

Description

Title of the invention: Storage installation for liquefied gas

Technical field

[0001] The invention relates to the field of sealed and thermally insulated tanks with membranes. In particular, the invention relates to sealed and thermally insulated tanks for the storage and/or transport of low-temperature liquefied gas, such as tanks for the transport of Liquefied Petroleum Gas (also known as LPG), having a temperature range of between -50°C and 0°C, for example, or for the transport of Liquefied Natural Gas (LNG) at approximately -162°C at atmospheric pressure. These tanks can be installed on land or on a floating structure. In the case of a floating structure, the tank can be intended for the transport of liquefied gas or for receiving liquefied gas to be used as fuel for the propulsion of the floating structure.

Technological background

[0002] Storage installations for liquefied gas are known, for example, in document WO2020016509. A storage installation of this kind comprises a supporting structure and a sealed and thermally insulated tank located inside the supporting structure and attached thereto. The sealed and thermally insulated tank includes a multilayer structure comprising, in a thickness direction, a sealing membrane and a thermally insulating barrier arranged between the sealing membrane and the supporting structure.

[0003] A storage installation of this kind includes a sump structure on the bottom wall of the tank that interrupts the sealing membrane locally, said sump structure comprising a container penetrating the bottom wall of the tank. The sump structure is arranged in a well formed in the supporting structure in such a manner that the liquid in the container is at the lowest level of the tank. Hence, by placing a pump inside a container of this kind, it is possible to optimize the useful cargo volume that can be loaded into the tank and discharged from the tank.

[0004] During the loading of the tank with liquefied gas such as LNG, the components of the tank directly in contact with the fluid, such as the sump structure, undergo a significant temperature variation that results in thermal contraction. This is why provision is made in WO2020016509 to attach the sump structure to the supporting structure with the

help of a fastening device that allows for the contraction and expansion of the container of the sump structure, in order to limit stresses in the fastening device.

[0005] While a system of this kind is adequate for limiting the mechanical stresses associated with the thermal contraction of the sump structure, it has the disadvantage of being complex and requiring a significant assembly time when attaching the sump structure to the supporting structure.

[0006] In fact, during assembly, it is necessary to control the inclination and centring of the sump structure, while ensuring that the support around the structure is sufficient. Furthermore, the surface irregularities in the supporting structure must be taken into account for these checks.

Summary of the invention

[0007] The invention is based on the idea of simplifying the assembly of the sump structure in a storage installation, while allowing for the thermal contraction/expansion of the sump structure.

[0008] According to one embodiment, the invention provides a storage installation for liquefied gas comprising a supporting structure and a sealed and thermally insulated tank, wherein the tank includes at least one bottom wall attached to the supporting structure, in which the bottom wall comprises a multilayer structure in a thickness direction, including at least one sealing membrane and at least one thermally insulating barrier arranged between the sealing membrane and the supporting structure, in which the bottom wall includes a sump structure interrupting the sealing membrane of the bottom wall locally, the sump structure comprising a container comprising a side wall, the container being arranged through the thickness of the bottom wall and being located at least partially in a well formed in the supporting structure, said well extending towards the outside of the tank along a well axis, and the sump structure comprises a metal support ring attached all around the side wall, in such a manner as to protrude from the container in a radial direction towards the outside of said container, in which the storage installation includes at least one support beam attached to the supporting structure and arranged around the well, the support beam including at least one mastic layer extending parallel to the supporting structure, the metal support ring of the sump structure being configured to rest on the support beam.

- [0009] Thanks to these characteristics, the support beam allows the assembly of the sump structure to be simplified. In fact, the mastic layer of the support beam allows for easier adjustment of the inclination of the sump structure during the assembly of said sump structure, the mastic layer being capable of being compressed to a greater or lesser extent in different areas to compensate for defects in the supporting structure.
- [0010] Preferably, the support beam is a structural element having an elongated shape. The support beam can have different shapes. In the preferred embodiment of the invention, the support beam has a curved shape.
- [0011] According to some embodiments, an installation of this kind may include one or more of the following characteristics.
- [0012] According to one embodiment, the support beam includes, in the direction parallel to the well axis, the mastic layer, a plywood layer and a metal layer, the metal support ring of the sump structure being configured to rest on the metal layer of the support beam.
- [0013] Hence, the metal layer of the support beam, in cooperation with the metal support ring, allows for some sliding to be guaranteed between the sump structure and the supporting structure with metal-on-metal contact. Finally, the plywood layer allows heat transfers between the sump structure and the supporting structure to be limited.
- [0014] The plywood layer could also be replaced with any component possessing insulating properties and therefore be realized in solid wood or composite, for example.
- [0015] According to one embodiment, the sealing membrane is tightly bonded to the container all around said container.
- [0016] According to one embodiment, the supporting structure includes fixing studs arranged all around the well and extending parallel to the well axis, the support beam being attached to the supporting structure with the help of said fixing studs.
- [0017] According to one embodiment, the supporting structure includes a flat supporting wall drilled with an opening forming a well entrance, the at least one support beam being attached to the flat supporting wall around the opening.
- [0018] According to one embodiment, the container and the well have a cylindrical shape with a circular cross-section.
- [0019] According to one embodiment, the storage installation includes at least two support beams, each beam having an annular sector shape.

- [0020] According to one embodiment, the at least two support beams are sized in such a manner that the sum of the annular sectors of the support beams forms an annular sector of at least 180°.
- [0021] According to one embodiment, the storage installation includes a single annular-shaped support beam located all around the well.
- [0022] According to one embodiment, the storage installation includes at least one stop attached to the supporting structure and located between two support beams in a circumferential direction around the well, the metal support ring including a notch in which the stop is housed and the notch having a shape configured to limit, in cooperation with the stop, the movement of the sump structure in the circumferential direction and to restrict the movement of the sump structure in the radial direction.
- [0023] The stop therefore allows for the movements of the sump structure to be limited, while retaining the degree of freedom necessary for thermal contraction/expansion.
- [0024] According to one embodiment, the storage installation includes at least one stop that is radially offset to be arranged beyond the annular sector shape of the support beam, the metal support ring having a notch in which the stop is housed, the notch having a shape configured to limit, in cooperation with the stop, the movement of the sump structure in the circumferential direction and to restrict the movement of the sump structure in the radial direction. In a configuration of this kind, a portion of the support beam can be interposed between the stop and the sump structure.
- [0025] According to one embodiment, the stop has a cylindrical shape with a circular section, whereas the notch has an oblong shape.
- [0026] According to one embodiment, the metal support ring includes a main annular body and at least one offset portion, the offset portion being displaced from the main annular body in a direction parallel to the well axis and towards the supporting structure, the notch being formed in the offset portion.
- [0027] Therefore, the interaction between the stop and the notch is accomplished as close as possible to the supporting structure.
- [0028] According to one embodiment, the storage installation includes four support beams evenly distributed around the well and four stops evenly distributed around the well, the sealing membrane having a first series of parallel corrugations extending in a first direction and a second series of parallel corrugations extending in a second direction,

two of the four stops being aligned with the centre of the container in the first direction and the other two of the four stops being aligned with the centre of the container in the second direction.

- [0029] Hence, a greater number of support beams allows assembly of the sump structure to be made easier by allowing flat-to-flat contact between the support beams and the metal support ring to be obtained more easily. Moreover, choosing the number four allows the stops to be positioned along the main axes of the tank.
- [0030] According to one embodiment, the storage installation includes a film arranged between the mastic layer and the supporting structure in a direction parallel to the well axis, the film being configured to prevent the mastic layer from adhering to the supporting structure.
- [0031] The film therefore allows the stresses undergone by the mastic layer during the deformation of the supporting structure to be limited.
- [0032] According to one embodiment, the film is made with the help of a sheet of paper, for example Kraft paper, or also a polyethylene film.
- [0033] According to one embodiment, the mastic layer includes a plurality of sections of mastic spaced apart from one another, foam blocks being arranged between the mastic sections.
- [0034] In this way, the foam blocks make it possible to avoid excessively rapid creep of the mastic layer during the assembly stage of the sump structure and before the mastic layer polymerizes.
- [0035] According to one embodiment, the storage installation includes at least one anti-lifting plate attached to the support beam, the metal support ring being interposed between the support beam and the at least one anti-lifting plate.
- [0036] The anti-lifting plate thereby helps to limit any potential lifting of the sump structure in a direction parallel to the well axis, especially in the case of pressure differences between the interior of the tank and the thermally insulating barrier.
- [0037] According to one embodiment, the metal support ring and the metal layer of the support beam are made of stainless steel.
- [0038] According to one embodiment, an upper surface of the metal layer and a lower surface of the metal support ring have an arithmetic mean roughness (R_a) ranging between 0.2 and 3.2 μm , preferably between 0.2 and 1.6 μm .

- [0039] According to one embodiment, the metal layer of the support beam has a coating made of a material with a coefficient of friction less than 0.2, preferably between 0.05 and 0.2. In order to facilitate sliding, it is possible to add a polytetrafluoroethylene (PTFE) or high-density polyethylene (HDPE) type coating to the metal layer or lubricate the metal layer.
- [0040] According to one embodiment, the well axis is an axis of revolution of the well and the sump structure has an axis of revolution of the sump structure, the axis of revolution of the well and the axis of revolution of the sump structure being parallel and spaced apart from one another by a distance ranging between 0 and 30 mm
- [0041] An installation of this kind may be an onshore storage installation, for example, for storing LNG, or it may be a floating, coastal, or deep-water storage installation, especially for a liquefied natural gas carrier, a floating storage and regasification unit (FSRU), an offshore floating production storage unit (FPSO) and others. An installation of this kind may also act as a fuel tank in any kind of vessel.
- [0042] According to one embodiment, the invention also provides a method for assembling a sump structure of a storage installation for liquefied gas, the storage installation comprising a supporting structure and a sealed and thermally insulated tank supported by the supporting structure, in which the method comprises the following steps:
- providing the supporting structure including a well, said well extending outwards from the tank along a well axis,
 - providing a sump structure comprising a container having a side wall, and the sump structure comprising a metal support ring fixed all around the side wall in such a manner as to protrude from the container in a radial direction towards the outside of the container,
 - attaching supporting feet and at least one support beam to the supporting structure, in such a manner that the supporting feet and the support beam are arranged around the well, the support beam including at least one mastic layer extending parallel to the supporting structure,
 - lowering the sump structure in such a manner as to place the metal support ring on the at least one support beam and to position the container in the well at least partially,
 - adjusting the centring and inclination of the sump structure with the help of the supporting feet,
 - waiting for the mastic layer to polymerize,
 - removing the supporting feet.

- [0043] According to one embodiment, the invention also provides a method for assembling a sump structure of a storage installation for liquefied gas, the storage installation comprising a supporting structure and a sealed and thermally insulated tank supported by the supporting structure, in which the method comprises the following steps:
- providing the supporting structure including a well, said well extending towards the outside of the tank along a well axis,
 - providing a sump structure comprising a container having a side wall, and the sump structure comprising a metal support ring fixed all around the side wall in such a manner as to protrude from the container in a radial direction towards the outside of the container,
 - preassembling a portion of at least one support beam on the metal support ring,
 - attaching supporting feet to the supporting structure in such a manner that the supporting feet are disposed around the well,
 - placing a mastic layer belonging to the at least one support beam around the well,
 - lowering the sump structure in such a manner as to place the portion of the at least one support beam on the mastic layer and to partially position the container in the well,
 - adjusting the centring and inclination of the sump structure with the help of the supporting feet,
 - waiting for the mastic layer to polymerize,
 - removing the supporting feet.
- [0044] According to one embodiment, the portion of the at least one support beam includes a plywood layer and a metal layer.
- [0045] According to one embodiment, the supporting feet include a first adjustment device and a second adjustment device, the first adjustment device allowing the centring of the sump structure to be adjusted, and the second adjustment device allowing the inclination of the sump structure to be adjusted.
- [0046] According to one embodiment, the first adjustment device includes an adjusting screw extending in the radial direction in respect of the sump structure.
- [0047] According to one embodiment, the second adjustment device includes an adjusting screw extending in a direction parallel to the well axis.
- [0048] According to one embodiment, the invention likewise relates to a vessel for transporting a cold liquid product, said vessel having a double hull and a storage installation as referred to arranged within the double hull.

[0049] According to one embodiment, the invention also provides a transfer system for a cold liquid product, said system including the aforementioned vessel, insulated pipelines arranged in such a manner as to connect the tank installed in the hull of the vessel to a floating or onshore storage installation, and a pump for driving a flow of cold liquid product through the insulated pipelines from or to the floating or onshore storage installation to or from the tank of the vessel.

[0050] According to one embodiment, the invention also provides a method for loading or unloading a vessel, in which a cold liquid product is conveyed through insulated pipelines from or to a floating or onshore storage installation to or from the tank of the aforementioned vessel.

Brief description of the figures

[0051] The invention will be better understood and other objectives, details, characteristics and advantages thereof will become more apparent from the following description of several specific embodiments of the invention, provided solely by way of illustration and without any limiting force, with reference to the accompanying drawings.

[0052] Figure 1 shows a perspective view of a supporting structure at a well made in the supporting structure following the placement of a mastic layer according to a first assembly variant.

[0053] Figure 2 represents a partial perspective view of a sump structure, particularly the metal support ring thereof, mounted on a pre-assembled portion of a support beam in the first assembly variant.

[0054] Figure 3 shows a perspective view of the support beams attached to the supporting structure around the well according to a second assembly variant.

[0055] Figure 4 represents a perspective view of a sump structure arranged in the well of the supporting structure according to one embodiment, after the placement of the sump structure.

[0056] Figure 5 shows a partial perspective view of the sump structure at the connection between a stop of the supporting structure and a notch in the metal support ring according to one embodiment.

[0057] Figure 6 represents a partial perspective view of the sump structure at the connection between the metal support ring and the support beam according to one embodiment.

[0058] Figure 7 shows a sectional view of the sump structure arranged in the well of the supporting structure according to one embodiment.

[0059] Figure 8 is an exploded schematic representation of an LNG carrier with a storage installation and a loading/unloading terminal for that storage installation.

Description of embodiments

[0060] In the description below, we will describe a storage installation 1 for the storage and/or transport of liquefied gas comprising a supporting structure 2 and a sealed and thermally insulating tank 71. The sealed and thermally insulating tank includes, in particular, a bottom wall 3, preferably generally flat, located at the bottom of the tank in respect of the Earth's field of gravity. The general geometry of the tank can also be of different types. Polyhedral geometries are the most common. A cylindrical geometry is also possible.

[0061] The bottom wall 3 is mounted on a supporting structure 2, made, for example, of thick steel sheet such as the inner hull of a double-hulled vessel 70. The bottom wall 3 has a multilayer structure including, in succession, a secondary thermal insulation barrier 4 fixed on the supporting structure 2, a secondary sealing membrane 5 supported by the secondary thermal insulation barrier 4, a primary thermal insulation barrier 6 arranged on the secondary sealing membrane 5 and a primary sealing membrane 7 supported by the primary thermal insulation barrier 6 and intended to be in contact with the liquefied gas contained in the tank 71. The multilayer structure is, in particular, schematically represented in Figure 7. The primary sealing membrane 7 defines an internal space intended to receive the liquefied gas. By way of example, membrane tanks of this kind are, in particular, described in patent applications WO2019239048, WO14057221, FR2691520 and FR2877638.

[0062] The liquefied gas intended to be stored in the tank 71 can, in particular, be liquefied natural gas (LNG), in other words a gas mixture primarily composed mainly of methane and one or more other hydrocarbons. The liquefied gas can also be ethane or liquefied petroleum gas (LPG), in other words a hydrocarbon mixture derived from petroleum refining, essentially composed of propane and butane.

[0063] Figure 1 shows a substantially flat supporting wall of the supporting structure 2 on which the bottom wall 3 of the tank 71 will be fixed. The supporting wall is drilled with an opening forming an entrance of a well 8. The well 8 extends towards the outside of the tank 71 along a well axis 39.

[0064] The well 8 is intended to receive a sump structure 9 which will be described later.

[0065] As can be seen in Figure 7, the sump structure 9 includes a first container 10 in communication with the interior of the tank and a second container 11 surrounding the lower part of the first container 10. The first container 10 is continuously connected in a sealed manner to the primary sealing membrane 7. Similarly, the second container 11 is continuously connected in a sealed manner to the secondary sealing membrane 5, thereby completing it in a sealed manner.

[0066] More specifically, the first container 10 includes a cylindrical side wall 12, the axis of which is perpendicular to the supporting wall and which has a first attachment flange 13 located on an upper part of the cylindrical side wall 12, said attachment flange being substantially aligned with the primary sealing membrane 7. A lower part of the cylindrical side wall 12 is engaged in the well 8 of the supporting structure 2. A lower wall 14 parallel to the supporting structure 2 closes the cylindrical side wall 12 at its lower part. The first attachment flange 13 is fixed at the edge of the upper part of the cylindrical side wall 12 and protrudes radially on the outside thereof all around the first container 10. Hence, the fluid contained in the first container 10 is located at the lowest point of the tank 71.

[0067] Similarly, the second container 11 includes a cylindrical side wall 15, the axis of which is perpendicular to the supporting wall and which has a second attachment flange 16 substantially aligned with the secondary sealing membrane 5 and a lower part engaged in the well 8 below the lower wall 14 of the first container 10. A lower wall 17 parallel to the supporting wall closes the cylindrical side wall 15 of the second container 11 at its lower part. The cylindrical side wall 15 of the second container 11 surrounds the cylindrical side wall 12 of the first container 10 at a distance therefrom. The second attachment flange 16 is fixed at the edge of the upper part of the cylindrical side wall 15 and protrudes radially on the outside thereof all around the second container 11.

[0068] Insulating components 37 that can be seen in Figure 7 are arranged all around the first container 10 and the second container 11.

[0069] When in service, due to its position below the primary sealing membrane 7, the first container 10 receives by gravity any liquid residue present in the tank in the manner of a sump. The first container 10 provides sufficient capacity to keep the suction head of a pump immersed in the liquid and thereby maximizes the operational efficiency of the tank.

- [0070] For good structural stability, the first container 10 and the second container 11 are made of a more rigid material than the sealing membranes, for example, with a metal sheet of about 6 to 20 mm thickness.
- [0071] As shown in Figures 2 and 7, in particular, the sump structure 9 comprises a metal support ring 18 welded all around the cylindrical side wall 15 of the second container 11. The metal support ring 18 allows the sump structure 9 to rest on the supporting structure 2.
- [0072] In the embodiment described, the sump structure 9 includes two containers 10, 11 located one inside the other because the tank 71 in the example is a double-membrane tank. However, the invention is equally applicable to single-membrane tanks. In a case such as this, the cylindrical side wall of the single container includes a metal support ring that allows the sump structure to rest on the supporting structure.
- [0073] Other embodiments of a sump structure 9 are described in document WO2016/001142, for example.
- [0074] The storage installation also includes a plurality of support beams 19, numbering four in the example shown in Figure 4, which are evenly distributed around the edge of the well 8 and attached to the supporting structure 2. In other embodiments which are not shown, the number of support beams 19 could be different, for example, a single support beam 19 or also two support beams 19.
- [0075] Each support beam includes, in a direction parallel to the well axis 39, a mastic layer 20, a plywood layer 21 on top of the mastic layer 20 and a metal layer 22 attached to the plywood layer 21, for example by screws or rivets. As can be seen in Figure 3, the support beams 19 have an annular sector shape.
- [0076] The metal support ring 18 of the sump structure 9 therefore comes to rest on the metal layer 22 of the support beams 19 all around the well 8.
- [0077] The sump structure 9 and the support thereof on the supporting structure 2 will be described in greater detail with the help of Figures 1 to 7 which illustrate the invention at different stages of the sump structure 9 assembly.
- [0078] Figure 1 represents a first stage of assembling the sump structure 9 on the supporting structure 2 according to a first assembly variant.
- [0079] First of all, the positioning of the various constituent components of the tank 71, particularly including secondary insulating panels of the secondary thermal insulation

barrier 4 and the sump structure 9, is marked on the supporting wall of the supporting structure 2. Following this marking, anchor studs 23 are welded onto the supporting structure 2 at the desired attachment points of the various components.

- [0080] All around the well 8, films 24, made of Kraft paper for example, are arranged on the future locations of the support beams 19, in order to prevent the mastic layer 20 of the support beams 19 from adhering to the supporting structure 2.
- [0081] Supporting feet 25 are also attached to the supporting structure 2 around the well 8, in order to facilitate the precise positioning of the sump structure 9.
- [0082] In this first variant, the mastic layer 20 is directly applied onto the Kraft paper 24 in the form of a plurality of mastic sections 26 spaced apart from one another. Advantageously, foam blocks (not shown) are interposed between the different mastic sections, in order to avoid excessively rapid creep of the mastic layer 20.
- [0083] As for the plywood layer 21 and the metal layer 22 of the support beams 19, these are preassembled with one another; the portion of the support beam 19 formed by the plywood layer 21 and the metal layer 22 is then temporarily attached, for example with the help of wood screws 27, to the metal support ring 18 of the sump structure 9, as can be seen in Figure 2. It is only when positioning the sump structure 9 in the well 8 that the mastic layer 20 and the portion of the support beam attached to the metal support ring are assembled to form the support beam 19. After positioning the sump structure 9, the support beams 19 are attached to the supporting structure 2 with the help of anchor studs 23, so that portions of the anchor studs 23 protrude from the support beams 19.
- [0084] Figure 3 represents a first stage of assembling the sump structure 9 on the supporting structure 2 in a second assembly variant.
- [0085] In this variant, each support beam 19 is preassembled before being positioned on the supporting structure 2. The metal layer 22 is therefore screwed or riveted onto the plywood layer 21 and the mastic layer 20 is arranged immediately below the plywood layer 21 in different sections of mastic spaced apart from one another, advantageously separated by foam blocks (not shown).
- [0086] Then, after pre-assembly, each support beam 19 is attached to the supporting structure with the help of the anchor studs 23 located all around the well 8, in such a manner that the mastic layer 20 rests on a sheet of Kraft paper 24 arranged on the

supporting structure 2. Portions of the anchor studs 23 therefore protrude from the support beams 19.

[0087] Figure 4 represents a second stage of assembling the sump structure 9 on the supporting structure 2. In this stage, the sump structure 9 is lifted and positioned in alignment with the well 8 with the help of a winch, for example. The sump structure is then lowered into the well in such a manner that:

- in the first assembly variant, the plywood layer 21 temporarily attached to the metal support ring 18 adheres to the mastic layer 20 so as to form the support beams 19,
- in the second assembly variant, the metal support ring 18 is placed in contact with the metal layer 22 of the support beams 19.

[0088] Furthermore, after being lowered, the second attachment flange 16 of the sump structure 9 is brought into contact with one end of the supporting feet 25. In the example shown, the supporting feet 25 include at said end a height-adjustment screw 28 extending in a direction parallel to the well axis 39 and a centring screw 29 extending radially in respect of the sump structure 9.

[0089] By actuating the height-adjustment screws 28 of the different supporting feet 25 arranged all around the well 8, it is possible to adjust the inclination of the sump structure 9. Similarly, by actuating the centring screws 29 of the different supporting feet 25 arranged all around the well 8, it is possible to adjust the centring of the sump structure 9 in relation to the well 8.

[0090] During the placement of the sump structure 9 and the subsequent adjustment of inclination and centring, the mastic layer 20 of the support beams 19 is compressed to a greater or lesser extent in different areas by the weight of the sump structure 9 itself, in order to compensate for any irregularities in the planarity of the supporting structure 2.

[0091] During the centring of the sump structure 9, it is possible to centre the sump structure 9 with the markings made on the supporting structure 2 and representing the future locations of the insulating panels and/or corrugations of the corrugated sealing membranes. This centring using the markings may result in a misalignment 38 between the axis of revolution 39 of the well 8 and the axis of revolution 40 of the sump structure 9, as can be seen in Figure 7. Nevertheless, despite any possible misalignment, the support of the sump structure 9 on the supporting structure 2 is still ensured by the support beams 19.

- [0092] The assembly process then provides for a waiting period when the sump structure 9 is held in position until the mastic layer is polymerized, for example for a period of 24 hours. In another embodiment which is not shown, for the second assembly variant the step of compressing the mastic layer 20 could be carried out before placing the sump structure 9 in the well 8, for example with the help of a lighter structure with dimensions suitable for compressing all the support beams 19 simultaneously.
- [0093] Once the mastic layer 20 has polymerized, the supporting feet 25 are dismantled from the supporting structure 2.
- [0094] Figure 5 represents a third stage of assembling the sump structure 9 on the supporting structure 2.
- [0095] As can be seen in this figure, the metal support ring 18 includes a main annular body 30 and a plurality of offset portions 31 evenly distributed around the sump structure 9. Each offset portion 31 is displaced from the main annular body 30 in a direction parallel to the well axis 39 and towards the supporting structure 2. Each offset portion 31 protrudes from the main annular body 31 in a radial direction of the container 11 and towards the outside of the container 11. Each offset portion 31 has an oblong-shaped notch 32.
- [0096] In this step, cylindrical stops 33 with a circular section are arranged in each of the notches 32 in the metal support ring 18 and are welded to the supporting structure 2. The stops 33, cooperating with the notches 32, allow the movement of the sump structure 9 in the circumferential direction to be limited and also the movement of the sump structure 9 in the radial direction, in order to prevent any damage to the primary 7 or secondary 5 sealing membranes and also any damage to the primary 6 or secondary 4 thermal insulation barriers.
- [0097] By welding the stops 33 to the supporting structure 2 after positioning the sump structure 9, it is possible to overcome manufacturing and assembly tolerances and therefore facilitate assembly of the sump structure.
- [0098] It may be advantageous, following partial welding of the stops 33 to the supporting structure 2, to temporarily lift the sump structure 9 to complete the welding of the stops 33 to facilitate the welding operation. In this case, for the first assembly variant and before lifting the sump structure 9, the wood screws 27 are removed.
- [0099] In the case of a primary sealing membrane 7 or a corrugated secondary sealing membrane 5 that includes a first series of parallel corrugations extending in a first

direction and a second series of parallel corrugations extending in a second direction, the installation may advantageously include four stops 33, two of the four stops 33 being located on either side of the sump structure and aligned with the centre of the second container 11 in the first direction, and the other two of the four stops 33 being located on either side of the sump structure 9 and aligned with the centre of the second container 11 in the second direction. In the illustrated embodiment, the stops 33 are arranged between two adjacent support beams 19 in the circumferential direction of the well 8. In another embodiment that is not shown, the stops 33 are radially offset in such a manner as to be arranged beyond the annular sector shape of the support beams 19.

- [0100] Furthermore, in the case of a storage installation 1 installed on a vessel 70, the first direction can advantageously be the longitudinal direction of the vessel 70, whereas the second direction can be the transverse direction of the vessel 70.
- [0101] As can also be seen in Figure 5, the metal support ring 18 also has cutouts 34 aligned with the portions of anchor studs 23 protruding from the support beams 19. These cutouts 34 allow the metal support ring 18 to be positioned at a distance from the anchor studs 23 and therefore allow for thermal contraction/dilation deformation of the sump structure 9. These cutouts 34 are made at the free end of the main annular body 30.
- [0102] In the case of the first assembly variant, the wood screws 27 temporarily attaching the plywood layer 21 to the metal support ring 18 are removed at the end of this assembly stage, for example.
- [0103] Figure 6 represents a fourth stage of assembling the sump structure 9 on the supporting structure 2.
- [0104] In this stage, anti-lifting plates 35 are attached to the anchor studs 23 protruding from the support beams 19, in such a manner that the metal support ring 18 is clamped between the anti-lifting plates 35 and the support beams 19. The translational movement in the direction parallel to the well axis 39 of the sump structure 9 is therefore limited. The anti-lifting plates 35 are not tightened on the metal support ring 18 or are tightened relatively loosely, so that the sump structure 9 is not prevented from thermally contracting/dilating.

- [0105] The attachment of these anti-lifting plates 35 can be achieved with the help of a washer/nut assembly 36 as shown in Figure 6. The anti-lifting plates 35 have a disk shape with a diameter greater than the diameter of the cutouts 34, for example.
- [0106] Following this stage, insulating components are arranged all around the sump structure 9, then the secondary thermal insulation barrier 4 is assembled around the sump structure 9. The secondary sealing membrane 5, the primary thermal insulation barrier 6 and the primary sealing membrane 7 are then assembled successively.
- [0107] With reference to Figure 8, an exploded view of a vessel 70 shows a sealed and thermally insulated tank 71 with a generally prismatic shape mounted in the double hull 72 of the vessel 70. The tank wall includes the primary sealing membrane 7 intended to be in contact with the LNG contained in the tank, the secondary sealing membrane 5 arranged between the primary sealing membrane 7 and the double hull 72 of the vessel 70, and the two thermal insulation barriers arranged between the primary sealing membrane 7 and the secondary sealing membrane 5, respectively, and between the secondary sealing membrane 5 and the double hull 72.
- [0108] As known in the art, loading/unloading pipelines 73 arranged on the upper deck of the vessel can be connected, by means of appropriate connectors, to a maritime or port terminal to transfer a cargo of LNG from or to the tank 71.
- [0109] Figure 8 depicts an example of a maritime terminal comprising a loading and unloading station 75, an underwater pipeline 76 and an onshore facility 77. The loading and unloading station 75 is a fixed offshore installation including a movable arm 74 and a tower 78 that supports the movable arm 74. The movable arm 74 carries a bundle of insulated flexible pipes 79 that can be connected to the loading/unloading pipelines 73. The orientable movable arm 74 can adapt to all LNG carrier sizes. A connecting pipeline that is not shown extends inside the tower 78. The loading and unloading station 75 allows loading and unloading of the methane carrier 70 to or from the onshore facility 77. The onshore facility 77 includes liquefied gas storage tanks 80 and connecting pipelines 81 connected by the underwater pipeline 76 to the loading or unloading station 75. The underwater pipeline 76 enables liquefied gas to be transferred between the loading or unloading station 75 and the onshore facility 77 over a long distance, for example, 5 km, allowing the methane-carrying vessel 70 to remain far from the coast during loading and unloading operations.

- [0110] In order to generate the pressure required for the transfer of the liquefied gas, pumps are used on board the vessel 70 and/or pumps equipping the onshore facility 77 and/or pumps equipping the loading and unloading station 75.
- [0111] Although the invention has been described in connection with several specific embodiments, it is quite clear that it is in no way limited to these and that it comprises all the technical equivalents of the means described, as well as combinations thereof, if they fall within the scope of the invention.
- [0112] The use of the verb "include," "comprise" or "contain" and its conjugated forms does not preclude the presence of other components or other stages than those mentioned in a claim.
- [0113] In the claims, any reference sign shown in brackets should not be interpreted as limiting the claim.

REVENDICATIONS

- [Claim 1] Storage installation (1) for liquefied gas comprising a supporting structure (2) and a sealed and thermally insulated tank, the tank including at least one bottom wall (4) attached to the supporting structure (2), in which the bottom wall (4) comprises a multilayer structure in a thickness direction, including at least one sealing membrane (5, 7) and at least one thermally insulating barrier (4, 6) arranged between the sealing membrane (5, 7) and the supporting structure (2),
- in which the bottom wall (4) wall includes a sump structure (9) interrupting the sealing membrane (5, 7) of the bottom wall (4) locally, the sump structure (9) having a container (11) comprising a side wall (15), the container (11) being arranged through the thickness of the bottom wall (4) and being located at least partially in a well (8) formed in the supporting structure (2), the well (8) extending towards the outside of the tank (71) along a well axis (39), and the sump structure (9) comprising a metal support ring (18) attached all around the side wall (15), in such a manner as to protrude from the container (11) in a radial direction towards the outside of the container (11),
- in which the storage installation (1) includes at least one support beam (19) attached to the supporting structure (2) and arranged around the well (8), the support beam (19) including at least one mastic layer (20) extending parallel to the supporting structure (2), the metal support ring (18) of the sump structure (9) being configured to rest on the support beam (19).
- [Claim 2] Storage installation (1) according to Claim 1, in which the support beam (19) includes, in the direction parallel to the well axis (39), the mastic layer (20), a plywood layer (21) and a metal layer (22), the metal support ring (18) of the sump structure (9) being configured to rest on the metal layer (22) of the support beam (19).
- [Claim 3] Storage installation (1) according to Claim 1 or Claim 2, in which the supporting structure (2) includes a flat supporting wall drilled with an opening forming a well entrance (8), the at least one support beam (19) being attached to the flat supporting wall around the opening.
- [Claim 4] Storage installation (1) according to any one of Claims 1 to 3, in which the container (11) and the well (8) have a cylindrical shape with a circular cross-section and the storage installation (1) includes at least two support beams (19), each beam having an annular sector shape.

- [Claim 5] Storage installation (1) according to Claim 4, in which the at least two support beams (19) are sized in such a manner that the sum of the annular sectors of the support beams (19) forms an annular sector of at least 180°.
- [Claim 6] Storage installation (1) according to Claim 4 or Claim 5, in which the storage installation (1) includes at least one stop (33) attached to the supporting structure (2) and located between two support beams (19) in a circumferential direction around the well, the metal support ring (18) including a notch (32) in which the stop (33) is housed, the notch (32) having a shape configured to limit, in cooperation with the stop (33), the movement of the sump structure (9) in the circumferential direction and to restrict the movement of the sump structure (9) in the radial direction.
- [Claim 7] Storage installation (1) according to Claim 6, in which the storage installation (1) includes four support beams (19) evenly distributed around the well (8) and four stops (33) evenly distributed around the well, the sealing membrane (5, 7) having a first series of parallel corrugations extending in a first direction and a second series of parallel corrugations extending in a second direction, two of the four stops (33) being aligned with the centre of the container (11) in the first direction and the other two of the four stops (33) being aligned with the centre of the container (11) in the second direction.
- [Claim 8] Storage installation (1) according to any one of Claims 1 to 7, in which the storage installation (1) includes a film (24) arranged between the mastic layer (20) and the supporting structure (2) in a direction parallel to the well axis (39), the film (24) being configured to prevent the mastic layer (20) from adhering to the supporting structure (2).
- [Claim 9] Storage installation (1) according to any one of Claims 1 to 8, in which the storage installation (1) includes at least one anti-lifting plate attached to the support beam (19), the metal support ring (18) being interposed between the support beam (19) and the at least one anti-lifting plate (35).
- [Claim 10] Storage installation (1) according to any one of Claims 1 to 9, in which the well axis (39) is an axis of revolution of the well (39) and the sump structure has an axis of revolution of the sump structure (40), the axis of revolution of the well (39) and the axis of revolution of the sump structure (40) being parallel and spaced apart from one another by a distance ranging between 0 and 30 mm.
- [Claim 11] Vessel (70) for transporting a cold liquid product, said vessel having a double hull (72) and a storage installation (1) according to any one of Claims 1 to 10 arranged within the double hull.

[Claim 12] Transfer system for a cold liquid product, said system including a vessel (70) according to Claim 11, insulated pipelines (73, 79, 76, 81) arranged in such a manner as to connect the tank (71) installed in the hull of the vessel to a floating or onshore (77) storage installation (1), and a pump for driving a flow of cold liquid product through the insulated pipelines from or to the floating or onshore storage installation (1) to or from the tank of the vessel.

[Claim 13] Method for assembling a sump structure (9) of a storage installation (1) for liquefied gas, the storage installation comprising a supporting structure (2) and a sealed and thermally insulated tank (71), in which the method comprises the following steps:

- providing the supporting structure (2) including a well (8), said well (8) extending towards the outside of the tank along a well axis (39),
- providing a sump structure (9) comprising a container (11) having a side wall (15), and the sump structure (9) comprising a metal support ring (18) fixed all around the side wall (15) in such a manner as to protrude from the container (11) in a radial direction towards the outside of the container (11),
- attaching supporting feet (25) and at least one support beam (19) to the supporting structure (2), in such a manner that the supporting feet (25) and the support beam (19) are arranged around the well (8), the support beam (19) including at least one mastic layer (20) extending parallel to the supporting structure (2),
- lowering the sump structure (9) in such a manner as to place the metal support ring (18) on the at least one support beam (19) and to position the container (11) in the well (8) at least partially,
- adjusting the centring and inclination of the sump structure (9) with the help of the supporting feet (25),
- waiting for the mastic layer (20) to polymerize,
- removing the supporting feet (25).

[Claim 14] Method for assembling a sump structure (9) of a storage installation (1) for liquefied gas, the storage installation comprising a supporting structure (2) and a sealed and thermally insulated tank (71), in which the method comprises the following steps:

- providing the supporting structure (2) including a well (8), said well (8) extending towards the outside of the tank along a well axis (39),
- providing a sump structure (9) comprising a container (11) having a side wall (15), and the sump structure (9) comprising a metal support ring (18) fixed all around the

side wall (15) in such a manner as to protrude from the container (11) in a radial direction towards the outside of the container (11),

- preassembling a portion of at least one support beam (19) on the metal support ring (18),

- attaching supporting feet (25) to the supporting structure (2) in such a manner that the supporting feet (25) are disposed around the well (8),

- placing a mastic layer (20) belonging to the at least one support beam (19) around the well,

- lowering the sump structure (9) in such a manner as to place the portion of the at least one support beam (19) on the mastic layer (20) and to at least partially position the container (11) in the well (8),

- adjusting the centring and inclination of the sump structure (9) with the help of the supporting feet (25),

- waiting for the mastic layer (20) to polymerize,

- removing the supporting feet (25).

[Claim 15] Method for loading or unloading a vessel (70), in which a cold liquid product is conveyed through insulated pipelines (73, 79, 76, 81) from or to a floating or onshore (77) storage installation (1) to or from the tank (71) of the vessel (70) according to Claim 11.