ways depending on their shapes and dimensions, so that the weld regions can be positioned in different ways. Some of the corrugated metal sheets (hereinafter referred to as "the sheets" for convenience) are shown in Figure 3 and will be described in more detail below.

[0073] Regular sheets 68, 69 have a series of first corrugations 11 and a series of second corrugations 12 on their inner face (cf. Figure 2 and Figure 3). With reference to Figure 3, the first corrugations 11 are parallel to one another and extend in a first direction D1, and the second corrugations 12 are parallel to one another and extend in a second direction D2. The second direction D2 is orthogonal to the direction D1.

[0074] The first corrugations 11 are higher than the second corrugations 12. The height of a corrugation is measured between the peak of the corrugation and the level of the planar portion 19. With reference to Figure 2, the sealing membrane 4 also comprises corrugation nodes 15 formed at the intersection between a first corrugation 11 and a second corrugation 12. Each corrugation node 15 has a height greater than the height of the second corrugations 12. The corrugation nodes 15 are not shown in Figures 3, 5 and 7 so as not to overcomplicate the drawing. The corrugations 11, 12 project towards the inside of the tank 71.

[0075] Still referring to Figure 3, the first corrugations 11 are spaced apart by a first wave pitch P1 in the second direction D2, and the second corrugations 12 are spaced apart by a second wave pitch P2 in the first direction D1. The first wave pitch P1 and the second wave pitch P2 are measured between the peaks of two adjacent corrugations. The first wave pitch P1 and the second wave pitch P2 may be identical as shown, or they may be

different. The sheets of the plurality 10 have planar portions 19 located between the first corrugations 11 and between the second corrugations 12, so that the planar portions 19 rest against the thermally insulating barrier 3.

[0076] A first embodiment is now described with reference to Figures 1 to 4.

5 [0077] Figure 3 is a partial top view of the bottom wall 1 from inside the tank 71, in other words from the internal space of the tank delimited by the sealing membrane 4 and in which the fluid is contained. Figure 3 shows the support foot 5 and some of the sheets disposed around or in the vicinity of the support foot 5.

10 [0078] The support foot 5 is centred on the intersection X between a first directrix A1 (shown as a line of mixed dashes in Figure 3) and a second directrix A2 (shown as a dotted and dashed line in Figure 3). The first directrix A1 extends in the first direction D1 and is equidistant from two adjacent first corrugations 13 among the first corrugations 11. The second directrix A2 extends in the second direction D2 and is equidistant from two adjacent first corrugations 14, 16 among the second corrugations 12. Alternatively, the first directrix
15 A1 may extend between the corrugations 13 and not be equidistant from the corrugations 13, and/or the second directrix A2 may extend between the corrugations 14, 16 and not be equidistant from the corrugations 14, 16.

[0079] The second directrix A2 divides the plane of the load-bearing wall into a first half-plane PA, at the top of the drawing in Figure 3, and a second half-plane PF, at the bottom of the
20 drawing in Figure 3. The corrugation 14 is in the half-plane PA and the corrugation 16 is in the half-plane PF.

[0080] The plurality 10 of corrugated metal sheets is interrupted at a polygonal window 24 (hereinafter referred to as "the window 24" for convenience). The window 24 surrounds the through-element 5 in order to allow the through-element 5 to pass. In the example
25 shown, the window 24 has the shape of a regular octagon centred on the intersection X. Alternatively, other polygonal shapes are possible for the window 24, such as a square, rectangle, etc.

[0081] The window 24 interrupts the directrices G of the two corrugations 13 in the direction D1 and interrupts the directrices H of the two corrugations 14, 16 in the direction D2. The
30 directrices G and H are partially shown as a mixed line in Figure 3.

[0082] In order to extend the sealing membrane 4 and thus ensure the sealing of the tank around the support foot 5, two closure plates 25, 26 are disposed in the window 24. The closure plates 25, 26 sealingly connect the plurality 10 of corrugated metal sheets to the support foot 5. The closure plate 25 is located in the half-plane PA and the closure plate

26 is located in the half-plane PF. The closure plates 25, 26 can, for example, be symmetrical with respect to the second directrix A2, as shown. In the half-plane PA, the corrugations 13 and the corrugation 14 are sealingly connected to the closure plate 25 by end pieces 27. In the half-plane PF, the corrugations 13 are sealingly connected to the closure plate 26 by end pieces 28. On the other hand, the corrugation 16 is not connected to the closure plate 26, as will be explained in more detail below. The support foot 5, the closure plates 25, 26 and the end pieces 27, 28 can, in particular, be produced in accordance with the teachings of document WO 2011/157915 A1 or document WO 2016/170254 A1. Alternatively, other constructions are possible. In particular, a different number of closure plates can be provided and/or the closure plates can have different geometries.

[0083] The sheets shown in Figure 3 have rectangular shapes with sides parallel to the first direction D1 and the second direction D2 respectively. The dimensions of the sides of the sheets in the first direction D1 and the second direction D2 are substantially equal to integral multiples of the second wave pitch P2 and the first wave pitch P1, respectively. It should be noted that some of the sheets have been omitted from Figure 3, in particular those located away from the window 24.

[0084] The sheets shown in Figure 3 which are located in the half-plane PF are now described.

[0085] A sheet 41 is disposed on the first directrix A1 and symmetrical with respect to the first directrix A1. The sheet 41 has an indented edge 42 facing the support foot 5. The indented edge 42 is sealingly welded to the closure plate 26.

[0086] In the example shown, the sheet 41 has a width of 4 times the first wave pitch P1 in the second direction D2. Alternatively, the sheet 41 has a width greater than 4 times P1 in the second direction D2, preferably a width of N1 times P1 where N1 is an integer greater than 4. More preferably, N1 is even.

[0087] Two singular sheets 51 with a length of 1 times the second wave pitch P2 in the first direction D1 are disposed on either side of the first directrix A1. Each singular sheet 51 has an indented edge 52 facing the support foot 5 and extending the indented edge 42 as far as the sheet 31 described below in the half-plane PA. The indented edges 52 are sealingly welded to the closure plate 26. On either side of the window 24, the singular sheet 51 and the sheet 41 are welded in their overlap regions 54 parallel to the second direction D2.

[0088] In the example shown, the singular sheets 51 have a width of between 3 times and 4 times the first wave pitch P1 in the second direction D2. More specifically, one of the

singular sheets 51 (on the right in Figure 3) has a width of 4 times $P1$ and the other of the singular sheets 51 (on the left in Figure 3) has a smaller width, strictly less than 4 times $P1$. Alternatively, the singular sheets 51 could be symmetrical to each other with respect to the first directrix $A1$.

5 [0089] Two singular sheets 61 with a length of 1 times the second wave pitch $P2$ in the first direction $D1$ are disposed on either side of the sheet 41. More specifically, the singular sheets 61 are symmetrical to each other with respect to the first directrix $A1$. On either side of the window 24, the singular sheet 61 and the sheet 41 are welded in their overlap regions 64 parallel to the first direction $D1$, the singular sheet 61 and the singular sheet 51
10 are welded in their overlap regions 65 parallel to the second direction $D2$, and the singular sheet 61 and an adjacent regular sheet 69 are welded in their overlap regions 66 parallel to the second direction $D2$.

[0090] In the example shown, the singular sheets 61 have a width of 3 times the first wave pitch $P1$ in the second direction $D2$. Alternatively, the singular sheets 61 have a width
15 greater than 3 times $P1$ in the second direction $D2$, preferably a width of $N3$ times $P2$ where $N3$ is an integer.

[0091] As can be seen in Figure 3, the sheet 41 extends the corrugations 13 as far as the closure plate 26, the corrugations 13 being sealingly connected to the closure plate 26 by end pieces 28 as mentioned above. In addition, the sheet 41 and the singular sheets 51,
20 61 extend other corrugations 11 on either side of the window 24.

[0092] On the other hand, the corrugation 16 is absent from the sheets 51, so that the corrugation 16 is not extended as far as the closure plate 26. In addition, the corrugation 18 of the series of second corrugations 12 closest to the corrugation 16 in the half-plane PF is absent from the sheets 61. It is thus possible to obtain two areas on the sealing
25 membrane 4 adjacent to the support foot 5 and without the second corrugations 12. An offloading pump 7 (shown as a dashed line in Figure 3) can therefore be disposed in line with and at a distance from each of these regions in the internal space of the tank 71. With reference to Figure 2, the absence of the second corrugations 12 on the sheets 51, 61 ensures that the minimum spacing 22 under the offloading pump 7 is increased by a
30 spacing gain 23, which allows the spacing between the sealing membrane 4 and the offloading pump 7 to be adapted in order to optimize the volume of cargo that can be pumped, as described in document WO 2023/094330 A1.

[0093] The corrugations 16, 18 can be sealingly closed by end pieces 48, similar to the end pieces 27, 28, which are welded in the overlap region between the sheets 51, 61 and an
35 adjacent regular sheet 69.

[0094] The sheet 41 here has a corrugation portion 18U extending the corrugation 18 between the singular sheets 61. The corrugation portion 18U is sealed by end pieces 49 similar to the end pieces 27, 28, 48 at each overlap region between the sheet 41 and a singular sheet 61.

5 [0095] Finally, since the sheet 41 has a length of 2 times the second wave pitch P2 in the first direction D1, the sheet 41 extends a second corrugation 12 on the side opposite the window 24.

[0096] Regular sheets 69 are disposed around sheets 41, 51, 61 in the half-plane PF and are welded to the sheets 41 and/or 51 and/or 61. The regular sheets 69 can be dimensioned
10 in a wide range of ways according to requirements. The dimensions of the regular sheets 69 shown in Figure 3 are therefore only an example.

[0097] The sheets shown in Figure 3 which are located in the half-plane PA are now described.

[0098] An indented plate 31 has an indented edge 32 facing the support foot 5. The indented edge 32 is sealingly welded to the closure plate 25. On either side of the window 24, the
15 singular sheet 51 and the indented sheet 31 are welded in their overlap regions 53 parallel to the second direction D2 and located on the second directrix A2.

[0099] The indented sheet 31 has a width here of 7 times the first wave pitch P1 in the second direction D2 and a length of 3 times the second wave pitch P2 in the first direction D1, which allows the indented sheet 31 to be manufactured without excessive extra cost.
20 Alternatively, the indented sheet 31 has a width greater than or equal to 6 times P1 in the second direction D2, preferably a width of N4 times P1 where N4 is an integer, and/or a length greater than 3 times P2 in the first direction D1, preferably a length of M4 times P2 where M4 is an integer.

[0100] As can be seen in Figure 3, the indented sheet 31 extends the corrugations 13 as far
25 as the closure plate 25, in a similar way to the sheet 41. In addition, the indented sheet 31 extends other corrugations 11 on either side of the window 24, as far as the singular sheets 51. Finally, the indented sheet 31 extends the corrugation 14 as far as the closure plate 25.

[0101] Regular sheets 68 are disposed around the indented sheet 31 in the half-plane PF and
30 are welded to the indented sheet 31. A single regular sheet 68 is shown in Figure 3 for the sake of simplicity. The regular sheets 68 can be dimensioned in a wide range of ways according to requirements. The dimensions of the regular sheet 68 shown in Figure 3 are therefore only an example.

[0102] Finally, it should be noted that the sheets making up the sealing membrane 4, which are not shown in Figure 3, can also be dimensioned in a large number of ways according to requirements.

[0103] As mentioned above, the thermally insulating barrier 3 comprises a plurality of rectangular parallelepiped insulating blocks juxtaposed with one another. In Figure 4, which is a view of the thermally insulating barrier 3 disposed below the sealing membrane 4 shown in Figure 3, three of said insulating blocks 80 are shown together with the support foot 5. The insulating blocks 80 include a cover panel facing the inside of the tank, with a metal anchoring plate carried on an upper face of the cover panel. Bridging elements 81 are disposed in gaps between the insulating blocks 80 and also include a cover panel facing the inside of the tank, an upper face of the cover panel being able to carry a metal anchoring plate. Such insulating blocks 80 and bridging elements 81 are described, for example, in document US6035795. Together, the upper faces of the cover panels form a support surface for the sealing membrane 4. The metal anchoring plates are, for example, riveted to the upper faces of the cover panels.

[0104] Figure 4 also shows that the support foot 5 is surrounded by corner blocks and anchoring plates produced in accordance with the teaching of document WO 2011/157915 A1 or document WO 2016/170254 A1.

[0105] Reference signs 91 in Figure 4 refer to thermal protections (symbolized by hatched areas), i.e. strips of glass wool or other thermal insulation. The thermal protections 91 are disposed on the cover panels under the edges of the corrugated metal sheets or under the end pieces 27, 28, 48, 49, which makes it possible to weld these edges of the corrugated metal sheets and these end pieces 27, 28, 48, 49 without anchoring them to the insulating blocks 80 and without burning the cover panels of the insulating blocks 80. Reference sign 800 in Figure 4 refers to similar thermal protections around the support foot 5.

[0106] Still referring to Figure 4, the above-mentioned metal anchoring plates comprise anchoring plates 95, 96, 97.

[0107] With reference to Figure 3 and Figure 4, the anchoring plates 96 are located in the half-plane PF and extend in the second direction D2, and the overlap regions 65 (cf. Figure 3) are welded to the anchoring plates 96 (cf. Figure 4). In this way, the singular sheets 51, 61 are not only welded to one another in the overlap region 65, but also anchored by welding to the anchoring plates 96 carried by the thermally insulating barrier 3. The absence of corrugations 12 on the singular sheets 51, 61 therefore poses no difficulty with regard to the manufacture of the tank.

[0108] The anchoring plates 95 are located on the second directrix A2 and extend in the second direction D2. The overlap regions 53 (cf. Figure 3) are welded to the anchoring plates 95 (cf. Figure 4). Thus, the singular sheets 51 are not only welded to the sheet 31, but also anchored to the thermally insulating barrier 3.

5 [0109] The anchoring plates 97 are located in the half-plane PF and extend in the second direction D2. With reference to Figure 3 and Figure 4, the edge 43 (cf. Figure 3) of the sheet 41 parallel to the second direction D2 and opposite the indented edge 42 is welded to the anchoring plates 97 (cf. Figure 4). Thus, the sheet 41 is not only welded to an adjacent regular sheet 69, but also anchored to the thermally insulating barrier 3.
10 Alternatively, the edge 43 may not be anchored to the thermally insulating barrier 3. In this case, the anchoring plates 97 are replaced by thermal protections 91 to protect the thermally insulating barrier 3 when the edge 43 is welded to the adjacent regular sheet 69.

[0110] A second embodiment is now described with reference to Figures 5 and 6. In these figures, elements that are similar or identical to those described with reference to Figures
15 1 to 4 bear the same reference signs and are not described again.

[0111] With reference to Figure 5, in the second embodiment, the sheet 41 of the first embodiment is replaced by a sheet 141 with a length of 1 times P1 in the second direction D2. The corrugations 12 and 18 are absent from the sheet 141, and the sheet 141 also lacks the corrugation portion 18U extending the corrugation 18.

20 [0112] As with the edge 43 in the first embodiment, the edge 143 (cf. Figure 5) of the sheet 141 parallel to the second direction D2 and opposite the indented edge 42 can be welded to anchoring plates 197 (cf. Figure 6). Alternatively, the edge 143 may not be anchored to the thermally insulating barrier 3. In this case, the anchoring plates 197 are replaced by thermal protections 91.

25 [0113] The second embodiment is otherwise identical to the first embodiment and is therefore not described further for the sake of brevity.

[0114] A third embodiment is now described with reference to Figures 7 and 8. In these figures, elements that are similar or identical to those described with reference to Figures 1 to 4 bear the same reference signs and are not described again.

30 [0115] With reference to Figure 7, in the third embodiment, the sheet 141 of the second embodiment is replaced by a sheet 241 with a length of 2 times P1 in the first direction D1. The corrugations 12 and 18 are absent from the sheet 241, and the sheet 241 also lacks the corrugation portion 18U extending the corrugation 18.

[0116] In addition, the singular sheets 51 are replaced by singular sheets 251 with a width of between 2 times and 3 times P1 in the second direction D2. More specifically, one of the singular sheets 251 (on the right in Figure 3) has a width of 3 times P1 and the other of the singular sheets 251 (on the left in Figure 3) has a smaller width, strictly less than 3 times P1. Alternatively, the singular sheets 251 could be symmetrical to each other with respect to the first directrix A1. On either side of the window 24, the singular sheet 251 and the sheet 241 are welded in their overlap regions 256 parallel to the first direction D1, the singular sheet 251 and the sheet 31 are welded in their overlap regions 253 facing parallel to the second direction D2 and located on the second directrix A2, and the singular sheet 251 and the singular sheet 61 are welded in their overlap regions 265 parallel to the second direction D2.

[0117] The sheet 241 has an indented edge 242 similar to the indented edge 42 and extending as far as the sheet 31. On either side of the window 24, the sheet 241 and the sheet 31 are welded in their overlap regions 255 parallel to the second direction D2 and located on the second directrix A2.

[0118] Due to this geometry of the sheet 241, one of the singular sheets 251 has the same dimensions as the singular sheets 61, or optionally the two singular sheets 251 if they are symmetrical to each other with respect to the first directrix A1.

[0119] Referring now to Figure 7 and Figure 8, the overlap regions 265 are welded to the anchoring plates 96. Similarly, the overlap regions 253 are welded to the anchoring plates 95.

[0120] As with the edge 143 in the second embodiment, the edge 243 (cf. Figure 7) of the sheet 241 parallel to the second direction D2 and opposite the indented edge 242 can be welded to the anchoring plates 197 (cf. Figure 8). Alternatively, the edge 243 may not be anchored to the thermally insulating barrier 3. In this case, the anchoring plates 197 are replaced by thermal protections 91.

[0121] The third embodiment is otherwise identical to the second embodiment and is therefore not described further for the sake of brevity.

[0122] The invention has been described in connection with an offloading pump 7. However, this of course applies to any element inside the tank 71 located close to the sealing membrane 4.

[0123] With reference to Figure 9, a cutaway view of an LNG tanker 70 shows a generally prismatic, sealed and thermally insulated tank 71 mounted in the double hull 72 of the ship. The wall of the tank 71 comprises a primary sealing membrane intended to be in contact

with the LNG contained in the tank, a secondary sealing membrane arranged between the primary sealing membrane and the double hull 72 of the ship, and two thermally insulating barriers arranged respectively between the primary sealing membrane and the secondary sealing membrane and between the secondary sealing membrane and the double hull 72.

5 [0124] In a manner known per se, loading/offloading pipes 73 disposed on the upper deck of the ship can be connected, by means of appropriate connectors, to a maritime or port terminal in order to transfer an LNG cargo from or to the tank 71.

[0125] Figure 9 shows an example of a maritime terminal including a loading and offloading station 75, an underwater line 76 and an onshore facility 77. The loading and offloading station 75 is a fixed offshore facility including a mobile arm 74 and a tower 78 supporting the mobile arm 74. The mobile arm 74 carries a bundle of insulated flexible hoses 79 that can be connected to the loading/offloading pipes 73. The orientable mobile arm 74 can be adapted to suit all sizes of LNG carrier. A connecting line (not shown) extends inside the tower 78. The loading and offloading station 75 enables the LNG tanker 70 to be loaded and offloaded from or to the onshore facility 77. This comprises liquefied gas storage tanks 80 and connecting lines 81 linked by the underwater line 76 to the loading or offloading station 75. The underwater line 76 enables liquefied gas to be transferred between the loading or offloading station 75 and the onshore facility 77 over a long distance, for example 5 km, which means that the LNG carrier 70 can be kept a long way from the coast during loading and offloading operations.

[0126] In order to generate the pressure required to transfer the liquefied gas, pumps on board the ship 70 and/or pumps provided in the onshore facility 77 and/or pumps provided in the loading and offloading station 75 are used.

25 [0127] Although the invention has been described in conjunction with several particular embodiments, it is clearly obvious that it is in no way limited to these and that it comprises all the technical equivalents of the described means as well as their combinations if these fall within the scope of the invention.

[0128] The use of the verbs "include" or "comprise" and their conjugated forms does not exclude the presence of other elements or other steps than those stated in a claim.

30 [0129] In the claims, any reference sign between parentheses should not be interpreted as a limitation of the claim.

Claims

[Claim 1] Sealed and thermally insulated tank (71) incorporated in a load-bearing structure (2) including a load-bearing wall, said tank including a tank wall (1) fixed to the load-bearing wall of the load-bearing structure (2), wherein the tank wall (1) includes, in a thickness direction from the outside to the inside of the tank, a thermally insulating barrier (3) and a sealing membrane (4) supported by the thermally insulating barrier (3) and intended to be in contact with a fluid contained in the tank, the sealing membrane (4) including a plurality of membrane portions that are juxtaposed and welded to each other, the plurality of membrane portions comprising at least one regular membrane portion (68, 69), the regular membrane portion (68, 69) having a series of parallel first corrugations (11) extending in a first direction (D1) and spaced apart by a first wave pitch (P1) in a second direction (D2), the second direction (D2) being orthogonal to the first direction (D1), and a series of parallel second corrugations (12) extending in the second direction (D2) and spaced apart by a second wave pitch (P2) in the first direction (D1), the tank (71) including a through-element (5) passing through the tank wall (1), the through-element (5) being centred on the intersection (X) between a first directrix (A1) extending in the first direction (D1) and located between directrices of two (13) of said first corrugations (11) and a second directrix (A2) extending in the second direction (D2) and located between a first (14) and a second (16) of said second corrugations (12), the second directrix (A2) dividing the plane of the load-bearing wall into a first half-plane (PA) and a second half-plane (PF), the first (14) of said second corrugations being located in the first half-plane (PA) and the second (16) of said second corrugations being located in the second half-plane (PF), the plurality of membrane portions being interrupted at a polygonal window (24) surrounding the through-element (5) to allow the through-element (5) to pass, the window (24) interrupting the directrices (G) of said two first corrugations (13) and interrupting the directrices (H) of the first (14) of said second corrugations and the second (16) of said second corrugations, the sealing membrane (4) comprising at least one closure plate (25, 26) sealingly connecting the plurality of membrane portions to the through-element (5), the plurality of membrane portions comprising, around the window (24), a plurality of corrugated metal sheets, the corrugated metal sheets having sides parallel to the first direction (D1) and the second direction (D2) respectively, the plurality of corrugated metal sheets comprising, in the second half-plane (PF):

- a first rectangular metal sheet (41, 141, 241) having a width greater than or equal to 4 times the first wave pitch (P1) in the second direction (D2), the first rectangular metal sheet (41, 141, 241) being disposed on the first directrix (A1) and symmetrically with respect to the first directrix (A1), the first rectangular metal sheet (41, 141, 241) including a first indented edge (42, 242) facing the through-element (5),
 - two second singular rectangular metal sheets (51, 251) having a width greater than or equal to 2 times the first wave pitch (P1) in the second direction (D2) and a length of 1 times the second wave pitch (P2) in the first direction (D1), and
 - two third singular rectangular metal sheets (61) having a width greater than or equal to 3 times the first wave pitch (P1) in the second direction (D2) and a length of 1 times the second wave pitch (P2) in the first direction (D1), and symmetrical to each other with respect to the first directrix (A1),
- the second singular rectangular metal sheets (51, 251) being disposed on either side of the window (24) and each welded to the first rectangular metal sheet (41, 141, 241),
- the third singular rectangular metal sheets (61) being disposed on either side of the first metal sheet (41, 141, 241) and each welded to one of the second singular rectangular metal sheets (51, 251) and to the first rectangular metal sheet (41, 141, 241),
- wherein the first rectangular metal sheet (41, 141, 241) extends said two first corrugations (13) as far as the at least one closure plate (25, 26),
- wherein the first rectangular metal sheet (41, 141, 241), the second singular rectangular metal sheets (51, 251) and the third singular rectangular metal sheets (61) extend others of said first corrugations (11) on either side of the window (24),
- wherein the second (16) of said second corrugations is absent from the second singular rectangular metal sheets (51), and a third (18) of said second corrugations is absent from the third singular rectangular metal sheets (61).
- [Claim 2] Sealed and thermally insulated tank (71) according to Claim 1, wherein an edge of the second singular rectangular metal sheets (51, 251) parallel to the second direction (D2) and an edge of the third singular rectangular metal sheets (61) parallel to the second direction (D2) delimit a first overlap region (65, 265), said first overlap region (65, 265) being anchored to the thermally insulating barrier (3) over only part of its length.
- [Claim 3] Sealed and thermally insulated tank (71) according to Claim 2, wherein an inner surface of the thermally insulating barrier (3) forms a support surface for the sealing membrane and carries metal anchoring plates intended to be welded to the membrane portions in order to hold said plurality of membrane portions against said support

surface, wherein the metal anchoring plates comprise first metal anchoring plates (96) located in the second half-plane (PF) in line with the first overlap region (65, 265), the first overlap region (65, 265) being welded to the first metal anchoring plates (96).

[Claim 4] Sealed and thermally insulated tank (71) according to Claim 3, wherein the metal anchoring plates comprise second metal anchoring plates (97, 197) located in the second half-plane (PF), one edge (43, 143, 243) of the first rectangular metal sheet (41, 141, 241) parallel to the second direction (D2) and opposite the first indented edge (42, 242) of the first rectangular metal sheet (41, 141, 241) in the first direction (D2) being welded to the second metal anchoring plates (97, 197).

[Claim 5] Sealed and thermally insulated tank (71) according to any one of Claims 1 to 4, wherein the plurality of corrugated metal sheets comprises, in the first half-plane (PA), an indented rectangular metal sheet (31) having a width greater than or equal to 6 times the first wave pitch (P1) in the second direction (D2) and a length greater than or equal to 3 times the second wave pitch (P2) in the first direction (D1), the indented rectangular metal sheet (31) having an indented edge (32) facing the through-element (5),

wherein the second singular rectangular metal sheets (51, 251) are each welded to the indented rectangular metal sheet (31), and

wherein the indented rectangular metal sheet (31) extends said two first corrugations (13) and the first (14) of said second corrugations as far as the at least one closure plate (25, 26), and extends the others of said first corrugations (11) on either side of the window (24).

[Claim 6] Sealed and thermally insulated tank (71) according to Claim 5, wherein an edge of the indented rectangular metal sheet (31) parallel to the second direction (D2) and an edge of the second singular rectangular metal sheets (51, 251) parallel to the second direction (D2) delimit a second overlap region (53, 253), the second overlap region (53, 253) being anchored to the thermally insulating barrier (3) over only part of its length.

[Claim 7] Sealed and thermally insulated tank (71) according to Claim 6 taken in combination with Claim 3 or Claim 4, wherein the metal anchoring plates further comprise third metal anchoring plates (95) disposed on the second directrix (A2), the second overlap region (53, 253) being welded to the third metal anchoring plates (95).

[Claim 8] Sealed and thermally insulated tank (71) according to any one of Claims 1 to 7, wherein the first rectangular metal sheet (41) has a length of 2 times the second wave pitch (P2) in the first direction (D1) and includes a corrugation portion (18U) extending said third (18) of said second corrugations between the two third singular

rectangular metal sheets (61), each third singular rectangular metal sheet (61) being sealingly connected to the corrugation portion (18U).

[Claim 9] Sealed and thermally insulated tank (71) according to any one of Claims 1 to 7, wherein the first rectangular metal sheet is a first singular rectangular metal sheet (141, 241), said third (18) of said second corrugations being absent from the first singular rectangular metal sheet (141, 241).

[Claim 10] Sealed and thermally insulated tank (71) according to Claim 9, wherein the first singular rectangular metal sheet (141) has a length of 1 times the second wave pitch (P2) in the first direction (D1).

[Claim 11] Sealed and thermally insulated tank according to any one of Claims 8 to 10, wherein the second singular rectangular metal sheets (51) each comprise a second indented edge (52) facing the through-element (5) and extending the first indented edge (42) of the first singular rectangular metal sheet (41, 141).

[Claim 12] Sealed and thermally insulated tank (71) according to Claim 9, wherein the first singular rectangular metal sheet (241) has a length of 2 times the second wave pitch (P2) in the first direction (D1) and is welded to each of the second singular rectangular metal sheets (251) at a distance from the window (24).

[Claim 13] Sealed and thermally insulated tank (71) according to any one of Claims 1 to 12, wherein the first corrugations (11) have a height in the thickness direction of the tank wall (1) which is less than a height in the thickness direction of the tank wall (1) of the second corrugations (12).

[Claim 14] Sealed and thermally insulated tank (71) according to any one of Claims 1 to 13, wherein the sealing membrane (4) comprises a first closure plate (25) in the first half-plane (PA) and a second closure plate (26) in the second half-plane (PF), the first closure plate (25) and the second closure plate (26) surrounding the through-element (5).

[Claim 15] Sealed and thermally insulated tank (71) according to any one of Claims 1 to 14, wherein the tank (71) comprises a loading/offloading tower (6) and an offloading pump (7) attached to the loading/offloading tower (6), the through-element (5) being a support foot for the loading/offloading tower (6).

[Claim 16] Ship (70) for transporting a liquefied gas, the ship including a double hull (72) and a tank (71) according to any one of Claims 1 to 15 disposed in the double hull.

[Claim 17] Transfer system for a liquefied gas, the system including a ship (70) according to Claim 16, insulated pipes (73, 79, 76, 81) arranged to connect the tank (71) of the ship to a floating or onshore storage facility (77), and a pump for driving a flow of

liquefied gas through the insulated pipes from or to the floating or onshore storage facility, to or from the tank of the ship.

[Claim 18] Method for loading or offloading a ship (70) according to Claim 16, wherein a liquefied gas is conveyed through insulated pipes (73, 79, 76, 81) from or to a floating or onshore storage facility (77), to or from the tank (71) of the ship (70).