

Description

Title of the invention: Liquefied gas storage installation comprising a dome structure supporting a spray boom

Technical field

[0001] The invention relates to the field of the sealed and thermally insulating tanks for storing and/or transporting a liquefied gas, such as tanks for transporting Liquefied Petroleum Gas (also called LPG) having, for example, a temperature of between -50°C and 0°C, or for transporting Liquefied Natural Gas (LNG) at approximately -162°C at atmospheric pressure.

[0002] These tanks can be installed onshore or on a floating structure. In the case of a floating structure, the tank can be intended for the transportation of liquefied gas or to receive liquefied gas serving as fuel for the propulsion of the floating structure.

[0003] The invention relates more particularly to a tank comprising a dome structure which passes through an aperture produced in the ceiling wall of the tank and which is equipped with a spray boom intended to spray liquefied gas inside the tank.

Technological background

[0004] The document KR20140088975 discloses a dome structure for a sealed and thermally insulating tank for storing a liquefied gas. The dome structure comprises:

- an inner drum which passes through an aperture formed in the bearing structure of the ceiling wall, passes through the ceiling wall of the tank and is tightly welded to the primary sealing membrane of the ceiling wall;
- an outer drum which is disposed around the inner drum and is welded to the bearing structure around the aperture passed through by the inner drum;
- a support duct intended for the venting of gas which passes through the inner drum; and
- a spray boom which is intended to spray liquefied gas into the support duct and which is mounted on a crown ring fixed to the bottom end of the support duct.

[0005] Such a dome structure is not fully satisfactory. In particular, the diameter of the inner drum is particularly important. Indeed, the diameter of the inner drum must be greater than the diameter of the spray boom and of the crown ring which supports it in order to allow them to pass through the inner drum when the support duct is lowered into the spray boom, when the dome structure is mounted. Now, since the primary sealing membrane is welded to the inner drum, the diameter of the inner drum should be limited so as to limit the loss of elasticity of the primary sealing membrane in the zone of welding to the inner drum.

[0006] In addition, the interior of the inner drum is likely to be subjected to dynamic pressures due to the “sloshing” effect, that is to say due to the movement of the cargo in the tank. The movement of the cargo is also likely to create the undesirable presence of liquefied gas in the dome structure and in gas extraction ducts emerging in the dome structure. Now, such gas extraction ducts can notably be equipped with a compressor likely to be damaged by the presence of liquefied gas.

Summary

[0007] One idea on which the invention is based is to design a liquefied gas storage installation comprising a dome structure of the above-mentioned type that makes it possible to resolve the above-mentioned drawbacks and in particular limit the losses of elasticity of the sealing membranes caused by the welding of said sealing membranes to the inner drum of the dome structure.

[0008] According to one embodiment, the invention relates to a liquefied gas storage installation comprising a bearing structure defining an internal space and comprising a top bearing wall comprising an aperture, and a sealed and thermally insulating tank comprising a ceiling wall comprising at least one thermally insulating barrier fixed to the top bearing wall and a sealing membrane intended to be in contact with the liquefied gas, the installation comprising a dome structure comprising:

- an outer drum extending outside of the bearing structure and comprising a bottom end welded around the aperture of the bearing structure;
- an inner drum which passes through the aperture of the bearing structure and of the ceiling wall, extends inside the outer drum and comprises a bottom end which is welded to the sealing membrane;
- a support duct which passes through the inner drum and comprises a bottom portion extending beyond the bottom end of the inner drum;
- a supply duct intended to be supplied with liquefied gas which is fixed to the support duct;
- a crown ring which supports a spray boom and is fixed to the bottom portion of the support duct, the spray boom comprising a plurality of spray nozzles and being coupled to said supply duct, the crown ring having a diameter greater than the diameter of the inner drum.

[0009] According to one embodiment, the invention also provides a method for mounting a dome structure of a liquefied gas storage installation, said method comprising:

- providing a bearing structure defining an internal space and comprising a top bearing wall intended to receive a ceiling wall of a sealed and thermally insulating tank, the top bearing wall comprising an aperture;

- providing a gas dome structure comprising:
 - an outer drum extending outside of the bearing structure and comprising a bottom end welded around the aperture of the bearing structure;
 - an inner drum which passes through the aperture of the bearing structure, extends inside the outer drum, and is anchored to said outer drum;
 - a support duct which passes through the inner drum and comprises a bottom portion extending beyond the bottom end of the inner drum; and
 - a supply duct intended to be supplied with liquefied gas which is fixed to the support duct;
- providing a crown ring supporting a spray boom which comprises a plurality of spray nozzles; said crown ring having a diameter greater than a diameter of the inner drum;
- displacing the crown ring from the internal space until the crown ring comes into contact with the support duct;
- fixing the crown ring to the support duct; and
- tightly coupling an upstream end of the spray boom to a downstream end of the supply duct.

[0010] Thus, such an installation and such a method are particularly advantageous in that, for a determined diameter of installation of the spray boom, the diameter of the inner drum is smaller, which makes it possible in particular to limit the loss of elasticity of the sealing membrane. In addition, the crown ring thus makes it possible to protect the interior of the inner drum against the movements of liquefied gas inside the tank. More specifically, the crown ring makes it possible in particular to avoid the presence of liquefied gas in gas extraction ducts including a compressor.

[0011] According to embodiments, such an installation and such a method can comprise one or more of the following features.

[0012] According to one embodiment, the support duct comprises a fixing collar which extends radially around the support duct and the crown ring comprises an annular bottom which is fixed against a bottom face of the fixing collar. Such an arrangement allows the crown ring to be fixed simply to the support duct by the internal space.

[0013] According to one embodiment, the annular bottom of the crown ring comprises openings which are distributed around the support duct and which have edges welded to the fixing collar. This contributes also to allowing the fixing of the crown ring to the support duct by the internal space.

- [0014] According to one embodiment, the fixing collar and the annular bottom comprise orifices configured to allow the passage of fixing members through the fixing collar and the annular bottom.
- [0015] According to one embodiment, the fixing collar and the annular bottom each comprise an aperture, said apertures being positioned facing one another and passed through by the supply duct.
- [0016] According to one embodiment, the spray boom is coupled to said supply duct in a weld zone positioned below the annular bottom.
- [0017] According to one embodiment, the bottom portion of the support duct comprises a base wall which closes a bottom end of the support duct and windows which are formed in a cylindrical wall of the bottom portion of the support duct and the weld zone is positioned facing one of the windows. This facilitates the welding operations, and in particular the handling of the welding torch.
- [0018] According to one embodiment, the support duct comprises a fixing collar which extends radially around the support duct and the crown ring comprises an annular bottom and, in order to fix the crown ring to the support duct, the annular bottom of the crown ring is welded against a bottom face of the fixing collar.
- [0019] According to one embodiment, prior to the welding of the annular bottom of the crown ring against the bottom face of the fixing collar, the fixing collar and the annular bottom are fixed to one another by means of fixing members.
- [0020] According to one embodiment, the fixing members are temporary fixing members.
- [0021] According to one embodiment, the temporary fixing members are removed after the operations of welding of the annular bottom of the crown ring against the bottom face of the fixing collar. This prevents the fixing members from becoming separated from and thus damaging the bottom wall of the tank and in particular its primary sealing membrane.
- [0022] According to one embodiment, the annular bottom of the crown ring comprises openings which are distributed around the support duct and the edges of said openings are welded to the fixing collar.
- [0023] According to one embodiment, the bottom portion of the support duct comprises a base wall which closes a bottom end of the support duct and windows which are formed in a cylindrical wall of the bottom portion of the support duct and the upstream end of the spray boom is welded to the downstream end of the supply duct in a weld zone which is positioned facing one of the windows.

[0024] According to one embodiment, the dome structure comprises a protection plate fixed to the bottom end of the support duct, the protection plate covering the crown ring and having a plurality of holes.

[0025] According to one embodiment, the inner drum is anchored to said outer drum.

[0026] According to one embodiment, the inner drum is anchored to the outer drum by a top anchoring device and a bottom anchoring device.

[0027] According to one embodiment, the inner drum is anchored to the outer drum, by a bottom anchoring device, which is positioned at a distance h from the bottom end of the inner drum, the distance h is determined such that the contraction Δh of the distance h when the tank is cooled lies between 90 and 110% Δl , with:

Δl the vertical displacement of the sealing membrane 17 due to the contraction of the primary 15 and secondary 12 thermally insulating barriers when the tank is cooled.

[0028] Such an installation can form part of an onshore storage installation, for example for storing LNG, or be installed in a floating, coastal or deep-water structure, notably a methane tanker vessel, a floating storage and regasification unit (FSRU), a floating production, storage and offloading (FPSO) unit, and the like. Such a tank can also serve as fuel reservoir in any type of vessel.

[0029] According to one embodiment, a vessel for transporting a liquefied gas comprises a liquefied gas storage installation of the above-mentioned type.

[0030] According to one embodiment, the invention also provides a transfer system for a liquefied gas, the system comprising the above-mentioned vessel, insulated pipelines arranged so as to link the tank of the liquefied gas storage installation of the vessel to a floating or onshore storage installation and a pump for driving a flow of liquefied gas through the insulated pipelines from or to the floating or onshore storage installation to or from the tank of the liquefied gas storage installation of the vessel.

[0031] According to one embodiment, the invention also provides a method for loading or offloading such a vessel, in which a liquefied gas is conveyed through insulated pipelines from or to a floating or onshore storage installation to or from the liquefied gas storage installation of the vessel.

Brief description of the figures

[0032] The invention will be better understood, and other aims, details, features and advantages thereof will become more clearly apparent from the following description of several particular embodiments of the invention, given in a purely illustrative and nonlimiting manner, with reference to the attached drawings.

[0033] [fig.1] Figure 1 is a schematic perspective view of a bearing structure intended to support a sealed and thermally insulated liquefied gas storage tank, the dome structure not being represented.

[0034] [fig.2] Figure 2 is a schematic view of the multilayer structure of the walls of the tank.

[0035] [fig.3] Figure 3 is a cross-sectional view of a dome structure, according to an embodiment, passing through a ceiling wall of a sealed and thermally insulating tank.

[0036] [fig.4] Figure 4 is another cross-sectional view of the dome structure of figure 3.

[0037] [fig.5] Figure 5 is a cross-sectional and perspective view of the dome structure of figure 2, passing through the ceiling wall of the sealed and thermally insulating tank.

[0038] [fig.6] Figure 6 is a detail view of the dome structure of figures 2 and 3 illustrating, in particular, a spray boom and a support crown ring ensuring the fixing of the spray boom to a support duct.

[0039] [fig.7] Figure 7 is a bottom view of the support crown ring and of the spray boom.

[0040] [fig.8] Figure 8 is a bottom perspective view of the support crown ring and of the spray boom.

[0041] [fig.9] Figure 9 is a bottom perspective view illustrating another embodiment in which a protection plate is positioned below the support crown ring.

[0042] [fig.10] Figure 10 is a cutaway schematic representation of a vessel comprising a liquefied natural gas storage tank and a terminal for loading/offloading this tank.

Description of the embodiments

[0043] Regarding figure 1, a bearing structure 1 is described, against which a sealed and thermally insulating liquefied gas storage tank is intended to be fixed. The bearing structure 1 is, for example, formed by the double hull of a vessel. The double hull comprises an outer hull 19 and an inner hull 18 disposed inside the outer hull 19. The bearing structure 1 has a generally polyhedral form. It has two, front and rear, bearing walls, here of octagonal form, of which only the rear bearing wall 2 is represented in figure 1. The front and rear walls 2 are, for example, cofferdam walls of the vessel which extend transversely to the longitudinal direction of the vessel. The bearing structure 1 also comprises a top bearing wall 3, a bottom bearing wall 4 and lateral bearing walls 5, 6, 7, 8, 9, 10. The sealed and thermally insulating liquefied gas storage tank comprises a plurality of tank walls which are each anchored against one of the bearing walls 2, 3, 5, 6, 7, 8, 9, 10 of the bearing structure 1 and which thus define an internal space intended to contain the liquefied gas.

[0044] As represented in figure 2, each wall of the tank has, in succession, from the outside to the inside, in the thicknesswise direction of the wall:

- a secondary thermally insulating barrier 12 comprising insulating elements 13 fixed to the bearing structure 1;
- a secondary sealing membrane 14 anchored to the insulating elements 13 of the secondary thermally insulating barrier 12;
- a primary thermally insulating barrier 15 comprising insulating elements 16 fixed to the insulating elements 13 of the secondary thermally insulating barrier 12 or to the bearing structure 1 and resting against the secondary sealing membrane 14; and
- a primary sealing membrane 17 anchored to the insulating elements 16 of the primary thermally insulating barrier 15 and intended to be in contact with the liquefied gas contained in the tank.

[0045] The liquefied gas intended to be stored in the tank can notably be ethane, liquefied natural gas (LNG), that is to say a gaseous mixture mostly comprising methane and one or more other hydrocarbons, or liquefied petroleum gas (LPG), that is to say a mixture of hydrocarbons derived from the refining of the oil essentially comprising propane and butane.

[0046] In the embodiment represented in figures 3 and 4, the insulating elements 13 of the secondary thermally insulating barrier 12 are secondary insulating panels 20 comprising a layer of insulating polymer foam 21, for example made of polyurethane, sandwiched between a cover plate 22 and a bottom plate 23 that are rigid, for example made of plywood.

[0047] The secondary sealing membrane 14 is formed by a continuous sheet of strakes with raised edges. Each strake has a flat central portion resting on the cover plate of the secondary insulating panels 20 and two raised edges protruding toward the interior of the tank. The strakes are welded by their raised edges onto weld supports which are fixed in the grooves formed on the cover plates of the secondary insulating panels 20. The strakes are, for example, produced in Invar®, that is to say an alloy of iron and nickel, the coefficient of expansion of which is typically between $1.2 \times 10^{-6} \text{ K}^{-1}$ and $2.0 \times 10^{-6} \text{ K}^{-1}$. It is also possible to use alloys of iron and manganese, the coefficient of expansion of which is typically of the order of $7 \times 10^{-6} \text{ K}^{-1}$ to $10 \times 10^{-6} \text{ K}^{-1}$.

[0048] The insulating elements 16 of the primary thermally insulating barrier 15 are primary insulating panels 24 comprising a layer of insulating polymer foam, for example made of polyurethane, sandwiched between a cover plate and a bottom plate that are rigid, for example made of plywood.

[0049] The primary sealing membrane 17 is obtained by assembling a plurality of corrugated metal sheets, that are welded to one another along their edges. The corrugations protrude toward the interior of the tank. The corrugated metal sheets are fixed onto anchoring bands which are fixed in countersinks formed in the cover plates of the primary insulating panels 24. The corrugated metal sheets are, for example, produced in stainless steel or in aluminum.

[0050] Alternatively, the walls of the tank can also be produced according to the technologies described in the patent applications WO14057221, FR2691520 and FR2877638 respectively targeting the Mark V, Mark III® and NO96® products developed by the applicant.

[0051] Regarding figures 3 and 4, a dome structure 25 is described hereinbelow according to one embodiment. The dome structure 25 comprises an outer drum 26, of cylindrical form, which extends in the thicknesswise direction of the ceiling wall of the tank. The outer drum 26 passes through an aperture formed in the outer hull 19. The bottom end of the outer drum 26 is tightly welded to the inner hull 18, around an aperture 27 formed in said inner hull 18. The top end of the outer drum 26 is tightly closed by a removable cover 28.

[0052] The dome structure 25 also comprises an inner drum 29 which is disposed inside the outer drum 26. The inner drum 29 is concentric to the outer drum 26 and passes through the aperture 27 formed in the inner hull 18. The inner drum 29 passes also through the top wall of the tank. The inner drum 29 comprises a bottom end which is tightly welded to the primary sealing membrane 17 so as to ensure the seal-tightness of the primary thermally insulating barrier 15 with respect to the internal space of the tank. The inner drum 29 comprises a compensation device 30, formed by a series of bellows, making it possible to confer upon it a flexibility in its longitudinal direction so as to allow the contraction and expansion thereof. The outer drum 26 and the inner drum 29 are anchored to one another by a top anchoring device 31 and a bottom anchoring device 32 which will be described later. The inner drum 29 is open at each of its two ends.

[0053] The dome structure 25 also comprises a support duct 33 which is concentric to the inner drum 29 and passes through it. This support duct 33 has two main functions, namely to ensure the support of a spray boom 34 intended to spray liquefied gas inside the tank and to conduct the vapor phase of the gas from the internal space of the tank to a collection zone 35 positioned at the top end of the dome structure 25.

[0054] The support duct 33 comprises a support collar 36 which is welded to the top end of the support duct 33 and which protrudes radially outward. The support collar 36 rests

against an annular flange 37 which is welded to the outer drum 26 and protrudes radially inward. The support collar 36 and the annular flange 37 are tightly welded to one another.

[0055] The dome structure 25 also comprises a crown ring 38 which bears the spray boom 34 and which is fixed to the bottom end of the support duct 33. In the embodiment represented, the crown ring 38 comprises an annular bottom 39 which extends in a plane orthogonal to the thicknesswise direction of the ceiling wall, around the support duct 33. The crown ring 38 also comprises a cylindrical rim 40 which protrudes downward from the radially outer edge of the annular bottom 39. In the embodiment represented, the annular bottom 39 and the cylindrical rim 40 are fixed to one another by a plurality of cleats welded to said annular bottom 39 and to said cylindrical rim 40.

[0056] The annular bottom 39 is welded against a fixing collar 41 which is welded to the support duct 33 and extends radially around the latter. The fixing collar 41 is positioned at a distance from the bottom end of the support duct 33 such that a bottom portion of the support duct 33 extends below the annular bottom 39 of the crown ring 38.

[0057] The bottom portion of the support duct 33 comprises a base wall 42 which closes the bottom end of the support duct 33 and windows 43 which are formed in the cylindrical wall of the bottom portion. There are at least two windows 43 and there are four of them in the embodiment represented. The windows 43 are regularly distributed around the axis of the support duct 33. Such a structure prevents gas in the liquid phase from being introduced into the support duct 33.

[0058] The spray boom 34 comprises one or more rings 44 disposed around the crown ring 38 and more particularly around the cylindrical rim 40. Each ring 44 comprises a plurality of spray nozzles 45 which are regularly distributed around the central axis of the crown ring 38. Each ring 44 is fixed to the crown ring 38 by any appropriate means, such as fixing clamps 46, visible in particular in figure 7 or fixing clips for example. Furthermore, the cylindrical rim 40 has a groove allowing a bent portion of the spray boom 34 to pass through said cylindrical rim 40 so as to link each ring 44 to a supply duct 47.

[0059] Moreover, as represented for example in figures 6 to 8, each ring 44 of the spray boom 34 is coupled to a supply duct 47 intended to supply the spray boom 34 with liquefied gas. As represented for example in figure 3, the supply ducts 47 pass through the inner drum 29 and the outer drum 26 from one end to the other. The supply ducts 47 are coupled to a pump, not illustrated, which is configured to pump liquefied gas, for example into the tank or into a dedicated reservoir. It will be seen, in figure 3, that the supply ducts 47 each have a helical zone 48 winding around the support duct 33 and thus allowing the thermal contractions and expansions of said supply ducts 47. Moreover, the supply ducts 47 are

fixed to the support duct 33, by anchoring devices 49, visible in particular in figure 3. The anchoring devices 49 are regularly distributed along the support duct 33. Advantageously, the anchoring devices 49 ensure a sliding anchoring of the supply ducts 47, that is to say that they allow the relative displacement of the supply ducts 47 with respect to the support duct 33 in order to allow them to contract and expand.

[0060] As represented in figure 3, the diameter d_2 of the inner drum 29 is less than the diameter d_1 of the crown ring 38. Similarly, the diameter d_3 of the aperture 27 formed in the inner hull 18 is, preferably, less than the diameter d_2 of the crown ring 38. Such an arrangement offers several advantages over an arrangement according to the state-of-the-art in which the diameter d_2 of the inner drum 29 is greater than that of the crown ring 38. On the one hand, for a determined diameter of installation of the spray boom 34, the diameter d_2 of the inner drum 29 is smaller, which makes it possible in particular to interrupt a more limited number of corrugations of the primary sealing membrane 17, thus limiting the loss of elasticity of said primary sealing membrane 17 resulting from these interruptions. On the other hand, the crown ring 38 makes it possible to protect the interior of the inner drum 29 against the movements of liquefied gas inside the tank. More specifically, the crown ring 38 makes it possible to avoid the presence of liquefied gas in gas extraction ducts including a compressor. As will be described later, in order to allow the installation of such a dome structure 25, the assembly comprising the crown ring 38 and the spray boom 34 is fixed to the support duct 33, from the internal space of the tank, and after said support duct 33 has been lowered through the inner drum 29.

[0061] Returning to figure 3, the top anchoring device 31 and the bottom anchoring device 32 which ensure the fixing of the inner drum 29 to the outer drum 26 can be observed. The top anchoring device 31 comprises a support collar 50 which is welded to the inner drum 29 and protrudes radially outward, around the latter and an annular flange 51 which is welded to the outer drum 26 and protrudes radially toward the interior thereof. The support collar 50 rests against the annular flange 51. The support collar 50 and the annular flange 51 are tightly welded to one another. Thus, a secondary sealed space 52 is formed between the outer drum 26 and the inner drum 29, below said support collar 50 and annular flange 51. According to an advantageous embodiment, an insulating layer 65, represented by dotted lines in figures 3 and 4, is distributed uniformly over the outer reach of the inner drum 29.

[0062] Moreover, the bottom anchoring device 32 comprises a tapered support element 53 which flares out downward and which is welded to the inner drum 29 around the latter. It also comprises a support ring which is welded to the radially outer edge of the tapered support element 53 and which comprises a support collar 54 which protrudes radially

outward. The bottom anchoring device 32 also comprises an annular flange 55 which is welded to the outer drum 26 and protrudes radially toward the interior thereof. The support collar 54 rests on the annular flange 55 directly or indirectly via a filler block 56 interposed between said support collar 54 and said annular flange 55 as in the embodiment represented. The filler block 56 is, for example, made of wood and glued, for example by means of resin, against the support collar 54 and against the annular flange 55. Advantageously, the thickness of the filler block 56 is determined in order to take up the manufacturing and/or positioning tolerances of the inner drum 29 with respect to the outer drum 26 in the thicknesswise direction of the ceiling wall of the tank.

[0063] The inner drum 29 is anchored to the outer drum 26 at a distance h from the bottom end. According to an advantageous embodiment, the distance h is determined such that its contraction Δh when the tank is cooled is substantially equal to the vertical displacement Δl of the primary sealing membrane 17 because of the contraction of the primary 15 and secondary 12 thermally insulating barriers. This prevents, or at the very least limits, any step effect between the primary sealing membrane 17 and the bottom end of the inner drum 29.

[0064] The dome structure 25 comprises, in addition, a sheath 57, visible in figures 3 and 4, which is concentric to the outer drum 26 and which is disposed radially between the outer drum 26 and the inner drum 29. The sheath 57 passes also through the aperture 27 formed in the inner hull 18. A sealed primary space 58 connecting with the primary thermally insulating barrier 15 is formed between the sheath 57 and the inner drum 29.

[0065] As represented in figure 4, the dome structure 25 comprises an exhaust duct 59 which emerges inside the sealed primary space 58. The exhaust duct 59 is linked to a valve, not illustrated, which, by default, is closed and which opens when the pressure in the primary thermally insulating barrier 15 exceeds a predetermined threshold pressure. The exhaust duct 59 is thus intended to protect the primary sealing membrane 17 against the overpressures likely to be manifested in the primary thermally insulating barrier 15. Advantageously, the exhaust duct 59 comprises a helical zone winding around the inner drum 29 and thus allowing the thermal contractions and expansions of said exhaust duct 59.

[0066] The dome structure 25 also comprises an inerting duct 60 which emerges also inside the sealed primary space 58. The inerting duct 60 is linked to a reservoir of inert gas, such as nitrogen, by a pump, which makes it possible to circulate inert gas in the primary thermally insulating barrier 15.

[0067] Moreover, as represented in figure 4, the sheath 57 is not welded to the inner hull 18 of the double hull so as to form an annular passage between said sheath 57 and the inner hull 18. An exhaust duct 61 and an inerting duct 62, visible in figure 4, pass tightly through the outer drum 26 to emerge in the secondary sealed space 52. The exhaust duct 61 is linked to a valve which, by default, is closed and which opens when the pressure inside the secondary thermally insulating barrier 12 exceeds a predetermined threshold. It thus makes it possible to protect the secondary sealing membrane 14 against the overpressures likely to be manifested in the secondary thermally insulating barrier 12. The inerting duct 62 is linked to a reservoir of inert gas, such as nitrogen, by a pump, which makes it possible to circulate the inert gas in the secondary thermally insulating barrier 12.

[0068] Moreover, the dome structure 25 comprises at least one vapor collection duct 63, 64 which passes tightly through the wall of the outer drum 26 and emerges in the collection zone 35 positioned at the top end of the dome structure 25. Thus, the vapor collection duct or ducts 63, 64 are able to conduct the vapor between the collection zone 35 and a vapor collector, not represented, disposed outside of the dome structure 25.

[0069] A method for mounting a dome structure 25, as described above, will now be described. Firstly, a first part of the dome structure 25 which does not have the crown ring 38 and the spray boom 34 is mounted and it is fixed to the bearing structure 1. For that, the outer drum 26 is tightly welded to the inner hull 18, around the aperture 27. The inner drum 29 is lowered into the outer drum 26 via the top end of the outer drum 26. In order to allow this movement, the inner diameter of the annular flange 37 is greater than the outer diameters of the support collars 50, 54 and the inner diameter of the annular flange 51 is greater than the outer diameter of the support collar 54. The support duct 33 is also lowered through the outer drum 26 and the inner drum 29 until the support collar 36 welded to the support duct 33 rests against the annular flange 37.

[0070] Secondly, the crown ring 38 and the spray boom 34 fixed to said crown ring 38 are brought close to the support duct 33 through the internal space of the tank and fixed thereto. For this, as represented in figure 8, the fixing collar 41 and the crown ring 38 include orifices 66 which are configured to be positioned facing one another and thus allow the passage of temporary fixing members 67 through said orifices 66. As an example, the temporary fixing members 67 comprise a screw-nut assembly. Moreover, the crown ring 38 and more particularly the annular bottom 39 include openings 68 which are regularly distributed around the support duct 33 and which make it possible to weld the crown ring 38 to the fixing collar 41 from below. Thus, the edges of the openings 68 are welded to the fixing collar 41. After the operations of welding of the crown ring 38 to the fixing collar 41,

the temporary fixing members 67 can then be removed, which avoids having them drop subsequently inside the tank and thus damage the primary sealing membrane 17.

[0071] The spray boom 34 is also coupled to one or more supply ducts 47. For this, as illustrated in figure 7, the annular bottom 39 of the crown ring 38 and the fixing collar 41 each include an aperture 69 allowing the supply ducts 47 to pass through the fixing collar 41 and the annular bottom 39 of the crown ring 38. In order to ensure the seal-tightness of the coupling, the spray boom 34 is welded to the supply ducts 47 in weld zones 82, one of which is notably represented by dotted lines in figure 8. In order to facilitate the welding operations and in particular the handling of the welding torch, the weld zones 82 are, preferably, situated radially facing one of the windows 43 formed in the bottom portion of the support duct 33.

[0072] Figure 9 illustrates a dome structure 25 according to another embodiment. This embodiment differs from that described above in relation to figures 3 to 8 in that the dome structure further comprises a protection plate 83 which is fixed to the bottom end of the support duct 33. This protection plate 83 covers the crown ring 38. It has a plurality of holes 84 allowing the gas in vapor phase to enter into the support duct via the windows 43. Such a protection plate 83 notably makes it possible to protect the crown ring 38 against the movements of liquefied gas in liquid phase inside the tank and avoid even more having liquefied gas in liquid phase reach the interior of the support duct 33 and the gas extraction line including a compressor.

[0073] Referring to figure 10, a cutaway view of a methane tanker vessel 70 shows a sealed and thermally insulating tank 71 of generally prismatic form mounted in the double hull 72 of the vessel. The wall of the tank 71 comprises a primary sealing membrane intended to be in contact with the LNG contained in the tank, a secondary sealing membrane arranged between the primary sealing membrane and the double hull 72 of the vessel, and two thermally insulating barriers arranged respectively between the primary sealing membrane and the secondary sealing membrane and between the secondary sealing membrane and the double hull 72.

[0074] As is known per se, loading/offloading pipelines 73 disposed on the top deck of the vessel can be coupled, by means of appropriate connectors, to a maritime or port terminal to transfer a cargo of LNG from or to the tank 71.

[0075] Figure 10 represents an example of maritime terminal comprising a loading and offloading station 75, a submarine duct 76 and an onshore installation 77. The loading and offloading station 75 is a fixed offshore installation comprising a movable arm 74 and a tower 78 which supports the movable arm 74. The movable arm 74 bears a bundle of

insulated flexible pipes 79 that can be connected to the loading/offloading pipelines 73. The orientable movable arm 74 adapts to all methane tanker templates. A link duct that is not represented extends inside the tower 78. The loading and offloading station 75 makes it possible to load and offload the methane tanker 70 from or to the onshore installation 77. The latter comprises liquefied gas storage tanks 80 and link ducts 81 linked by the submarine duct 76 to the loading or offloading station 75. The submarine duct 76 allows the transfer of the liquefied gas between the loading or offloading station 75 and the onshore installation 77 over a great distance, for example 5 km, which makes it possible to keep the methane tanker vessel 70 at a great distance from the coast during the loading and offloading operations.

[0076] To generate the pressure necessary to the transfer of the liquefied gas, pumps embedded in the vessel 70 and/or pumps with which the onshore installation 77 is equipped and/or pumps with which the loading and offloading station 75 is equipped are implemented.

[0077] Although the invention has been described in association with several particular embodiments, it is quite obvious that it is in no way limited thereto and that it encompasses all the technical equivalents of the means described and the combinations thereof if they fall within the framework of the invention, as defined by the claims.

[0078] The use of the verb “comprise” or “include” and its conjugate forms does not preclude the presence of elements or steps other than those stated in a claim.

[0079] In the claims, any reference symbol between parentheses should not be interpreted as a limitation of the claim.

Claims

[Claim 1] A liquefied gas storage installation comprising a bearing structure (1) defining an internal space and comprising a top bearing wall (3) comprising an aperture (27), and a sealed and thermally insulating tank comprising a ceiling wall comprising at least one thermally insulating barrier (12, 15) fixed to the top bearing wall (3) and a sealing membrane (17) intended to be in contact with the liquefied gas, the installation comprising a dome structure (25) comprising:

- an outer drum (26) extending outside the bearing structure (1) and comprising a bottom end welded around the aperture (27) of the bearing structure (1);
- an inner drum (29) which passes through the aperture (27) of the bearing structure (1) and of the ceiling wall, extends inside the outer drum (26) and comprises a bottom end which is welded to the sealing membrane (17);
- a support duct (33) which passes through the inner drum (29) and comprises a bottom portion extending beyond the bottom end of the inner drum (29);
- a supply duct (47) intended to be supplied with liquefied gas which is fixed to the support duct (33);
- a crown ring (38) which supports a spray boom (34) and is fixed to the bottom portion of the support duct (33), the spray boom (34) comprising a plurality of spray nozzles (45) and being coupled to said supply duct (47), the crown ring (38) having a diameter (d1) greater than a diameter (d2) of the inner drum (29).

[Claim 2] The liquefied gas storage installation as claimed in claim 1, wherein the support duct (33) comprises a fixing collar (41) which extends radially around the support duct (33) and the crown ring (38) comprises an annular bottom (39) which is fixed against a bottom face of the fixing collar (41).

[Claim 3] The liquefied gas storage installation as claimed in claim 2, wherein the annular bottom (39) of the crown ring (38) comprises openings (68) which are distributed around the support duct (33) and which have edges welded to the fixing collar (41).

[Claim 4] The liquefied gas storage installation as claimed in claim 2 or 3, wherein the fixing collar (41) and the annular bottom (39) comprise orifices configured

to allow fixing members (67) to pass through the fixing collar (41) and the annular bottom (39).

[Claim 5] The liquefied gas storage installation as claimed in any one of claims 2 to 4, wherein the fixing collar (41) and the annular bottom (39) each comprise an aperture (69), said apertures (69) being positioned facing one another and passed through by the supply duct (47).

[Claim 6] The liquefied gas storage installation as claimed in any one of claims 1 to 5, wherein the spray boom (34) is coupled to said supply duct (47) in a weld zone (82) positioned below the annular bottom (39).

[Claim 7] The liquefied gas storage installation as claimed in claim 6, wherein the bottom portion of the support duct (33) comprises a base wall (42) which closes a bottom end of the support duct (33) and windows (43) which are formed in a cylindrical wall of the bottom portion of the support duct (33) and wherein the weld zone (82) is positioned facing one of the windows (43).

[Claim 8] The liquefied gas storage installation as claimed in any one of claims 1 to 7, wherein a protection plate (83) is fixed to the bottom end of the support duct (33), the protection plate (83) covering the crown ring (38) and having a plurality of holes (84).

[Claim 9] A vessel (70) for transporting a liquefied gas, the vessel comprising a liquefied gas storage installation as claimed in any one of claims 1 to 8.

[Claim 10] A transfer system for a liquefied gas, the system comprising a vessel (70) as claimed in claim 9, insulated pipelines (73, 79, 76, 81) arranged so as to link the tank (71) of the liquefied gas storage installation of the vessel to a floating or onshore storage installation (77) and a pump for driving a flow of liquefied gas through the insulated pipelines from or to the floating or onshore storage installation to or from the tank of the liquefied gas storage installation of the vessel.

[Claim 11] A method for loading or offloading a vessel (70) as claimed in claim 9, wherein a liquefied gas is conveyed through insulated pipelines (73, 79, 76, 81) from or to a floating or onshore storage installation (77) to or from the tank (71) of the liquefied gas storage installation of the vessel.

[Claim 12] A method for mounting a dome structure of a liquefied gas storage installation, said method comprising:

- providing a bearing structure (1) defining an internal space and comprising a

top bearing wall (3) intended to receive a ceiling wall of a sealed and thermally insulating tank, the top bearing wall (3) comprising an aperture (27);

- providing a gas dome structure comprising:

- an outer drum (26) extending outside of the bearing structure (1) and comprising a bottom end welded around the aperture (27) of the bearing structure (1);

- an inner drum (29) which passes through the aperture (27) of the bearing structure (1) and extends inside the outer drum (26);

- a support duct (33) which passes through the inner drum (29) and comprises a bottom portion extending beyond the bottom end of the inner drum (29); and

- a supply duct (47) intended to be supplied with liquefied gas which is fixed to the support duct (33);

- providing a crown ring (38) supporting a spray boom (34) which comprises a plurality of spray nozzles (45); said crown ring (38) having a diameter (d1) greater than a diameter (d2) of the inner drum (29);

- displacing the crown ring (38) from the internal space until the crown ring (38) comes into contact with the support duct (33);

- fixing the crown ring (38) to the support duct (33); and

- tightly coupling an upstream end of the spray boom (34) to a downstream end of the supply duct (47).

[Claim 13] The mounting method as claimed in claim 12, wherein the support duct (33) comprises a fixing collar (41) which extends radially around the support duct (33) and the crown ring (38) comprises an annular bottom (39) and wherein, to fix the crown ring (38) to the support duct (33), the annular bottom (39) of the crown ring (38) is welded against a bottom face of the fixing collar (41).

[Claim 14] The mounting method as claimed in claim 13, wherein, prior to the welding of the annular bottom (39) of the crown ring (38) against the bottom face of the fixing collar (41), the fixing collar (41) and the annular bottom (39) are fixed to one another by means of temporary fixing members (67).

[Claim 15] The mounting method as claimed in claim 12 or 13, wherein the annular bottom (39) of the crown ring (38) comprises openings (68) which are

distributed around the support duct (33) and wherein the edges of said openings are welded to the fixing collar (41).

[Claim 16] The mounting method as claimed in any one of claims 12 to 15, wherein the bottom portion of the support duct (33) comprises a base wall (42) which closes a bottom end of the support duct (33) and windows (43) which are formed in a cylindrical wall of the bottom portion of the support duct (33) and wherein the upstream end of the spray boom (34) is welded to the downstream end of the supply duct (47) in a weld zone (82) which is positioned facing one of the windows (33).