Loading and/or unloading tower equipped with a device for spraying liquefied gas

Technical field

The invention relates to the field of sealed and thermally insulating tanks for storing and/or transporting a liquefied gas and relates more particularly to the loading and/or unloading towers intended to be suspended from the ceiling wall of such a tank and allowing liquefied gas to be loaded into the tank and/or to be unloaded.

Technological background

In the prior art, loading/unloading tanks are known that have a tripod structure, that is to say comprising three vertical masts that are suspended from a cover of a liquid dome and that are attached to each other by crossmembers. Each vertical mast is hollow. Two of the masts thus form a line for unloading the tank and to do this, each one is associated with an unloading pump supported by the loading/unloading tower, close to its lower end. The third mast in turn forms a safety well allowing a standby pump and an unloading line to be lowered in the event of failure of the other unloading pumps. The loading/unloading tower also supports loading lines that do not consist of one of the three masts. Such loading/unloading towers are described for example in document FR2785034.

The masts are subjected to thermal contraction and expansion phenomena that depend in particular on the filling conditions of the tank and on the temperature gradients to which they are subjected. In certain circumstances, the masts are likely to be subjected to different temperature gradients. This is the case in particular when liquefied natural gas is unloaded from the tank through one or more of the masts when one or more of the masts does not have liquefied natural gas passing through it. In such circumstances, the masts are likely to contract differently, which produces significant mechanical stresses on the crossmembers and on the cover of the liquid dome and is thus likely to cause irreversible deformation or fracture of the crossmembers or of the cover of the liquid dome. Likewise, the masts are also likely to be subjected to different temperature gradients when loading the tank.

Summary

An idea at the basis of the invention is to propose a loading and/or unloading tower making it possible to avoid excessive temperature differences appearing among the masts in particular when liquefied gas is only routed through just a part of the

three masts and/or when loading the tank.

According to an embodiment, the invention provides a loading and/or unloading tower for a tank intended for storing a liquefied gas, comprising an upper end intended to be suspended from a ceiling wall of said tank and a lower end, said loading and/or unloading tower comprising at least one first and one second vertical mast that are attached to each other by crossmembers; said loading and/or unloading tower being further equipped with a device for spraying liquefied gas comprising at least one first and one second nozzle that are respectively capable of spraying liquefied gas along a first and a second spray cone respectively directed along a first and a second central direction, the first and the second nozzles being arranged such that:

- the first and second central directions each have a vertical component oriented towards the lower end of the loading and/or unloading tower; and that
- the first and second masts respectively have a surface exposed to the first and second spray cone.

The term “spray cone” means the zone of extent of the liquefied gas extending from the outlet orifice of a nozzle, said zone having a conical (three-dimensional) shape, such as shown for example as dots on figure 1, whose apex is situated at this outlet orifice of the nozzle. Complementary explanations, with reference to the attached figures, are given in the continuation.

From then, the two spray cones respectively reach the two masts, which makes it possible to cool said two masts substantially uniformly, in particular before and/or while liquefied gas is unloaded from the tank through one or more of the masts. This makes it possible to limit the mechanical stresses likely to be exerted on the crossmembers.

According to other advantageous embodiments, such a loading and/or unloading tower can have one or more of the following characteristics.

According to an embodiment, the loading and/or unloading tower further comprises a third vertical mast that is attached to the first and second masts by crossmembers, the first and second masts defining a prism with a triangular cross section, the device for spraying liquefied gas comprising a third nozzle that is capable of spraying the liquefied gas along a third central direction, the third nozzle being arranged such that the third mast has a surface exposed to the third spray cone.

According to another embodiment, the loading and/or unloading tower can

also comprise only two vertical masts attached to each other by crossmembers.

According to an embodiment, when the loading and/or unloading tower comprises three vertical masts, the spray boom exclusively comprises three nozzles. This makes it possible to optimize the number of nozzles. However, according to other embodiments, the spray boom comprises a greater number of nozzles than three.

According to an embodiment, the first and second nozzles are further arranged such that said exposed surface of each of the first and second masts extends over more than 80% of the height of said mast. Advantageously, the third nozzle is further arranged such that said surface of the third mast extends over more than 80% of the height of said third mast. Advantageously, the exposed surface of each of the first, second and/or third masts extends over more than 90% of the height of said mast. This makes it possible to cool the masts substantially uniformly over a major part of their height.

According to an embodiment, the first, second and third nozzles are further arranged such that all of the crossmembers placed, in a portion of the prism with a triangular cross section extending over at least 80% of the height of the first, second and third masts, have a surface exposed to one or more of the first, second and third spray cones. Advantageously, all the crossmembers of the loading and/or unloading tower have a surface exposed to one or more of the first, second and third spray cones.

According to an embodiment, the surface exposed to one or more of the first, second and third spray cones of each of the crossmembers extends over the entire length of said crossmember.

According to an embodiment, the device for spraying liquefied gas comprises a spray boom placed close to the upper end of the loading and/or unloading tower and supporting the first, second and third nozzles.

According to an embodiment, the spray boom comprises a central portion and two lateral portions that are inclined with respect to the central portion, the central portion and the two lateral portions being respectively equipped with the first, second and third nozzles.

According to an embodiment, the central portion of the spray boom is placed parallel to a face of the prism with a triangular cross section defined by the second and third masts and is centered with respect to a plane perpendicular to said first face

and passing through the first mast.

According to an embodiment, the lateral portions are inclined with respect to the central portion so as to be away from the first mast.

According to an embodiment, the spray boom is placed outside the prism with a triangular cross section.

According to an embodiment, the first, second and third nozzles are positioned such that the first, second and third central directions each have a horizontal component, the horizontal component of the first central direction being oriented towards the first mast, the horizontal component of the second central direction being oriented towards a face of the prism with a triangular cross section that is defined by the first and second masts and the horizontal component of the third central direction being oriented towards a face of the prism with a triangular cross section that is defined by the first and third masts.

According to an embodiment, the first, second and third central directions each form an angle β that is between 20 and 40° with respect to the vertical direction.

According to an embodiment, the first, second and third nozzles each have a spraying angle between 50 and 80°.

According to an embodiment, the first, second and third nozzles are positioned such that the second and third central directions, projected in a horizontal plane, are inclined by an angle between 45 and 60° with respect to the first central direction.

According to an embodiment, the first and second nozzles are arranged to spray the liquefied gas respectively into the first and second masts.

According to an embodiment, the third nozzle is arranged to spray the liquefied gas into the third mast.

According to an embodiment, the first and second nozzles are each housed in a respective tapping connection leading to the interior of the first or the second mast.

According to an embodiment, the first and second masts respectively extend coaxially to a first and a second central axis and the first and second central directions are respectively oriented parallel to the first and second central axis.

According to an embodiment, the first and second central directions are

respectively oriented coaxially to the first and second central axis.

According to an embodiment, the first and second masts each have an upper portion intended to protrude above the ceiling wall of said tank and each tapping connection leads into the upper portion of one of the first and second masts or into an elbowed portion connected to said upper portion.

According to an embodiment, at least one of the first, second and third masts is hollow and is connected to an unloading pump so as to form an unloading line.

According to an embodiment, the second and third masts are aligned in a transverse plane P1. According to an embodiment, the transverse plane P1 is parallel to a back wall of the tank.

According to an embodiment, the second mast and the third mast are aligned in a transverse plane.

According to an embodiment, the second and third masts are hollow and each one is connected to an unloading pump so as to form an unloading line.

According to an embodiment, the spray boom is connected to a pump capable of compressing the liquefied gas under an operating pressure contained within the operating range of the first, second and third nozzles.

According to an embodiment, the invention also provides a sealed and thermally insulating tank equipped with an abovementioned loading and/or unloading tower.

According to an embodiment, the sealed and thermally insulating tank comprises a liquid dome protruding upwards from the ceiling wall and having a cover, said loading and/or unloading tower being suspended from said cover and the spray boom being housed inside said liquid dome.

According to an embodiment, the liquid dome is a combined dome that further comprises a duct for collecting vapor allowing a vapor circulating path to be defined between the interior space of the tank and a vapor collector situated outside the tank.

Such a tank can be part of an onshore storage installation, for example for storing LNG or it can be installed in a floating structure, coastal or in deep water, in particular a LNG tanker, a floating regasification and storage unit (FRSU), an offshore floating production storage and offloading unit (FPSO), the ships using the LNG as fuel, namely ships known as LFS “LNG Fuelled Ships” and others.

According to an embodiment, a ship for transporting a cryogenic fluid comprises a hull and an abovementioned tank placed in the hull.

According to an embodiment, the invention also provides a method for loading and unloading such a ship, in which a fluid is routed through insulated pipes from or to a floating or onshore storage installation to or from the tank in the ship.

According to an embodiment, the invention also provides a transfer system for a fluid, the system comprising the abovementioned ship, insulated pipes arranged so as to connect the tank installed in the hull of the ship to a floating or onshore storage installation and a pump for driving a fluid through the insulated pipes from or to the floating or onshore storage installation to or from the tank in the ship.

Brief description of the figures

The invention will be better understood, and other aims, details, characteristics and advantages of same will emerge more clearly during the following description of several particular embodiments of the invention, given only as an illustration and non-limitative, with reference to the attached drawings.

- **Figure 1** is a partial schematic view of a sealed and thermally insulating tank equipped with a loading/unloading tower.

- **Figure 2** is a top view of said loading/unloading tower that illustrates the device for spraying the liquefied gas and schematically shows the liquefied gas spray cones produced by said spraying device.

- **Figure 3** is a front view of the spraying device.

- **Figure 4** is a top sectional view of the spraying device along the plane IV-IV of figure 3.

- **Figure 5** is a side view of the spraying device.

- **Figure 6** is a stripped-down schematic illustration of a tank of a LNG tanker and a terminal for loading/unloading this tank.

- **Figure 7** is a top view of the cover of the liquid dome, the arrows schematically illustrating the nozzles of a device for spraying liquefied gas according to another embodiment.

- **Figure 8** illustrates the upper portion of one of the masts according to a variant of the embodiment of figure 7.

- **Figure 9** is a schematic illustration showing the arrangement of a nozzle at the upper portion of the mast of figure 8.

- **Figure 10** is a schematic illustration showing the arrangement of a nozzle with respect to the upper portion of a mast according to another embodiment variant.

Detailed description of embodiments

By convention, on the figures, an orthonormal reference defined by two axes x and y is used to describe the elements of the tower for loading and/or unloading the tank. The axis x corresponds to a longitudinal direction and the axis y corresponds to a transverse axis perpendicular to the longitudinal direction. According to an embodiment, when the loading and/or unloading tower is intended to be installed in a ship, the axis x advantageously corresponds to the longitudinal direction of the ship.

In relation to figure 1, part of a sealed and thermally insulating tank 1 for storing liquefied gas is seen that is equipped with a loading and/or unloading tower 2 allowing in particular the liquefied gas to be loaded into the tank 1 and/or to be unloaded. The liquefied gas can in particular be a liquefied natural gas (LNG), that is to say a gaseous mixture comprising mainly methane and one or more other hydrocarbons, such as ethane, propane, n-butane, i-butane, n-pentane, i-pentane, neopentane and nitrogen in small proportions.

The tank 1 is anchored in a supporting structure 3. The supporting structure 3 is formed for example by the double hull of a ship but can more generally be formed from any type of rigid bulkhead having appropriate mechanical properties. The tank 1 can be intended for transporting liquefied gas or for accommodating the liquefied gas used as fuel for propelling the ship.

According to an embodiment, the tank 1 is a membrane tank. In such a tank 1, each wall successively has, from the exterior to the interior, depending on the direction of thickness of the wall, a secondary thermally insulating barrier 4 resting against the supporting structure 3, a secondary sealing membrane 5 anchored on the secondary thermally insulating barrier 4, a primary thermally insulating barrier 6 resting against the secondary sealing membrane 5 and a primary sealing membrane 7 anchored on the primary thermally insulating barrier 6 and intended to be in contact with the fluid contained in the tank. As an example, each wall can in particular be of the Mark III type, as described for example in FR2691520, of the NO96 type as described for example in FR2877638, or of the Mark V type as described for example in WO14057221.

The tower 2 is installed in the proximity of the back wall 8 of the tank 1, which makes it possible to optimize the quantity of cargo likely to be unloaded by the tower 2, since the ships generally lean aft using the ballasts in a particular way.

The tower 2 is suspended from a ceiling wall 9 of the supporting structure 3. On figure 1, the ceiling wall 9 of the supporting structure comprises, close to the back wall, a space of a rectangle parallelepiped shape, protruding upward, called liquid dome 10. The liquid dome is defined by two transverse walls, front and back, and by two lateral walls that extend vertically and protrude upwards from the ceiling wall 9. The liquid dome 10 further comprises a horizontal cover 35 from which the tower 2 is suspended. According to an embodiment, the liquid dome is a combined dome, that is to say, it further comprises a duct for collecting vapor making it possible to define a vapor circulation path between the interior space of the tank 1 and a vapor collector situated outside the tank.

The tower 2 extends substantially over the entire height of the tank 1. In relation to figures 1 and 2, the tower 2 is seen to comprise a tripod structure, that is to say, it comprises three vertical masts 11, 12, 13, which are attached to each other by crossmembers 14. Each mast 11, 12, 13 is hollow and passes through the cover 35 of the liquid dome 10.

The three masts 11, 12, 13 define with the crossmembers 14 a prism with a triangular cross section. According to an embodiment, the three masts 11, 12, 13 are placed at equal distance from each other such that the prism section is an equilateral triangle. Advantageously, the three masts 11, 12, 13 are placed such that at least one of the faces of the prism extends in a transverse plane P1 that is parallel to the back wall 8 of the tank 1. In other words, two of the masts 12, 13 are aligned in the transverse plane P1. More particularly, the two masts 12, 13 that are aligned in the transverse plane P1 are the two back masts, that is to say, the nearest to the back wall 8 of the tank 1.

The front mast 11 has a larger diameter than the two back masts 12, 13. The front mast 11 forms a well allowing a pump and an unloading line to be lowered. The pump lowered via the mast 11 is for example a standby pump in the event of failure of the other unloading pumps, or a conventional pump, which simplifies the maintenance of said pump. The two back masts 12, 13 are structural and each can be connected to an unloading pump 15 and form an unloading line.

Furthermore, in the illustrated embodiment, the tower 2 is also equipped with

two loading lines 16, 17 that are attached to the front mast 11. One of the two loading lines 16 extends only in the upper portion of the tank 1, while the other loading line 17 extends substantially over the entire height of the tank 1 until close to the bottom wall 18 of the tank 1.

The tower 2 is also equipped with a spraying device, illustrated in detail on figures 2 to 5, that aims to spray liquefied gas onto the tower so as to cool it. Such a spraying device thus allows the masts 11, 12, 13 to be cooled, in particular before and while liquefied gas is unloaded from the tank through one or more of the masts 11, 12, 13 or during the step of cooling the tank 1 prior to loading it so as to ensure a certain uniformity of the temperature gradients to which the three masts 11, 12, 13 are subjected. This makes it possible to limit the mechanical stresses likely to be exerted on the crossmembers 14 due to the differences in thermal contraction of the masts 11, 12, 13.

The spraying device comprises a spray boom 19 that is connected to the end of a delivery duct 20, illustrated on figure 3, intended to be supplied with liquefied gas. In the illustrated embodiment, the delivery duct 20 passes through the cover 35 of the liquid dome 10. Furthermore, in the illustrated embodiment, the delivery duct 20 is housed in a sleeve 21 that passes in a sealed manner through the cover 35 of the liquid dome 10. The sleeve 21 has a cover wall 22 that is equipped with a connection 23 that makes it possible to connect, on one hand, the delivery duct 20 and on the other, another upstream duct 24 connected to the pump 25, schematically illustrated on figures 3 and 5. According to an embodiment, the pump 25 that is associated with the upstream duct 24 and ensures the supply of pressurized liquefied gas is placed, inside the tank 1, close to its bottom wall 18 and thus makes it possible to pump the last of the liquefied gas remaining in the tank 1. According to other embodiments, the supply of liquefied gas from the spraying device can be ensured by means of a pump 25 immersed in another tank. The pump 25 is capable of compressing the liquefied gas under an operating pressure contained within the operating range of the nozzles 26, 27, 28 that will be described below, that is to say the operating range making it possible to reach the spray angles mentioned above. As an example, the relative operating pressure of the spraying device is between 100 and 600 kPa (kilo Pascals), preferably between 200 and 300 kPa.

The spray boom 19 is placed close to the upper end of the tower 2. More particularly, when the tank 1 is equipped with a liquid dome 10 protruding upwards with respect to the ceiling wall 9, the spray boom 19 is advantageously housed inside

said liquid dome 10.

As illustrated on figures 3 and 4, the spray boom 19 extends in a horizontal plane and comprises a central portion 29 that extends along a transverse direction and two lateral portions 30, 31 that are inclined backwards at an angle α. The angle α is advantageously between 45 and 65°. In other words, the spray boom 19, seen in a horizontal plane, has a general C shape directed towards the back wall of the tank 1. The spray boom 19 also comprises three nozzles 26, 27, 28 that are associated respectively with the central portion 29 and with one and the other of the two lateral portions 30, 31.

Each of the three nozzles 26, 27, 28 has a central direction d1, d2, d3 and is capable of spraying the liquefied gas along a spray cone oriented along the corresponding central direction d1, d2, d3. Each central direction d1, d2, d3 is oriented perpendicular to the central portion 29 or lateral portion 30, 31 with which said corresponding nozzle 26, 27, 28 is associated. The central directions d2 and d3 are thus inclined with respect to the central direction d1, projected in a horizontal plane, at an angle corresponding to the abovementioned angle α. Each central direction d1, d2, d3 has a vertical component oriented towards the lower end of the tower 2 and a horizontal longitudinal component directed forwards.

In the illustrated embodiment, the central direction of each of the three nozzles 26, 27, 28 is oriented at an angle β that is between 20 and 40°, for example of the order of 20° with respect to the vertical direction.

Furthermore, as illustrated on figure 2, the horizontal component of the central direction d1 is oriented towards the mast 11, the horizontal component of the central direction d2 is oriented towards the face of the prism with a triangular cross section defined by the masts 11, 12 and the horizontal component of the central direction d3 is oriented towards the face of the prism with a triangular cross section defined by the masts 11, 13.

Furthermore, the nozzles 26, 27, 28 advantageously have a spray angle between 50 and 80°, for example of the order of 70°.

As illustrated on figures 1 and 2, the spray boom 19 is substantially centered with respect to the longitudinal axis of symmetry of the prism. In other words, the longitudinal axis passing through the axis of the mast 13 passes through the central portion 29 of the spray boom 19. Furthermore, the spray boom 19 is placed slightly behind the transverse plane P1 passing through the central axis of the two back

masts 12, 13, which makes it possible to ensure that liquefied gas is sprayed onto the crossmembers connecting the back masts 12, 13.

It should be noted that in order to simplify the observation of the three spray cones and their relative position with respect to the masts in the tower, only the upper portion of the spray cones 32, 33, 34 is illustrated on figures 1 and 2. Thus, when extending the upper portion of the spray cone 32 provided by the nozzle 26 associated with the central portion 29 of the spray boom 19 downwards, it is found on these figures that the front mast 11 is also reached by said spray cone 32.

It is thus noted that the three nozzles 26, 27, 28 are arranged to spray liquefied gas along three spray cones 32, 33, 34 which respectively reach the mast 11, the mast 12 and the mast 13.

Furthermore, it is noted that the arrangement, orientation and spray angles of the nozzles 26, 27, 28 are such that each of the three masts 11, 12, 13 has a surface exposed to one of the spray cones 32, 33, 34 that extends over more then 80% and advantageously over more than 90% of the height of said mast 11, 12, 13. This makes it possible to cool the masts 11, 12, 13 substantially uniformly over a major part of their height.

Moreover, the three spray cones 32, 33, 34 are also positioned such that all the crossmembers 14 that connect the masts 11, 12, 13 on a portion of the triangular prism corresponding to at least 80% of the height of the masts 11, 12, 13 have a surface exposed to one or more of the spray cones 32, 33, 34. Advantageously, all the crossmembers 14 of the tower 2 have a surface exposed to one or more of the spray cones. Furthermore, the surface of each crossmember 14 exposed to one or more spray cones 32, 33, 34 extends advantageously over the entire length of said crossmembers 14.

Obviously, other equivalent structures and arrangements of the spray boom 19 can be envisaged as long as they make it possible to obtain the abovementioned positioning characteristics of the spray cones 32, 33, 34 with respect to the masts 11, 12, 13 and crossmembers 14. In particular, according to other embodiments, not illustrated, the arrangement of the spray boom 19 can be swiveled by an angle of 120° around the central axis of the prism with a triangular cross section.

A device for spraying liquefied gas according to another embodiment is described below in relation to figures 7 to 9.

As illustrated on figure 7, the masts 11, 12, 13 have an upper portion that

protrudes upwards to outside the structure supporting the tank 1 and more particularly outside the cover 35 of the liquid dome 10. The upper portion of the masts 11, 12, 13 is connected to a network 39 for unloading the liquefied gas through one or more elbowed portions 40, 41, 42. In this embodiment, the device for spraying liquefied gas comprises three nozzles 36, 37, 38 schematically illustrated by arrows on figure 7, that each allow liquefied gas to be injected into the internal space of one of the three masts 11, 12, 13. The three nozzles 36, 37, 38 are placed at the upper portion of the masts 11, 12, 13 protruding outside the cover 35 of the liquid dome 10. Each of the three nozzles 36, 37, 38 is connected to a delivery duct 43 that is connected to a pump, not illustrated. The pump can be immersed in the tank 1, in another tank or it can be associated with the loading terminal intended to ensure that the tank 1 is loaded with liquefied gas.

In relation to figures 8 and 9, the arrangement is observed of a nozzle 36, 37, 38 according to an embodiment variant allowing liquefied gas to be injected into the internal space of the masts 11, 12 13. The nozzle 36, 37, 38 is mounted in a tapping connection 43, tubular in shape, that leads into an elbowed portion 40, 41, 42 connecting the end of a mast 11, 12, 13 to the network for unloading the liquefied gas. In the illustrated embodiment, the tapping connection 43 is placed at the mast 11, 12, 13 and oriented vertically. Furthermore, advantageously, the tapping connection 43 extends in the extension of the central axis A of said mast 11, 12, 13. Also, advantageously, as illustrated on figure 9, the central spraying direction d1, d2, d3 of the nozzle 36, 37, 38 is coaxial to the central axis A of said mast 11, 12, 13. This makes it possible to ensure excellent cooling uniformity of the mast 11, 12, 13. In this embodiment, the nozzles 36, 37, 38 advantageously have a spray angle between 45 and 90°, for example of the order of 60°.

Such an arrangement is particularly advantageous in that the device for spraying liquefied gas is arranged outside the tank, which simplifies its installation.

Advantageously, the nozzle 36, 37, 38 does not protrude or only protrudes slightly inside the elbowed portion 40, 41, 42 so as to be subjected to the least possible strain when liquefied gas is unloaded through said mast 11, 12, 13. In other words, the nozzle 36, 37, 38 does not protrude outside the tubular connection or protrudes by a distance less than 10cm inside the elbowed portion 40, 41, 42.

The tapping connection 43 comprises an annular attaching flange 44 against which an annular flange 45 integral with the nozzle 36, 37, 38 is attached. Advantageously, the annular flanges 44, 45 are attached to each other by means of

removable attachment components, such as screws passing through orifices made in the annular flanges 44, 45. Such a removable assembly of the nozzle 36, 37, 38 in the tapping connection 43 allows the nozzle 36, 37, 38 to be dismantled for the purpose of inspection and maintenance operations.

Figure 10 illustrates the arrangement of a nozzle 36, 37, 38 according to another embodiment variant. In this embodiment, the tapping connection 43 leads directly into the upper portion of the mast 11, 12, 13 that protrudes above the cover 35 of the liquid dome 10. In this case, the tapping connection 43 cannot be placed coaxially to the central axis A of the mast 11, 12, 13 and is consequently placed perpendicular (this arrangement is not illustrated on the attached figures), or inclined with respect to the central axis A of the mast 11, 12, 13. Advantageously, the central direction d1, d2, d3 of the nozzle 36, 37, 38 is oriented parallel to the central axis A of the mast 11, 12, 13. However, in order not to protrude too significantly inside the mast 11, 12, 13 and thus to limit the strains likely to be exerted on the nozzle 36, 37, 38 when liquefied gas is unloaded through said mast 11, 12, 13.

The technique described above for materializing a loading and/or unloading tower can be used in different types of sealed and thermally insulating tanks, for example for a tank of LNG in an onshore or floating structure such as a LNG tanker or other.

With reference to figure 6, a stripped-down view of a LNG tanker 70 shows a sealed and insulated tank 71, generally prismatic in shape, assembled in the double hull 72 of the tanker. The wall of the tank 71 comprises 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 tanker, and two insulating barriers arranged respectively between the primary sealed barrier and the secondary sealed barrier and between the secondary sealed barrier and the double hull 72.

In a manner known per se, loading/unloading pipes 73 placed on the upper deck of the tanker can be connected, by means of approved connectors, to a maritime or port terminal to transfer a cargo of LNG from or to the tank 71.

Figure 6 illustrates an example of a maritime terminal comprising a loading and unloading station 75, a submarine pipe 76 and an onshore installation 77. The loading and unloading station 75 is a fixed offshore installation comprising a mobile arm 74 and a tower 78 that supports the mobile arm 74. The mobile arm 74 supports

a loom of insulated flexible pipes 79 that can be connected to the loading/unloading pipes 73. The orientable mobile arm 74 adapts to all sizes of LNG tanker. A connection duct not illustrated extends inside the tower 78. The loading and unloading station 75 allows the LNG tanker 70 to be loaded and unloaded from or to the onshore installation 77. This installation comprises liquefied gas storage tanks 80 and connection ducts 81 connected by the submarine duct 76 to the loading and unloading station 75. The submarine duct 76 allows liquefied gas to be transferred between the loading or unloading station 75 and the onshore installation 77 over a long distance, for example 5 km, which makes it possible to keep the LNG tanker a long distance from the coast during loading and unloading operations.

In order to produce the pressure necessary for transferring the liquefied gas, pumps on board the ship 70 and/or pumps equipping the onshore installation 77 and/or pumps equipping the loading and unloading station 75 are used.

Although the invention has been described in connection with several particular embodiments, it is obvious that it is not at all limited to same, and that it comprises all the equivalent technologies of the described means, and their combinations if they belong within the framework of the invention.

The use of the verbs “to include”, “ to comprise” or “to contain” and their conjugated forms does not exclude the presence of elements or steps other than those stated in a claim.

In the claims, any reference mark in brackets may not be interpreted as a limitation of claim.

CLAIMS

1. A loading and/or unloading tower (2) for a tank (1) intended for storing a liquefied gas, comprising an upper end intended to be suspended from a ceiling wall (9) of said tank (1) and a lower end, said loading and/or unloading tower (2) comprising at least one first and one second vertical mast (11, 12) that are attached to each other by crossmembers (14); said loading and/or unloading tower (2) being further equipped with a device for spraying liquefied gas comprising at least one first and one second nozzle (26, 27, 36, 37) that are respectively capable of spraying liquefied gas along a first and a second spray cone (32, 33, 34) respectively directed along a first and a second central direction (d1, d2), the first and the second nozzles (26, 27, 36, 37) being arranged such that:
- the first and second central directions (d1, d2) each have a vertical component oriented towards the lower end of the loading and/or unloading tower (2); and that
- the first and second vertical masts (11, 12) respectively have a surface exposed to the first and second spray cones (32, 33).

2. The loading and/or unloading tower (2) as claimed in claim 1, further comprising a third vertical mast (13) that is attached to the first and second vertical masts (11, 12) by crossmembers (14), the first, second and third vertical masts (11, 12 ,13) defining a prism with a triangular cross section, the device for spraying liquefied gas comprising a third nozzle (28, 38) that is capable of spraying the liquefied gas along a third spray cone directed along a third central direction (d3), the third nozzle being arranged such that the third vertical mast (13) has a surface exposed to the third spray cone (34).

3. The loading and/or unloading tower (2) as claimed in claim 2, in which the first, second and third nozzles (26, 27, 28, 36, 37, 38) are further arranged such that said exposed surface of each of the first, second and third vertical masts (11, 12, 13) extends over more than 80% of the height of said first, second or third vertical mast (11, 12, 13).

4. The loading and/or unloading tower (2) as claimed in claim 2 or 3, in which the first, second and third nozzles (26, 27, 28) are further arranged such that all of the crossmembers (14) placed, in a portion of the prism with a triangular cross section extending over at least 80% of the height of the first, second and third vertical masts (11, 12, 13), have a surface exposed to one or more of the first, second and third spray cones (32, 33, 34).

5. The loading and/or unloading tower (2) as claimed in claim 4, in which the surface exposed to one or more of the first, second and third spray cones (32, 33,

34) of each of the crossmembers (14) extends over the entire length of said crossmember (14).

6. The loading and/or unloading tower (2) as claimed in any one of claims 2 to 5, in which the device for spraying liquefied gas comprises a spray boom (19) placed close to the upper end of the loading and/or unloading tower (2) and supporting the first, second and third nozzles (26, 27, 28).

7. The loading and/or unloading tower (2) as claimed in claim 6, in which the spray boom (19) comprises a central portion (29) and two lateral portions (30, 31) that are inclined with respect to the central portion (29), the central portion (29) and the two lateral portions (30, 31) being respectively equipped with the first, second and third nozzles (26, 27, 28).

8. The loading and/or unloading tower (2) as claimed in claim 7, in which the central portion (29) of the spray boom (19) is placed parallel to a first face of the prism with a triangular cross section defined by the second and third vertical masts (12, 13) and is centered with respect to a plane perpendicular to said first face and passing through the first vertical mast (11).

9. The loading and/or unloading tower (2) as claimed in claims 7 or 8, in which the lateral portions (30, 31) are inclined with respect to the central portion (29) so as to be away from the first vertical mast (11).

10. The loading and/or unloading tower (2) as claimed in any one of claims 2 to 9, in which the first, second and third nozzles (26, 27, 28) are positioned such that the first, second and third central directions (d1, d2, d3) each have a horizontal component, the horizontal component of the first central direction (d1) being oriented towards the first vertical mast (11), the horizontal component of the second central direction (d2) being oriented towards a face of the prism with a triangular cross section that is defined by the first and second vertical masts (11,12) and the horizontal component of the third central direction (d3) being oriented towards a face of the prism with a triangular cross section that is defined by the first and third vertical masts (11, 13).

11. The loading and/or unloading tower (2) as claimed in any one of claims 2 to 10, in which the first, second and third central directions (d1, d2, d3) each form an angle β that is between 20 and 40° with respect to the vertical direction.

12. The loading and/or unloading tower (2) as claimed in any one of claims 2 to 11, in which the first, second and third nozzles (26, 27, 28) each have a spraying angle between 50 and 80°.

13. The loading and/or unloading tower (2) as claimed in any one of claims 2 to 12, in which the first, second and third nozzles (26, 27, 28) are positioned such that the second and third central directions (d2, d3), projected in a horizontal plane, are inclined by an angle between 45 and 60° with respect to the first central direction (d1).

14. The loading and/or unloading tower (2) as claimed in any one of claims 1 to 3, in which the first and second nozzles (36, 37) are arranged to spray the liquefied gas respectively into the first and second vertical masts (11, 12).

15. The loading and/or unloading tower (2) as claimed in claim 14, in which the first and second nozzles (36, 37) are each housed in a respective tapping connection (43) leading to the interior of the first or the second vertical mast (11, 12).

16. The loading and/or unloading tower (2) as claimed in claim 15, in which the first and second vertical masts (11, 12) respectively extend coaxially to a first and a second central axis (A) and in which the first and second central directions (d1, d2) are respectively oriented parallel to the first and second central axis (A).

17. The loading and/or unloading tower (2) as claimed in claim 16, in which the first and second central directions (d1, d2) are respectively oriented coaxially to the first and second central axis (A).

18. The loading and/or unloading tower (2) as claimed in any one of claims 15 to 17, in which the first and second vertical masts (11, 12) each have an upper portion intended to protrude above the ceiling wall (9) of said tank (1) and in which each tapping connection (43) leads into the upper portion of one of the first and second vertical masts (11, 12) or in an elbowed portion (40, 41, 42) connected to said upper portion

19. The loading and/or unloading tower (2) as claimed in any one of claims 1 to 18, in which at least one of the first, second and third vertical masts (11,12, 13) is hollow and is connected to an unloading pump (15) so as to form an unloading line.

20. A sealed and thermally insulating tank comprising a loading and/or unloading tower (2) as claimed in any one of claims 1 to 19.

21. A sealed and thermally insulating tank comprising a loading and/or unloading tower (2) as claimed in any one of claims 6 to 9 comprising a liquid dome (10) protruding upwards from the ceiling wall (9) and having a cover (35), said loading and/or unloading tower (2) being suspended from said cover (35) and the spray boom (19) being housed inside said liquid dome (10).

22. A ship (70) for transporting a fluid, the ship comprising a hull (72) and a

tank (71) as claimed in claim 20 or 21 placed in the hull (72).

23. A method for loading or unloading a ship (70) as claimed in claim 22, in which a fluid is routed through insulated pipes (73, 79, 76, 81) from or to a floating or onshore storage installation (77) to or from the tank in the ship (71).

24. A system for transferring a fluid, the system comprising a ship (70) as claimed in claim 22, insulated pipes (73, 79, 76, 81) arranged so as to connect the tank (71) installed in the hull of the ship to a floating or onshore storage installation (77) and a pump for driving a fluid through the insulated pipes from or to the floating or onshore storage installation (77) to or from the tank in the ship.