

Description

Title of the invention: Dome structure for a sealed and thermally-insulating tank

Technical field

- 5 [0001] The invention relates to the field of sealed and thermally-insulating tanks for the storage and/or the transportation of a fluid, such as a cryogenic fluid. Sealed and thermally-insulating tanks are employed in particular for storing liquefied natural gas (LNG) that is stored at atmospheric pressure at about -162°C.

Technological background

- 10 [0002] The document WO 2019/215414 discloses a liquefied gas storage installation including a supporting structure consisting of the double hull of a ship and a sealed and thermally-insulating tank arranged in the supporting structure. The installation includes a dome structure that serves as a point of penetration for a loading/offloading tower including pipes for loading or offloading the tank. The dome structure projects upwards from an
15 upper supporting wall. It includes vertical supporting walls that rise above the deck of the ship and a horizontal wall that is positioned at the top of the vertical supporting walls. The horizontal wall supports a lid that includes a metal lid wall and thermal insulation that is fixed against the lower face of the metal lid wall. Moreover, the vertical supporting walls of the dome structure are coated by a multilayer structure including, from the exterior to the
20 interior, a secondary thermally-insulating barrier, a secondary sealing membrane, a primary sealing membrane, a primary thermally-insulating barrier and a primary sealing membrane. The primary sealing membrane includes a plurality of corrugations enabling it to have elasticity conferred on it and that project toward the interior of the dome structure.

- [0003] As described with reference to figures 15 and 16 of the aforementioned document,
25 after the metal lid wall has been mounted on and welded against the other walls of the dome structure and the loading/offloading tower has then been fixed against said metal lid wall insulating elements are fixed in a central portion of the lid. At this stage a peripheral portion of the metal lid wall is not covered with insulating elements. In a subsequent step edge insulating elements are positioned against the peripheral portion of the metal lid wall.
30 However, the presence of the corrugations of the primary sealing membrane projecting toward the interior in the upper part of the vertical walls of the dome structure impedes the positioning of the edge insulating elements against the peripheral portion of the metal lid wall in a space formed between the primary sealing membrane of one of the dome vertical walls and one of the insulating elements fixed in the central portion of the metal lid wall.

Summary

[0004] One idea on which the invention is based is to propose a dome structure in which placing insulation against the lid of the dome structure is facilitated.

[0005] In accordance with one embodiment, the invention provides a dome structure for a
 5 sealed and thermally-insulating tank, the dome structure including a plurality of lateral dome walls intended to project vertically from a ceiling wall of the tank and defining a passage intended to have passed through it at least one pipe for loading or offloading liquefied gas into or from the tank and a horizontal lid that closes the passage, the plurality of lateral dome walls comprising a first lateral dome wall comprising a corrugated sealing
 10 membrane, the corrugated sealing membrane including at least one corrugation that projects in the direction of the passage, the dome structure including at least one insulating block anchored against a lower face of the lid, said insulating block and the corrugation being, in projection in a horizontal plane, spaced from one another by a first distance, an insulating lining including one or more lining elements, said insulating lining being adjacent
 15 to the first lateral wall, placed against the lid and disposed between the insulating block and the first lateral wall, the or each lining element having a thickness in a direction orthogonal to the first lateral dome wall that is less than the first distance or being adapted to be compressed in the direction orthogonal to the first lateral dome wall that is less than the first distance, a retaining plate being anchored to a lower surface of the insulating block
 20 and extending under the insulating lining.

[0006] Thanks to these features thermal insulation of the dome structure is complete, the insulating lining enabling thermal insulation of the edges of the corrugated sealing membrane. Moreover, given the aforementioned features of the insulating lining, the latter can easily be installed despite the presence of the corrugations of the sealing membrane.

25 [0007] In accordance with embodiments of the invention a dome structure of this kind may have one or more of the following features.

[0008] In accordance with one embodiment the retaining plate is placed at a distance from the sealing membrane.

30 [0009] A configuration of this kind therefore prevents rubbing between the retaining plate and the corrugated sealing membrane, rubbing resulting in premature wear of the retaining plate and of the corrugated sealing membrane and possibly being aggravated by the effect of phenomena of thermal contraction and of deformation of the supporting structure.

[0010] In accordance with one embodiment a distance between the retaining plate and the sealing membrane is between 5 mm and 25 mm inclusive.

[0011] In accordance with a preferred embodiment a distance between the retaining plate and the sealing membrane is between 10 mm and 20 mm inclusive.

[0012] It is more preferable for a target value of the distance between the retaining plate and the sealing membrane to be 15 mm.

5 [0013] Such distance values therefore enable reduction of the risk of the retaining plate rubbing on the surface of the sealing membrane.

[0014] In accordance with one embodiment, the retaining plate is made of wood.

[0015] In accordance with one embodiment, the retaining plate has cut-outs through which pass vertical corrugations.

10 [0016] In accordance with a preferred embodiment the retaining plate is made of plywood.

[0017] Indeed, wood – and plywood in particular – is a material having a low coefficient of thermal conductivity. Moreover, in the event of accidental contact between the retaining plate and the sealing membrane the wood retaining plate involves a lesser risk of scratching the sealing membrane than if the retaining plate were made of some other material (for example metal).

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[0018] In accordance with one embodiment, the at least one insulating lining element is made of a material chosen from glass wool, rock wool and polyester wadding.

[0019] The lining element therefore consists of a flexible and thermally-insulating material.

[0020] Moreover, such materials are compressible and therefore make it possible to facilitate the insertion of the lining element or elements.

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[0021] In accordance with one embodiment, the at least one insulating lining element is made of insulating polymer foam.

[0022] The lining element therefore consists of a thermally-insulating material therefore enabling thermal insulation of the dome structure.

25 [0023] In accordance with one embodiment, the corrugated sealing membrane comprises vertical corrugations and the insulating lining includes a plurality of lining elements of which a contact element is placed against the sealing membrane between two successive vertical corrugations.

[0024] In accordance with one embodiment, the contact lining element has bevelled ends.

30 [0025] The contact lining element therefore espouses optimally the shape of the corrugations of the corrugated sealing membrane, which enables optimum thermal insulation to be provided.

[0026] In accordance with one embodiment, the contact lining element has a thickness in a direction normal to the lateral dome wall identical to a corrugation height.

5 [0027] In accordance with one embodiment, the lining elements include a secondary lining element, the secondary lining element extending in a space between the contact lining element and the insulating block and having a dimension in a direction normal to a plane of symmetry of the vertical corrugations greater than a dimension of the contact lining element in said direction.

[0028] The number of steps for fitting the insulating lining is therefore reduced because the secondary lining element is common to a plurality of contact lining elements.

10 [0029] In accordance with one embodiment, the sealing membrane is, in a portion arranged above the retaining plate, covered with insulating lining elements.

[0030] The dome structure can therefore be completely thermally insulated using the insulating lining.

15 [0031] In accordance with one embodiment, at least one insulating block is anchored to the lid by means of a stud, the stud passing through the at least one insulating block completely, a bearing plate being positioned against a lower face of the at least one insulating block, a nut being screwed onto the stud and retaining the bearing plate.

[0032] Such a feature therefore enables easy fixing of at least one insulating block.

20 [0033] In accordance with one embodiment, the invention provides a sealed and thermally-insulating tank including an aforementioned dome structure.

[0034] In accordance with one embodiment, the sealed and thermally-insulating tank includes a loading/offloading tower comprising at least two vertical masts passing through the lid and fixed to one another by crossmembers, each of the two vertical masts forming a pipe for loading or offloading the tank.

25 [0035] In accordance with one embodiment, the invention provides a ship for the transportation of a fluid, the ship including an aforementioned sealed and thermally-insulating tank.

30 [0036] In accordance with one embodiment, the invention provides a transfer system for a fluid, the system including an aforementioned ship, insulated pipes arranged in such a manner as to connect the tank of the ship to a floating or terrestrial storage installation, and a pump for driving a fluid through the insulated pipes from or to the floating or terrestrial storage installation to or from the tank of the ship.

[0037] In accordance with one embodiment, the invention provides a method of assembling a dome structure for a sealed and thermally-insulating tank, said dome structure including a plurality of lateral dome walls intended to project vertically from a ceiling wall of the tank and defining a passage intended to have passed through it at least one pipe for loading or offloading liquefied gas into or from the tank and a horizontal lid that closes the passage, the plurality of lateral dome walls comprising a first lateral dome wall comprising a corrugated sealing membrane, the corrugated sealing membrane including at least one corrugation that projects in the direction of the passage, the dome structure including at least one insulating block anchored against a lower face of the lid, said insulating block and the corrugation being, in projection in a horizontal plane, spaced from one another by a first distance, the assembly method including the following steps:

- disposing an insulating lining including one or more lining elements between the insulating block and the first lateral wall, the or each lining element having a thickness in a direction orthogonal to the first lateral dome wall that is less than the first distance or being compressed in the direction orthogonal to the first lateral wall until it has a thickness in a direction orthogonal to the first lateral dome wall that is less than the first distance,
- anchoring a retaining plate to a lower surface of the insulating block, the retaining plate extending under the insulating lining so as to hold it in place.

[0038] In accordance with one embodiment, the assembly method is such that the at least one lining element is inserted vertically in a space between the corrugated sealing membrane and the insulating block and is then moved so as to come into the contact with the corrugated sealing member.

[0039] In accordance with one embodiment, the assembly method is such that the at least one insulating block is fixed beforehand to the lid by means of a stud, the stud passing through the at least one insulating block completely, a bearing plate being positioned against a lower face of the at least one insulating block, a nut being screwed onto the stud and retaining the bearing plate.

[0040] In accordance with one embodiment, the assembly method is such that lining elements cover a portion of the corrugated sealing membrane that is positioned above the retaining plate.

[0041] In accordance with one embodiment, the method further includes the following steps:

- disposing contact lining elements between two successive vertical corrugations, the contact lining elements having a height identical to a corrugation height,

- disposing secondary lining elements occupying an interstice between the contact lining elements and the at least one insulating block.

5 [0042] In accordance with one embodiment, the secondary lining elements have a dimension in a direction normal to a plane of symmetry of the corrugations longer than a dimension of the contact lining elements in said direction.

[0043] In accordance with one embodiment, the assembly method is such that edges of the lining elements are first bevelled before being inserted into the space between the corrugated sealing membrane and the insulating block.

10 [0044] In accordance with one embodiment, the invention also provides a method of loading or offloading an aforementioned ship in which a fluid is routed through insulated pipes from or to a floating or terrestrial storage installation to or from the tank of the ship.

Brief description of the figures

15 [0045] The invention will be better understood and other aims, details, features and advantages thereof will become more clearly apparent in the following description given by way of non-limiting illustration only and with reference to the appended drawings of a plurality of particular embodiments of the invention.

[0046] [fig.1] Figure 1 is a partial schematic view of a supporting structure intended to receive the walls of a sealed and thermally-insulating tank.

[0047] [fig.2] Figure 2 is a schematic view of the multilayer structure of the walls of the tank.

20 [0048] [fig.3] Figure 3 is a schematic view depicting a loading/offloading tower and partially depicting the supporting structure inside which it is mounted.

[0049] [fig.4] Figure 4 is a schematic view in section of a dome structure that may be used in the supporting structure from figure 1.

25 [0050] [fig.5] Figure 5 is a partial schematic representation of the dome structure during a preliminary insulation step.

[0051] [fig.6] Figure 6 is a partial schematic representation of the dome structure during a step of insertion of an insulating lining.

[0052] [fig.7] Figure 7 is a partial schematic representation of the dome structure during a step of attaching an insulating lining.

30 [0053] [fig.8] Figure 8 is a partial schematic representation of the dome structure in a final state.

[0054] [fig.9] Figure 9 is a schematic representation in perspective during the preliminary insulation step.

[0055] [fig.10] Figure 10 is a schematic representation in perspective after the preliminary insulation step.

5 [0056] [fig.11] Figure 11 is a schematic representation in perspective of a detail of the dome structure after mounting a contact lining element.

[0057] [fig.12] Figure 12 is a schematic representation in perspective of the detail of the dome structure portion after mounting a secondary lining element.

10 [0058] [fig.13] Figure 13 is a schematic representation in perspective of lining elements in the dome structure portion.

[0059] [fig.14] Figure 14 is a schematic representation in side view of the lining elements in the dome structure portion.

[0060] [fig.15] Figure 15 is a schematic representation in perspective of the detail of the dome structure portion after mounting a retaining plate.

15 [0061] [fig.16] Figure 16 is a schematic representation in perspective of the dome structure portion in the final state.

[0062] [fig.17] Figure 17 is a schematic cutaway representation of a methane tanker ship tank and a terminal for loading/offloading that tank.

Description of embodiments

20 [0063] Figure 1 represents the rear part of a supporting structure 1 intended to receive the walls of a sealed and thermally-insulating tank. The supporting structure 1 is formed by the double hull of a ship. The supporting structure 1 has a polyhedral general shape. The supporting structure 1 has a front wall 2 and a rear wall 3, here of octagonal shape. In figure 1 the front wall 2 is represented only in part in order to enable viewing of the internal
25 space of the supporting structure 1. The front wall 2 and the rear wall 3 are cofferdam walls of the ship and extend transversely to the longitudinal direction of the ship. The supporting structure 1 also includes an upper wall 4, a lower wall 5 and lateral walls 6, 7, 8, 9, 10, 11. The upper wall 4, the lower wall 5 and the lateral walls 6, 7, 8, 9, 10, 11 extend in the longitudinal direction of the ship and connect the front wall 2 and the rear wall 3.

30 [0064] The upper wall 4 includes near the rear wall 3 of the supporting structure 1 a space of rectangular parallelepiped shape projecting upwards, known as the liquid dome 12. The liquid dome 12 is defined by a front transverse wall 13 and a rear transverse wall 14 and by two lateral walls 15, 16 that extend vertically and project upwards from the upper wall

4. The liquid dome 12 further includes a horizontal lid, not represented in figure 1, which is intended to cover in sealed manner the opening between the front wall 13, the rear wall 14 and the lateral walls 15, 16 of the liquid dome 12.

[0065] Referring to figure 2, the tank the method of assembly of which will be described hereinafter is a membrane tank having a multilayer structure. Also, as represented schematically in figure 2, each wall of the tank includes successively, from the exterior to the interior, in the direction of thickness of the wall, a secondary thermally-insulating barrier 44 including insulating elements resting against the supporting structure 1, a secondary sealing membrane 18 anchored to the insulating elements of the thermally-insulating barrier 44, a primary thermally-insulating barrier 19 including insulating elements resting against the secondary sealing membrane 18, and a primary sealing membrane 20 anchored to the insulating elements of the primary thermally-insulating barrier 19 and intended to be in contact with the fluid contained in the tank. This multilayer structure of the tank is disposed on each of the walls 4, 5, 6, 7, 8, 9, 10, 11 of the supporting structure 1. This multilayer structure is also present in the walls of the liquid dome 12 except at the level of the lid.

[0066] For example, each wall of the tank may in particular be of the Mark III type, as described for example in FR2691520, or of the Mark V type, as described for example in WO14057221.

[0067] Each wall of the tank is anchored to the respective wall of the supporting structure 1, proceeding from the exterior to the interior of the tank, that is to say:

- the insulating elements of the secondary thermally-insulating barrier 44 are anchored to the respective wall of the supporting structure 1;
- the secondary sealing membrane 18 is anchored to the insulating elements of the secondary thermally-barrier 44;
- the insulating elements of the primary thermally-insulating barrier 19 are anchored to the insulating elements of the secondary thermally-insulating barrier 44 or to the supporting structure 1 through the secondary sealing membrane 18; and then
- the primary sealing membrane 20 is anchored to the insulating elements of the primary thermally-insulating barrier 19.

[0068] Moreover, the tank includes a loading/offloading tower depicted in figures 3 and 4 in particular enabling loading the cargo into the tank before it is transported and/or offloading the cargo after it has been transported. The loading/offloading tower 21 is installed near the rear wall 3 of the supporting structure 1 because when offloading the cargo the ship

tilts toward the rear, which makes it possible to optimise the quantity of cargo that can be offloaded via the loading/offloading tower 21.

[0069] The loading/offloading tower 21 is suspended from the upper wall 4 of the supporting structure 1 and more particularly from the lid of the liquid dome 12. The loading/offloading tower 21 extends over substantially all the height of the tank. The loading/offloading tower 21 supports at its lower end one or more pumps for offloading the cargo.

[0070] It is seen that the loading/offloading tower 21 has a tripod structure, that is to say includes three vertical masts 22, 23, 24 that are fixed to one another by crossmembers 25. Each of the masts 22, 23, 24 is hollow and passes through the lid of the liquid dome 12. Each of the masts 22, 23, 24 therefore forms either a loading and/or offloading line enabling loading or offloading of the fluid to or from the tank or a standby well enabling lowering of a back-up pump and an offloading line in the event of failure of the other offloading pumps. In an embodiment that is represented two of the masts 22, 23 form a line for offloading the tank and to this end each of them is associated with an offloading pump 26, 27 fixed to the lower end of the loading/offloading tower 21 while the third mast 24 forms a standby well. In an embodiment of this kind the loading/offloading tower 21 carries one or more loading lines, not represented, that do not constitute one of the masts 22, 23, 24 of the tripod structure.

[0071] The method of mounting insulation against the lid 17 of the dome structure 12 will be described with reference to figures 5 to 8.

[0072] In a first step represented schematically in figure 5 the dome structure 12 is in a preliminary state in which a central insulating block 30 is anchored to the lid 17. The lateral wall 15 is covered by a sealing membrane 32. An attachment member 36 is fastened to the lid 17 and is placed vertically.

[0073] The first step consists in placing an edge insulating block 31 against the central insulating block 30 and the sealing membrane 32. The edge insulating block 31 has dimensions such as to be able to be inserted vertically between the central insulating block 30 and the sealing membrane 32 without coming into contact with a corrugation 33, the corrugation 33 extending in a direction normal to the plane of figure 5.

[0074] The edge insulating block 31 is anchored to the lid by means of the attachment member 36, the attachment member 36 being intended to pass completely through the edge insulating block 31.

[0075] The edge insulating block 31 and the central insulating block 30 can be made of insulating polymer foam, for example polyurethane foam, or, with a lower thickness, made of wood, preferably plywood.

5 [0076] Referring to figure 6, after the first mounting step the edge insulating block 31 has the attachment member 36 passed through it so that it projects from a lower surface of the edge insulating block 31. The attachment member 36 is preferably placed at the centre of the edge insulating block 31.

10 [0077] The edge insulating block 31 is placed against the central insulating block 30, leaving an interstice 34 between the edge insulating block 31 and the sealing membrane 32. Moreover, a height of the edge insulating block 31 in a direction normal to the lid 17 is identical to a height of the central insulating block 30. As depicted in this figure 6 the edge insulating block 31 and the corrugation 33, which has the greatest height, are, in projection in a horizontal plane, spaced from one another by a first dimension that corresponds to the reference d1 in figure 6.

15 [0078] Referring to figures 6 and 7, a second mounting step is represented. The second mounting step consists in inserting an insulating lining 40 between the edge insulating block 31 and the sealing membrane 32, the insulating lining 40 being inserted via the interstice 34. The insulating lining 40 is inserted in such a manner as to fill the interstice 34 completely.

20 [0079] In one embodiment the insulating lining 30 includes a lining element that has a dimension d2 in the direction orthogonal to the lateral wall 15 that is greater than the dimension d1. In this case the insulating lining 40 is made of a compressible material, the insulating lining 40 then being compressed in such a manner as to be able to occupy all of the interstice 34.

25 [0080] In an alternative embodiment the insulating lining 40 may equally be made up of a plurality of lining elements, each lining element then having a dimension d2 in the free or compressed state that is less than d1. Thus lining elements can be inserted sequentially and thereafter juxtaposed in the interstice.

30 [0081] In this case the lining elements are inserted vertically into the interstice and then moved horizontally until they come into contact with the sealing membrane 32 or with a preceding lining element previously disposed against the sealing membrane 32. The sealing elements may be compressed to be passed through the interstice although this is not obligatory if they have a dimension d2 less than d1.

[0082] The insulating lining 40 is made up of insulating elements such as glass wool, rock wool, polyester wadding or flexible foam. The insulating lining 40 may equally comprise polymer foam, for example polyurethane foam.

5 [0083] It is moreover possible to combine different types of materials and to have heterogeneous lining elements consisting two by two of different elements.

[0084] Referring to figures 7 and 8, a third mounting step consists in placing a retaining plate 35 under the insulating lining 40 in such a manner as to hold it in place. The retaining plate 35 is made of wood, preferably plywood.

10 [0085] The retaining plate 35 is placed in such a manner as partly to overlie a lower surface of the edge insulating block 31 and is anchored to said lower surface. The retaining plate 35 extends under the insulating lining 40 and as far as the sealing membrane 32 (although not into direct contact with said sealing membrane 32) in such a manner as to prevent the insulating lining 40 from escaping.

15 [0086] The retaining plate 35 may be glued or screwed to the edge insulating block, for example.

[0087] Referring to figures 9 to 11, a portion of the dome structure 12 is represented in perspective in the preliminary state. The lid 17 is equipped with regularly distributed attachment members 36, such as studs.

20 [0088] The central insulating block 30 is intended to be placed in contact with the lid 17 and fixed thereto, for example by gluing it thereto or by means of anchoring devices that are not represented.

[0089] A first lateral wall 15 is covered by a first sealing membrane 321. A second lateral wall 16 is covered by a second sealing membrane 322.

25 [0090] The first sealing membrane 321 and the second sealing membrane 322 include horizontal corrugations 33 extending parallel to a plane of the lid 17.

[0091] The first sealing membrane 321 and the second sealing membrane 322 further include vertical corrugations 39 perpendicular to the horizontal corrugations 33 and parallel to a direction normal to the plane of the lid 17.

30 [0092] Referring to figure 10, a first edge insulating block 311 is placed between the central insulating block 30 and the first sealing membrane 321. A second edge insulating block 312 is placed between the central insulating block 30 and the second sealing membrane 322.

[0093] The first edge insulating block 311 and the second edge insulating block 312 are however not in direct contact with the first sealing membrane 321 and the second sealing membrane 322, respectively.

5 [0094] The first edge insulating block 311 and the second edge insulating block 321 are fixed to the lid by attachment members 36, here pins. The attachment members 36 form a grid on the lid wall 17 and are placed equidistantly from one another. The attachment members 36 project from the surface of the lid wall 17. The attachment members 36 pass completely through the edge insulating blocks 311, 321 and are held in place at the level of a lower surface of the insulating blocks. To this end, for example, bearing plates are mounted on
10 an end of the attachment members 36, positioned against the lower face of the insulating blocks and held in place by bolts.

[0095] An arrangement of lining elements between the edge insulating block 31 and the sealing membrane 32 in one embodiment is explained with reference to figures 11 to 15. In the aforementioned figures a detail of a corner zone of the dome structure 12 is
15 represented in perspective.

[0096] Referring to figure 11, a first contact lining element 41 is inserted into the interstice 34 and then placed against the sealing membrane 32. The first contact lining element 41 has a height in a direction normal to the plane of the lid 17 such that the first contact lining element 41 occupies a space between the lid 17 and the edge horizontal corrugation 331,
20 the edge horizontal corrugation 331 being the horizontal corrugation nearest the lid 17.

[0097] The first contact lining element 41 moreover has a dimension such that it can be housed between two successive vertical corrugations 39 or alternatively between an edge of the dome structure 12 and a first vertical corrugation 39.

[0098] Finally, a thickness of the first contact lining element 41 in a direction normal to the first
25 lateral wall 15 is identical or substantially identical to a height of the corrugation 33. However, in other embodiments the contact lining element 41 may have a greater thickness and occupy all of the interstice 34, in particular in the situation where the contact lining element 41 is made of a compressible material.

[0099] Referring to figure 12, a secondary lining element 42 is inserted between the contact
30 lining element 41 and the edge insulating block 31. The secondary lining element 42 has a length greater than the length of the contact lining element 41. Indeed, the secondary lining element 42 is not limited in length by the presence of vertical corrugations 39, in contrast to the contact lining element 41.

[0100] Referring to figures 13 and 14, a contact lining element 41 is placed between the horizontal corrugations 33 of each successive pair. Moreover, the secondary lining element 42, having a greater length than the contact lining element 41, may be common to a plurality of successive contact lining elements 41. In accordance with a preferred embodiment the contact elements 41 have bevelled sides 43 with an inclination such that the contact lining elements 41 are tangential to the corrugations of the sealing membrane 32, the horizontal corrugation 33 having two curved sides.

[0101] The second lining element 42 is placed against the contact lining elements 41 and is tangential to the top of the horizontal corrugation 33.

[0102] Referring to figure 14, it is seen that the lining elements can have different thicknesses for each dimension of the dome structure 12. Indeed, when the sealing membrane includes corrugations having different heights the highest corrugations are those oriented in the longitudinal direction of the ship while the shortest are oriented in the transverse direction of the ship. This is why, depending on the orientation of the lateral wall of the dome structure, the vertical corrugations 33 of the sealing membrane 32 may be the largest on a lateral wall (when the latter is oriented transversely) and the smallest on an adjacent lateral wall (when the latter is oriented longitudinally). It is seen in figure 15 that the retaining plate 35 is not in contact with the sealing membrane 32. Indeed, the distance between the sealing membrane 32 and the retaining plate 35 is between 5 mm and 25 mm inclusive. The presence of such a clearance makes it possible to prevent contact between the sealing membrane 32 and the retaining plate 35 even if the tank is subjected to high thermal deformations when in use. Also, the retaining plate 35 equally includes cut-outs in which the vertical corrugations pass.

[0103] The adjustment is effected at the level of the edge insulating block 31. Indeed, depending on the margin that is required, the retaining plate 35 may be anchored more or less closely to the sealing membrane 32. The retaining plate 35 may be fixed by means of screws or glue.

[0104] Referring to figure 16, a more overall view of the corner zone of the dome structure is represented. The lining elements border the edges of the insulating blocks 31 facing the sealing membrane 32.

[0105] In accordance with an embodiment represented here each lining element of the insulating lining 40 occupies all of a zone delimited by the sealing membrane 32, the edge insulating block 31 and two successive vertical corrugations 39.

[0106] The liquefied gas intended to be stored in the tank may in particular be liquefied natural gas (LNG), that is to say a gas mixture containing mostly methane together with one or more other hydrocarbons. The liquefied gas may equally be hydrogen, ethane or liquefied petroleum gas (LPG), that is to say a mixture of hydrocarbons resulting from the refining of oil essentially including propane and butane.

[0107] Referring to figure 17, a cutaway view of a methane tanker ship 70 shows a sealed and insulated tank 71 of prismatic general shape mounted in the double hull 72 of the ship. The wall of the tank 71 includes a primary sealed barrier intended to be in contact with the LNG contained in the tank, a secondary sealed barrier arranged between the primary sealed barrier and the double hull 72 of the ship, and two insulating barriers respectively arranged between the primary sealed barrier and the secondary sealed barrier and between the secondary sealed barrier and the double hull 72.

[0108] In a manner known in itself loading/offloading pipes 73 disposed on the top deck of the ship may be connected by means of appropriate connectors to a maritime or harbour terminal to transfer a cargo of LNG from or to the tank 71.

[0109] Figure 17 shows an example of a maritime terminal including a loading and offloading station 75, an underwater pipe 76 and a terrestrial installation 77. The loading and offloading station 75 is a fixed off-shore installation including a mobile arm 74 and a tower 78 that supports the mobile arm 74. The mobile arm 74 carries a bundle of insulated flexible tubes 79 that can be connected to the loading/offloading pipes 73. The orientable mobile arm 74 adapts to all methane tanker loading gauges. A connecting pipe that is not shown extends inside the tower 78. The loading and offloading station 75 enables loading and offloading of the methane tanker 70 from or to the terrestrial installation 77. The latter includes liquefied gas storage tanks 80 and connecting pipes 81 connected via the underwater pipe 76 to the loading or offloading station 75. The underwater pipe 76 enables transfer of the liquefied gas between the loading or offloading station 75 and the terrestrial installation 77 over a great distance, for example 5 km, which enables the methane tanker ship 70 to remain at a great distance from the coast during loading and offloading operations.

[0110] Pumps onboard the ship 70 and/or pumps equipping the terrestrial installation 77 and/or pumps equipping the loading and offloading station 75 are used to generate the pressure necessary to transfer the liquefied gas.

[0111] Although the invention has been described in connection with a plurality of particular embodiments, it is obvious that it is in no way limited to them and that it encompasses all

technical equivalents and combinations of the means described if the latter fall within the scope of the invention.

[0112] The use of the verb "to include" or "to comprise" and conjugate forms thereof does not exclude the presence of elements or steps other than those stated in a claim.

- 5 [0113] In the claims, any reference sign between parentheses should not be interpreted as a limitation of the claim.

Claims

[Claim 1] Dome structure (12) for a sealed and thermally-insulating tank, the dome structure including a plurality of lateral dome walls (13, 14, 15, 16) intended to project vertically from a ceiling wall of the tank and defining a passage intended to have passed through it at least one pipe (21) for loading or offloading liquefied gas into or from the tank and a horizontal lid (17) that closes the passage, the plurality of lateral dome walls comprising a first lateral dome wall comprising a corrugated sealing membrane (32), the corrugated sealing membrane including at least one corrugation (33) that projects in the direction of the passage, the dome structure (12) including at least one insulating block (31) anchored against a lower face of the lid, said insulating block and the corrugation (33) being, in projection in a horizontal plane, spaced from one another by a first distance, an insulating lining including one or more lining elements (40, 41, 42), said insulating lining being adjacent to the first lateral wall (15), placed against the lid (17) and disposed between the insulating block and the first lateral wall, the or each lining element (40, 41, 42) having a thickness in a direction orthogonal to the first lateral dome wall that is less than the first distance or being adapted to be compressed in the direction orthogonal to the first lateral dome wall that is less than the first distance, a retaining plate (35) being anchored to a lower surface of the insulating block and extending under the insulating lining.

[Claim 2] Dome structure (12) according to claim 1 in which the retaining plate (35) is placed at a distance from the sealing membrane (32).

[Claim 3] Dome structure (12) according to claim 2 in which a distance between the retaining plate (35) and the sealing membrane (32) is between 5 mm and 25 mm inclusive.

[Claim 4] Dome structure (12) according to any one of the preceding claims in which the retaining plate (35) is made of wood.

[Claim 5] Dome structure (12) according to any one of the preceding claims in which the at least one insulating lining element (40, 41, 42) is made of a material chosen from glass wool, rock wool and polyester wadding.

[Claim 6] Dome structure (12) according to any one of claims 1 to 4, in which the at least one insulating lining element (40, 41, 42) is made of insulating polymer foam.

[Claim 7] Dome structure (12) according to any one of the preceding claims in which the corrugated sealing membrane (32) comprises vertical corrugations and in which the insulating lining includes a plurality of lining elements (40, 41, 42) of which a contact

element (41) is placed against the sealing membrane between two successive vertical corrugations.

[Claim 8] Dome structure (12) according to claim 6 in combination with claim 7 in which the contact lining element (41) has bevelled ends (43).

5 [Claim 9] Dome structure (12) according to claim 7 or 8 in which the contact lining element (41) has a thickness in a direction normal to the lateral dome wall identical to a corrugation height.

[Claim 10] Dome structure (12) according to claim 9 in which said lining elements (40, 41, 42) include a secondary lining element (42), the secondary lining element extending in a space between the contact lining element (41) and the insulating block (31) and having a dimension in a direction normal to a plane of symmetry of the vertical corrugations greater than a dimension of the contact lining element (41) in said direction.

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[Claim 11] Dome structure (12) according to any one of the preceding claims in which the sealing membrane (32) is, in a portion arranged above the retaining plate (35), covered with insulating lining elements.

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[Claim 12] Dome structure (12) according to any one of the preceding claims in which at least one insulating block is anchored to the lid by means of a stud, the stud passing through the at least one insulating block completely, a bearing plate being positioned against a lower face of the at least one insulating block, a nut being screwed onto the stud and retaining the bearing plate.

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[Claim 13] Sealed and thermally-insulating tank including a dome structure (12) according to any one of claims 1 to 12.

[Claim 14] Sealed and thermally-insulating tank according to claim 13 including a loading/offloading tower (21) comprising at least two vertical masts passing through the lid and fixed to one another by crossmembers, each of the two vertical masts forming a pipe for loading or offloading the tank.

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[Claim 15] Ship for the transportation of a fluid, the ship including a sealed and thermally-insulating tank according to claim 13 or 14.

[Claim 16] Transfer system for a fluid, the system including a ship according to claim 15, insulated pipes arranged in such a manner as to connect the tank of the ship to a floating or terrestrial storage installation, and a pump for driving a fluid through the insulated pipes from or to the floating or terrestrial storage installation to or from the tank of the ship.

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[Claim 17] Method of assembling a dome structure (12) for a sealed and thermally-insulating tank, said dome structure including a plurality of lateral dome walls intended

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to project vertically from a ceiling wall of the tank and defining a passage intended to have passed through it at least one pipe for loading or offloading liquefied gas into or from the tank and a horizontal lid that closes the passage, the plurality of lateral dome walls (13, 14, 15, 16) comprising a first lateral dome wall (15) comprising a corrugated sealing membrane (32), the corrugated sealing membrane including at least one corrugation (33) that projects in the direction of the passage, the dome structure including at least one insulating block (31) anchored against a lower face of the lid (17), said insulating block (31) and the corrugation (33) being, in projection in a horizontal plane, spaced from one another by a first distance, the assembly method including the following steps:

- disposing an insulating lining including one or more lining elements (40, 41, 42) between the insulating block (31) and the first lateral wall (15), the or each lining element having a thickness in a direction orthogonal to the first lateral dome wall that is less than the first distance or being compressed in the direction orthogonal to the first lateral wall until it has a thickness in a direction orthogonal to the first lateral dome wall that is less than the first distance,
- anchoring a retaining plate (35) to a lower surface of the insulating block, the retaining plate extending under the insulating lining so as to hold it in place.

[Claim 18] Assembly method according to the preceding claim in which the at least one lining element (40, 41, 42) is inserted vertically in a space between the corrugated sealing membrane (32) and the insulating block (31) and is then moved so as to come into the contact with the corrugated sealing member (32).

[Claim 19] Assembly method according to claim 17 or 18 in which the at least one insulating block (31) is fixed beforehand to the lid (17) by means of a stud (36), the stud passing through the at least one insulating block (31) completely, a bearing plate being positioned against a lower face of the at least one insulating block, a nut being screwed onto the stud and retaining the bearing plate.

[Claim 20] Assembly method according to any one of claims 17 to 19 in which lining elements (40, 41, 42) cover the corrugated sealing membrane (32).

[Claim 21] Assembly method according to preceding claim in which the insulating lining includes a plurality of lining elements (40, 41, 42) including a contact lining element (41) and a secondary lining element (42), the step of disposing the insulating lining including:

- disposing the contact lining element (41) between two successive vertical corrugations, the contact lining element having a height identical to a corrugation height,

- disposing the secondary lining element in an interstice (34) between the contact lining element (41) and the at least one insulating block (31), the secondary lining element having a dimension in a direction normal to a plane of symmetry of the corrugations longer than a dimension of the contact lining elements in said direction.

5 [Claim 22] Assembly method according to the preceding claim in which the contact lining element (41) has ends (43) bevelled before being inserted into the space between the corrugated sealing membrane (32) and the insulating block (31).

[Claim 23] Method of loading or offloading a ship according to claim 15 in which a fluid is routed through insulated pipes from or to a floating or terrestrial storage installation to
10 or from the tank of the ship.