

Storage and/or transport tank for a liquid gas cargo intended for a vessel

The present invention relates to the field of vessels for transporting a fluid, such as liquefied natural gas, for example. More particularly, the present invention relates to the field of tanks fitted to such vessels, in which natural gas is stored in the liquid state and which include towers for loading and/or unloading liquefied natural gas.

These vessels thus conventionally include tanks that contain natural gas in the liquid state. Since natural gas is liquid at temperatures below -163°C , these tanks are sealed and thermally insulating. The walls of these tanks also have corrugations, which are necessary for their mechanical strength. Indeed, these tanks are subjected to mechanical stresses related to their own weight, the weight of the vessel, the movement of this vessel on the water, and the tossing to which it is subjected. Producing corrugations on the walls of these tanks thus gives them sufficient flexibility to withstand these stresses.

These tanks also include loading and/or unloading towers, which allow the liquefied natural gas to be loaded and unloaded therein. These loading and/or unloading towers each comprise a tripod structure, that is to say a structure that has three masts which are each fixed to one another by cross-members. At least two of these masts are associated with unloading pumps so that they thus form unloading lines that make it possible to discharge the liquid natural gas in order to empty the concerned tank at least partially. In a known manner, these loading and/or unloading towers are most often arranged near a rear side wall of the tank, in other words, near angles formed between this rear side wall and the bottom wall of the tank.

The propulsion engines of these vessels can be powered, at least in part, by natural gas. At least one auxiliary pump is thus arranged in the tank. Such an auxiliary pump is configured to allow the supply of natural gas to the propulsion engines of the vessel and/or to a heat engine of an electric generator and/or to spray liquid gas into the empty tank, in order to lower the temperature before starting to fill it and/or to completely empty the concerned tank.

The builders of these vessels are now seeking to reduce the volume of unpumpable liquefied natural gas as much as possible, that is to say the volume of this liquefied natural gas that cannot be discharged from the tank by the unloading pumps or by the auxiliary pump. One means of reducing this volume consists, for example, in placing at least one of the pumps of each tank, at least partially, in a sump formed in the bottom wall of the concerned tank. However, it is understood that the establishment of such a sump causes a cut in the corrugations made on the bottom wall, which leads to a stiffening of the mechanical structure of the tank that causes stress concentrations exceeding the acceptable thresholds for corrugation tank technology.

The present invention falls within this context and proposes a simple and inexpensive means making it possible to reduce the unpumpable volume of gas, without the mechanical strength of the tank being affected.

One object of the present invention thus relates to a storage and/or transport tank for a fluid intended for a vessel, the tank comprising at least one loading and/or unloading tower for the fluid, at least one sump being formed in a bottom wall of the tank, the loading and/or unloading tower comprising at least one base situated at a lower end of this loading and/or unloading tower, the loading and/or unloading tower comprising at least three masts secured to the base, the loading and/or unloading tower carrying at least one pump, the masts delimiting a perimeter by axial projection onto the bottom wall of the tank. Remarkably, the pump is entirely arranged outside the perimeter and it extends, at least partially, into the sump.

According to the invention, the term “pump” denotes an assembly consisting of an electric motor and a pump body configured to suck a fluid, in this case to suck the cryogenic liquid present in the tank. The axial projection of the masts on the bottom wall is understood as the projection of an external perimeter of these masts. In other words, the axial projection of the masts on the bottom wall is understood as the projection of the largest perimeter possibly delimited by these masts.

Furthermore, the terms “entirely outside the perimeter” mean here that the entire pump is arranged outside this perimeter, that is to say both the electric motor and the pump body extend outside the perimeter formed by the axial projection of

the masts on the bottom wall of the tank. In other words, the perimeter formed by the axial projection of the masts on the bottom wall of the tank is at a non-zero distance from an axial projection of a contour of the pump on the bottom wall of the tank. It is further understood that the sump is also provided outside the perimeter
5 formed by the axial projection of the masts on the bottom wall of the tank.

The axial projections of the masts and/or of the pump mentioned above are determined by observing an image of the object in question projected onto the bottom wall while being placed on an axis perpendicular to the bottom wall of the tank. It is noted that the general shape of the axial projection of the masts is
10 generally a triangle.

According to the invention, the bottom wall of the tank has at least one corrugation. Advantageously, the bottom wall comprises a plurality of corrugations that impart flexibility to this bottom wall, which allows it better mechanical resistance to the various stresses experienced during the lifetime and movements of
15 the vessel for which it is intended. The invention and what is described below applies to another type of wall when the mechanical stresses make it necessary to provide a distance between two structural elements that interrupt the wall.

Advantageously, arranging the sump outside the perimeter delimited by the axial projection of the masts on the bottom wall of the tank makes it possible to
20 ensure that a sufficient number of corrugations produced on the bottom wall of the tank remain interrupted between two points on the bottom wall where these corrugations are interrupted. By way of example, the invention makes it possible to keep a minimum number of uninterrupted corrugations between a wedge situated at the intersection of the bottom wall with a side wall of the tank, and the sump.
25 According to another example, the invention makes it possible to keep a minimum number of uninterrupted corrugations between a support foot of the loading and/or unloading tower anchored in the bottom wall and the sump.

According to one feature of the present invention, the tank comprises at least one side wall that extends substantially perpendicular to the bottom wall of this
30 tank, the bottom wall having at least three corrugation pitches between the side wall of the tank and the sump. According to another feature of the present invention, the

bottom wall comprises a support foot for the loading and/or unloading tower, the bottom wall having at least three corrugation pitches between the support foot of the loading and/or unloading tower and the sump. It will be understood that these are the minimum numbers of corrugations necessary for the bottom wall to retain
5 its flexibility and therefore its mechanical strength despite the presence of the sump, which intersects these corrugations.

According to a first embodiment of the present invention, the pump situated outside the perimeter is an auxiliary pump configured to supply a vessel's engine with fluid and/or to cool the tank by spraying it with the fluid present in the tank
10 and/or to completely empty the tank before working in the tank. In such a situation, the loading and/or unloading tower may include an unloading pump dedicated to unloading the fluid, the pump situated outside the perimeter and in the sump being auxiliary with respect to the unloading pump because it manages one or more functions that are auxiliary with respect to the unloading of the cargo. The unloading
15 pump flow rate is significantly greater than the auxiliary pump flow rate.

The auxiliary pump powers the propulsion engine(s) of the vessel. Alternatively, the auxiliary pump circulates the fluid taken from the sump in a circuit that opens into an upper part of the tank, so as to cool the latter. Alternatively, the auxiliary pump empties all of the cargo, until the sump is emptied. This guarantees
20 total emptying of the tank.

According to a second embodiment of the present invention, the pump situated outside the perimeter is an unloading pump configured to unload at least part of the fluid contained in the tank.

In the remainder of the description, the term "pump" denotes, without
25 distinction, the auxiliary pump or the unloading pump, depending on the embodiment used.

According to one feature of the present invention, at least one support is arranged between the base and the pump. More particularly, this support is mounted secured to the base of the loading and/or unloading tower and of the
30 pump. In other words, this support forms a mechanical link between this pump and

the loading and/or unloading tower.

According to this feature of the invention, the at least one support comprises at least a first docking zone on which the base of the loading and/or unloading tower is fixed and at least a second docking zone on which the pump is fixed, the first
5 docking zone and the second docking zone being interconnected by a body of the support, the first docking zone extending in a first plane, the second docking zone extending in a second plane, the first plane and the second plane being distinct. As a result, the body of the support extends mainly in a third plane intersecting the first plane and the second plane.

10 According to an example of application of the present invention, the first plane in which the first docking zone of the support extends is parallel to the second plane in which the second docking zone of the support extends. According to this feature, the third plane in which the body of the support mainly extends is perpendicular to the first plane of the first docking zone of the support and to the second plane of the
15 second docking zone of the support.

For example, the first docking zone can be formed by a first plate extending, in the first plane, from the body of the support in a first direction and the second docking zone can be formed by a second plate extending, in the second plane, from the body of the support in a second direction opposite the first direction. In other
20 words, according to this example, the first docking zone and the second docking zone extend away from one another.

Advantageously, a first distance measured between the bottom wall of the tank and the first docking zone of the support, along a straight line perpendicular to the bottom wall, is greater than a second distance measured along the straight line
25 perpendicular to the bottom wall, between this bottom wall of the tank and the second docking zone of the support. In other words, it is understood that the second docking zone of the support is closer to the bottom wall of the tank than the first docking zone of this support.

According to one feature of the present invention, the second distance
30 measured between the bottom of the tank and the second docking zone of the

support is not zero. Advantageously, using this support thus makes it possible to generate a space between an inlet of the sump situated flush with the bottom wall of the tank and the base of the loading and/or unloading tower, so as to leave this inlet of the sump free despite the size of the pump that extends there. With this distance
5 between the base and the bottom wall of the tank, the distance from the base is guaranteed, which ensures that the base will not limit the flow of liquid towards the inlet of the sump.

According to the invention, the body of the support comprises at least one opening. Advantageously, the body of the support comprises two openings.
10 Whatever their number, these openings allow the fluid present in the tank to circulate in order to reach the sump, and more particularly to reach the entrance to the sump. In other words, this support is perforated so as not to obstruct the good flow of this fluid.

For example, the first docking zone, the second docking zone and the body of
15 the support form a one-piece assembly. In other words, the support forms a single unit that cannot be separated without causing damage to the first docking zone, the second docking zone or the body of the support.

According to one feature of the present invention, the base comprises at least one side flange that projects from the loading and/or unloading tower, the support
20 being fixed to this side flange. According to this feature of the present invention, the at least one side flange comprises a perforated box, the box comprising at least three walls that define a recess through which the support extends, at least partially. More precisely, part of the body of the support extends through this recess. Optionally, part of the pump carried by the support can also extend through this recess.

For example, the three walls of this perforated box are U-shaped, a base of the U being fixed to the base of the loading and/or unloading tower and two branches of this U shape extending from the base of this U shape, on either side of the pump. Alternatively, the recess of the box may be delimited by four walls. According to this alternative, the four walls can assume a rectangular, substantially rectangular or
30 square configuration.

According to the invention, the box is for example welded to the side flange of the base. Alternatively, the box can be bolted to the side flange of the base.

Each wall of the box comprises at least one lower face turned towards the bottom wall of the tank and at least one upper face turned away from the lower face, the first docking zone of the support being fixed against the upper face of one of the walls of the box. Advantageously, this allows the support to be inserted from above, until the first docking zone abuts against the upper face of at least one of the walls of the box carried by the side flange of the base.

According to an example of the invention, the tank may comprise at least two supports respectively fixed on the one hand to the box of the base of the loading and/or unloading tower and on the other hand to the pump. It is understood that these two supports are identical to each other and both include the features that have just been described with reference to one of them. In other words, each of these two supports comprises a first docking zone that forms a mechanical link between the base of the loading and/or unloading tower and the support, a second docking zone that forms a mechanical link between the pump and the support, and a body that forms a mechanical link between the first docking zone and the second docking zone, that is to say, indirectly, between the base of the loading and/or unloading tower and the pump.

Thus, according to this example of the invention, the first docking zone of a first support is for example fixed to an upper face of a first wall of the perforated box, and the first docking zone of a second support is fixed to an upper face of a second wall of the perforated box. It is understood that the second docking zone of the first support and the second docking zone of the second support are both fixed to the pump. Advantageously, the first wall of the box against which the first docking zone of the first support is fixed faces the second wall of the box on which the first docking zone of the second support is fixed. In other words, when the walls of the box form a U, the first docking zone of the first support is fixed on a first branch of this U shape and the first docking zone of the second support is fixed on a second branch of this U shape, this first branch and this second branch of the U shape both being connected to the base of this U shape. Alternatively, when the perforated box is rectangular, the first wall and the second wall, which respectively receive the first

docking zone of the first support and the first docking zone of the second support, are parallel. Advantageously, such arrangements make it possible to distribute the forces borne by the supports and therefore by the walls of the perforated box that receives these supports, so that the assembly has better mechanical strength.

- 5 According to a particular application of the present invention, the masts are arranged at an equal distance from each other so that the perimeter formed by the axial projection of these masts on the bottom wall of the tank is the perimeter of an equilateral triangle.

- 10 According to the invention, at least one fluid discharge tube is in fluid communication with the pump arranged outside the perimeter, the tank comprising at least one retaining arm configured to take up the force of the discharge tube. For example, this retaining arm can be fixed on one of the supports arranged between the base of the loading and/or unloading tower and the pump, advantageously on the first docking zone of the concerned support.

- 15 The present invention also comprises a vessel comprising at least one tank according to the invention and at least one support structure, the tank being anchored in the support structure.

- 20 The invention also relates to a method for loading or unloading a vessel according to the invention, in which a fluid is conveyed through pipes from or to a floating or onshore storage facility to or from the tank of the vessel.

- 25 Lastly, the invention relates to a transfer system for a fluid, the system comprising a vessel according to the invention, pipes arranged so as to connect the tank of the vessel to a floating or onshore storage facility and a pump for driving a fluid through the pipes from or to the floating or onshore storage facility to or from the tank of the vessel.

Other features, details and advantages will emerge more clearly on reading the detailed description given below, by way of indication, in relation to the various drawings illustrating the invention, among which:

- Fig. 1 is a schematic cut-away view of a sealed and thermally insulating tank

for storing a fluid according to the invention, this tank being equipped with a loading and/or unloading tower.

- Fig. 2 is a perspective view of a loading and/or unloading tower according to an embodiment of the present invention;

5 - Fig. 3 is a detailed view from below of the loading and/or unloading tower illustrating guiding of the loading and/or unloading tower on a support foot;

- Fig. 4 is a top view of a base of the loading and/or unloading tower according to a first embodiment of the present invention;

10 - Fig. 5 is a top view of a base of the loading and/or unloading tower according to a second embodiment of the present invention;

- Fig. 6 illustrates a perforated box carried by a side flange of the base of the loading and/or unloading tower according to the first embodiment illustrated in Fig. 4;

15 - Fig. 7 is an illustration of a support configured to form a mechanical link between the box and at least one of the pumps;

- Fig. 8 is a sectional view of the side flange partially illustrated in Fig. 6, to which the support is fixed, this support furthermore bearing one of the pumps of the loading and/or unloading tower;

20 - Fig. 9 illustrates, in perspective, a zone of the tank at which the loading and/or unloading tower extends;

- Fig. 10 is a cut-away schematic illustration of an LNG vessel tank and of a terminal for loading and/or unloading this tank.

By convention, in the figures, an orthonormal reference defined by two axes x and y is used to describe the elements of the tank. The x-axis corresponds to a longitudinal direction of a vessel and the y-axis is a transverse axis perpendicular to the longitudinal direction of the vessel. The terms “front” and “rear” are understood in relation to a main direction of movement of the vessel along the longitudinal direction.

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Fig. 1 schematically illustrates a tank 1 for storing and/or transporting a fluid. According to the example illustrated here, this fluid is liquefied natural gas, but it is understood that it could be a different fluid without departing from the context of the present invention. For example, this fluid could be a gas mixture mainly comprising methane as well as one or more other hydrocarbons, such as ethane, propane, n-butane, i-butane, n-pentane, i-pentane, neopentane, and nitrogen in small proportions. Thus, in the remainder of the description, the terms “fluid” and “liquefied natural gas” are used without distinction.

As shown, the tank 1 is equipped with a loading and/or unloading tower 2 making it possible in particular to load and/or unload the liquefied gas in/from the tank 1. This tank 1 is also anchored in a support structure 3 on board a vessel. The support structure 3 is for example formed by an internal hull of a vessel, but can more generally be formed of any type of rigid partition having suitable mechanical properties. The tank 1 may be intended for transporting liquefied gas or for receiving liquefied gas serving as fuel for the propulsion of the vessel, or for supplying a heat engine of an electric generator of the vessel.

According to one embodiment illustrated in Fig. 1, the tank 1 is a membrane tank. In such a tank 1, each wall successively has, from the outside to the inside, in the direction of the thickness of the wall, a secondary thermally insulating barrier 4 comprising insulating elements resting against the support structure 3, a secondary sealing membrane 5 anchored to the insulating elements of the secondary thermally insulating barrier 4, a primary thermally insulating barrier 6 comprising insulating elements resting against the primary waterproofing membrane 7 anchored to the insulating elements of the primary thermally insulating barrier 5 and intended to be in contact with the fluid contained in the tank 1. By way of 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 loading and/or unloading tower 2 is installed in the vicinity of a side wall 8 of the tank 1, and more particularly in the vicinity of a rear side wall 8 of the tank 1, which makes it possible to optimize the quantity of cargo capable of being unloaded by the loading and/or unloading tower 2 insofar as the vessels are generally tilted

backwards using ballasts, in particular in order to limit vibrations. In the remainder of the description, the terms “tower” and “loading and/or unloading tower” will be used without distinction to designate the same structure.

The tower 2 is suspended from an upper wall 9 of the support structure 3 and
5 it extends over substantially the entire height of the tank 1 between an upper end 200 and a lower end 201. As illustrated, the upper end 200 forms the end of the tower 2 by which it is suspended from the upper wall 9 of the support structure 3 and the lower end 201 forms the end of the tower 2 closest to a bottom wall 23 of the tank 1. It will thus be understood that the loading and/or unloading tower 2 is
10 arranged near a first stress zone of the tank 1 formed by a wedge 24 and situated at the intersection between the bottom wall 23 of the tank 1 and the rear side wall 8 of this tank 1.

At least one of the walls of the tank 1, advantageously at least the bottom wall 23 and the rear side wall 8 of the tank 1, have corrugations 230, for example
15 illustrated in Fig. 9. More particularly, it is the primary sealing membrane 7 that is a corrugated membrane, that is to say the membrane directly in contact with the fluid contained in the tank 1. As will be more fully detailed below with reference to Fig. 9, these corrugations impart a certain flexibility to the walls that bear them so that the latter have sufficient mechanical strength to withstand the stresses
20 experienced by the tank 1, in particular when the vessel is moving or when the cargo is moving.

Fig. 2 to 5 at least partially illustrate the loading and/or unloading tower 2, respectively, in a perspective view, in a bottom view, and in two top views, the tower 2 being produced according to a first embodiment in Fig. 4 and according to
25 a second embodiment in Fig. 2 and 5. We will first describe the elements common to these two embodiments before detailing their specificities.

The loading and/or unloading tower 2 thus comprises a tripod structure, that is to say it comprises at least three masts 11, 12, 13 that are each fixed to each other by cross-members 14. Each of these masts 11, 12, 13 is hollow and passes through a
30 cover 10 that closes the upper wall of the tank. Note that these masts 11, 12, 13 are not illustrated in Fig. 4 and 5, in which only a base 27 is visible comprising

rings 34, 35, 36 configured to receive these masts 11, 12, 13, the masts 11, 12, 13 being secured to these rings 34, 35, 36.

The three masts 11, 12, 13, with the cross-members 14, define a prism with a triangular section. According to the embodiment illustrated here, these
5 masts 11, 12, 13 are arranged at an equal distance from each other so that the section of the prism is an equilateral triangle. Advantageously, the three masts 11, 12, 13 are arranged such that at least one of the faces of the prism extends in a transverse plane P1 that is orthogonal to the longitudinal direction x of the vessel. In other words, two of the masts 11, 12 are aligned in the transverse plane P1. More
10 particularly, the two masts 11, 12 that are aligned in the transverse plane P1 are the two rear masts, that is to say those closest to the rear side wall of the tank.

As illustrated in Fig. 2, the front mast 13, that is to say the mast furthest from the rear side wall of the tank, has a larger diameter than the two rear masts 11, 12. The front mast 13 forms an emergency well allowing the lowering of an emergency
15 pump and an unloading line in the event of failure of the other unloading pumps. Furthermore, according to the example illustrated in particular in Fig. 2, the two rear masts 11, 12 form sheaths for the passage of electric power cables ensuring in particular the power supply of unloading pumps supported by the loading and/or unloading tower 2. Alternatively, the loading and/or unloading tower can be
20 equipped with sheaths for the passage of the electrical supply cable, which are then arranged in the transverse plane P1, between the two rear masts 11, 12.

In addition, the facility comprises three discharge or unloading ducts 15, 16, 17, which are each connected to a pump 18, 19, 20. The three ducts 15, 16, 17 are arranged in the transverse plane P1. The three ducts 15, 16, 17 are more particularly
25 placed between the two rear masts 11, 12. Each of the pumps 18, 19, 20 of the loading and/or unloading tower 2 comprises at least one electric motor and a pump body, this pump body comprising at least one suction member that forms an inlet for the fluid in the concerned pump.

Furthermore, as illustrated in Fig. 2, the loading and/or unloading tower 2 is
30 also equipped with two loading lines 21, 22 that are fixed to the front mast 13. One of the two loading lines 22 extends only in an upper portion of the tank, while the

other loading line 21 extends substantially over the entire height of the tank up to near the bottom wall of the tank 1. Advantageously, the loading line 21 that extends substantially over the entire height of the tank 1 is aligned with the front mast 13 along a transverse plane P2 which is orthogonal to the longitudinal direction x of the vessel. This makes it possible to limit the stresses due to the sloshing phenomena exerted on this loading line 21.

The loading and/or unloading tower 2 is also equipped with a base 27, which is fixed to the lower end 201 of the tower 2 and which supports the three pumps 18, 19, 20. The presence of three pumps 18, 19, 20 makes it possible, among other things, to ensure redundancy, which makes it possible in particular to reduce the risks of breakdown requiring the intervention of a maintenance operator in the tank.

As shown in Fig. 3, which illustrates the tower 2 seen from below, the loading and/or unloading tower 2 comprises a guide device that is fixed against a lower face of the base 27, that is to say a face of this base 27 turned towards the bottom wall 23, and which cooperates with a support foot 31 that is fixed to the bottom wall 23 of the tank 1. Such a guide device aims to allow the relative movements of the loading and/or unloading tower 2 with respect to the support foot 31 along the height direction of the tank in order to allow the loading and/or unloading tower 2 to contract or expand depending on the temperatures to which it is subjected while preventing horizontal or transverse movements of the base 27 of the loading and/or unloading tower 2.

As partially shown, the support foot 31 has a shape of revolution with a circular cross-section, with a frustoconical lower part that connects at its end of smaller diameter to a cylindrical upper part. The base of larger diameter of the frustoconical part bears against the support structure of the tank 1. The frustoconical lower part 54 extends through the thickness of the bottom wall 23 of the tank beyond the level of the primary sealing membrane. The cylindrical upper part is sealed by a circular plate. The primary and secondary sealing membranes are connected in a sealed manner to the lower frustoconical part 54.

Furthermore, at least two guide elements 57, 58 are welded to the support

foot 31 and respectively extend towards the rear and towards the front of the tank 1. Each of the two guide elements 57, 58 is equipped with two longitudinal faces and a transverse face, each of the longitudinal and transverse faces being in contact with a guide element 59 fixed on the base 27 of the loading and/or unloading tower 2. It
5 will be understood from what has just been described that the support foot 31 passes through the bottom wall 23 of the tank, so that the corrugations formed on this bottom wall 23 are cut, then generating a second stress zone of the tank.

As shown in Fig. 4 and 5, at least one of these pumps 18, 19, 20 is arranged outside a perimeter P defined by the three masts 11, 12, 13 of the loading and/or
10 unloading tower 2. More precisely, at least one of these pumps 18, 19, 20 is arranged entirely outside of this perimeter P, that is to say that the pump body and the electric motor are both arranged outside of this perimeter P. In other words, a contour P• of this pump is at a non-zero distance d1 from the perimeter P delimited by the masts 11, 12, 13 of the tower 2. As will be more fully detailed below with reference to
15 Fig. 9, this arrangement advantageously makes it possible to have a sufficient distance between the concerned pump and the first and second stress zones of the tank as defined above.

The first embodiment illustrated in Fig. 4 differs from the second embodiment illustrated in Fig. 5 by the type of pump arranged outside the perimeter P defined by
20 the masts 11, 12, 13. Thus, according to the first embodiment, the pump 19 arranged outside the perimeter P is an auxiliary pump, that is to say a supplementary or additional pump with respect to a pump dedicated specifically to unloading the cargo present in the tank. According to this embodiment illustrated in Fig. 4, the base 27 thus carries at least one unloading pump 18, 20 that intersects the
25 perimeter P of the masts or that is situated within the perimeter P of the masts, and at least one pump, called auxiliary, that extends into a sump of the tank and outside the perimeter P of the masts.

The auxiliary pump is configured to supply fluid, in this case natural gas in the liquid state, to the propulsion engine(s) of the vessel and/or a heat engine of an
30 electric generator of the vessel and/or to spray liquefied natural gas in the empty tank in order to cool the latter before it is filled, and/or to perform a complete emptying of the tank.

According to the second embodiment illustrated in Fig. 5, two pumps 18, 20 are arranged outside the perimeter P, these two pumps 18, 20 specifically being pumps for unloading the tank, that is to say pumps exhibiting a flow rate that is compatible with a liquefied natural gas unloading operation. It is understood that
5 this is only an example embodiment of the present invention and that provision could be made for a single unloading pump to be arranged outside the perimeter without departing from the context of the present invention.

In the remainder of the description, the term “pump” exclusively designates the pump(s) arranged outside the perimeter. The characteristics described for a
10 pump with reference to one of the two embodiments of the invention are directly transposable to the pump of the other embodiment or to the other pump carried by the same loading and/or unloading tower.

According to one of the first or second embodiments of the present invention, only the pump arranged outside the perimeter P delimited by the masts 11, 12, 13 is
15 at least partially arranged in a sump. Advantageously, as will be more fully detailed below, this arrangement of the pump in the sump makes it possible to reduce a volume of unpumpable liquefied natural gas, that is to say the volume of gas that cannot be removed from the tank.

With reference to Fig. 4 and 5, we will now describe the structure of the base 27
20 of the loading and/or unloading tower. As previously mentioned, the base 27 comprises rings 34, 35, 36 through which the lower ends of the three masts pass. The rings 34, 35, 36 are welded to the masts so as to fix said base 27 to the lower end of the three masts, and thus to the lower end of the loading and/or unloading tower.

As can be seen in Fig. 5, the base 27 comprises a central stiffening structure 37
25 that makes it possible to increase the stiffness of the base 27 and thus to increase the resistance of the loading and/or unloading tower to the sloshing phenomena. The central stiffening structure 37 comprises two stiffeners 38, 39, inclined relative to the longitudinal direction x of the vessel, that each extend in a straight line, between the central axis of one of the aft masts and the central axis of the front mast, in other
30 words, between a front ring 36 bearing the front mast and one of the rings 34, 35 bearing one of the rear masts. The central stiffening structure 37 comprises several

stiffeners 40, 41, 42, 43 that extend transversely and join the two inclined stiffeners 38, 39. The central stiffening structure 37 further comprises stiffeners 44 that extend in the longitudinal direction between the stiffeners 40, 41, 42, 43 extending transversely. In the illustrated embodiment, the base 27 comprises a flat metal sheet and the stiffeners 38, 39, 40, 41, 42, 43, 44 are metal beams that are welded to the flat metal sheet. This central stiffening structure 37 is also present on the base 27 of the first embodiment of the present invention, as visible in Fig. 4.

As illustrated in Fig. 4 and 5, the base 27 further comprises at least one side flange 45, 46 that projects in the transverse direction y beyond the perimeter P defined by the three masts. As illustrated, this at least one side flange 45, 46 bears the pump arranged outside the perimeter P defined by the masts. As previously mentioned, according to the first embodiment, a single pump 19 is arranged outside the perimeter P, so that the base 27 can only include a single side flange 45. On the other hand, according to the second embodiment, two pumps 18, 20 are arranged outside the perimeter P so that the base 27 comprises two side flanges 45, 46, each bearing one of these pumps 18, 20.

As illustrated in Fig. 4 and 5, each pump 18, 19, 20 arranged outside the perimeter P is more particularly housed in a box 47, 48, for example open to the outside of the loading and/or unloading tower and borne by one of the side flanges 45, 46 of the base 27 of the loading and/or unloading tower. Similarly to what has just been specified concerning the side flanges 45, 46, it will be understood that the base 27 of the loading and/or unloading tower comprises as many boxes as there are pump(s) arranged outside the perimeter P delimited by the masts.

As can be seen in Fig. 6, each perforated box 47, 48 comprises at least three walls 49, 50, 51 that define a recess 52 through which the pump extends, at least partially. As shown, these walls 49, 50, 51 have a U shape, a first wall 50 and a second wall 51 forming two branches of this U shape connected to each other by a third wall 49 which thus forms a base of the U shape. Each wall 49, 50, 51 has a lower face 490, 500, 510 facing towards the bottom wall of the tank and an upper face 491, 501, 511 facing away from the corresponding lower face 490, 500, 510.

Furthermore, each wall 49, 50, 51 that defines the recess 52 has a vertical

extension 492, 502, 512 that extends from the lower face 490, 500, 510 of the corresponding wall 49, 50, 51, perpendicularly, or substantially perpendicularly to this wall 49, 50, 51.

The box 47, 48 has a fixing plate 53 borne by the third wall 49, and more particularly by a portion of this third wall 49, that is to say a part of this third wall 49 that connects its lower face 490 to its upper face 491. According to the illustrated example, this fixing plate 53 has a plurality of holes 530 through which the box 47, 48 is bolted to the base of the loading and/or unloading tower. According to an embodiment that is not illustrated here, the fixing plate is welded to the base of the loading and/or unloading tower. Lastly, we note the presence of receiving members 503, 513 positioned on the upper faces 501, 511 of the first and second walls 50, 51 that define the recess 52. As described below, these receiving members 503, 513 each receive a support—for example illustrated in Fig. 7—which bears the pump arranged outside the perimeter delimited by the masts. Advantageously, such a configuration makes it possible to insert the concerned support from above, until it abuts against the upper face of the concerned wall.

According to an example that is not illustrated here, the box can assume a closed conformation, in particular rectangular, substantially rectangular or square. In other words and according to this example that is not illustrated, the recess of this box is delimited by four walls instead of three.

As mentioned above, the pumps carried by the side flanges of the base are the pumps that are arranged outside the perimeter defined by the masts and which are also the only pumps that extend, in part, each in a sump.

Such a sump, as visible in Fig. 8, is provided in the bottom wall of the tank, so that an inlet of each of this sump is formed flush with this bottom wall of the tank. Also, it is understood that in order to allow the fluid present in the tank to reach this sump, it is necessary to leave this inlet free, despite the space occupied by the pump in this sump.

To this end, the present invention proposes to use at least one support 60 such as that illustrated in Fig. 7. Fig. 8 illustrates the cooperation between two of these

supports 60 and a box 47 borne by a side flange 45.

Referring to Fig. 7, it is noted that the support 60 comprises at least one body 61 of the support 60 from which extend at least one first docking zone 62 and at least one second docking zone 63. As shown, these first and second docking zones 62, 63 extend from two opposite ends of the body 61 of the support 60. In other words, the first docking zone 62 extends mainly in a first plane X1 distinct from a second plane X2 in which mainly the second docking zone 63 extends. Furthermore, a third plane X3 in which the body 61 of the support 60 mainly extends intersects the first plane X1 and the second plane X2. According to a particular example illustrated in Fig. 6 and 7, the first plane X1 and the second plane X2 are more particularly parallel planes, so that the third plane X3 is a plane perpendicular to the first plane X1 and the second plane X2.

As shown in Fig. 7, the first docking zone 62 has at least two bores 620 through which the first docking zone 62, and therefore the support 60, is fixed to the upper face 501, 511 of one of the first or second walls of the box, as described above. In other words, the second docking zone 63 of the support 60 is inserted first through the recess of the concerned box, for example from above, then the support 60 is translated or lowered until the first docking zone 62 abuts against the upper face of the wall of the box on which this first docking zone 62 is intended to be fixed. For example, this first docking zone 62 is fixed to the box by means of screws. It is understood that this is only an example embodiment and that any other fixing means can be considered without departing from the context of the present invention. For example, the first docking zone can be welded to the upper face of one of the first or second walls of the box.

The second docking zone 63 of the support 60 in turn comprises a plurality of orifices 630 configured to receive means for fixing the pump to the support 60. In other words, the second docking zone 63 of the support 60 makes it possible to connect the concerned pump to the base of the tower.

The body 61 of the support 60 in turn comprises a main wall 610 that fits entirely in the third plane X3 and from which two secondary walls 611 extend. According to the example illustrated in Fig. 7, each secondary wall 611 extends

perpendicularly, or substantially perpendicularly, to the main wall 610. As shown, the main wall 610 and the two secondary walls 611 are all three connected to both the first docking zone 62 and the second docking zone 63. Furthermore, at least one and advantageously two openings 612 are formed in the main wall 610 of the body 61 of the support 60, these two openings 612 thus being aligned one above the other in the third plane X3. As will be more fully described below, an opening 612 allows the fluid present in the tank to reach the sump more easily, in which the pump borne by the concerned support 60 partially extends. The support 60 is then not a brake that limits the flow towards the sump.

Furthermore, the first docking zone 62 and the second docking zone 63 respectively have a first cutout 621 and a second cutout 631 that both assume the shape of an arc of a circle in order to adapt to the shapes of the pump carried by the support, as illustrated for example in Fig. 7. Note that the arc of the first cutout 621 has a diameter smaller than a diameter of the arc of a circle that forms the second cutout 631.

Finally, we note the presence of at least one bracket 65 arranged between the main wall 610 and at least one of the secondary walls 611 of the body 61 of the support 60, and more particularly, this bracket 65 is secured to the main wall 610 at a point situated between the two openings 612. It will be understood that this bracket 65 makes it possible to reinforce the structure of the support 60 and thus to make it more resistant to the various mechanical stresses to which it is subjected. Advantageously, the support comprises two identical brackets 65, respectively arranged between each secondary wall 611 and the main wall 610 of the body 61 of the support 60.

Fig. 8 illustrates, in sectional view, an assembly of the pump 18, 19, 20 on the support 60, which in turn is fixed to a box 47 of the base of the loading and/or unloading tower, the section being done along a plane in which a main axis Z of the pump 18, 19, 20 is inscribed, this plane intersecting the first plane X1 in which the first docking zone 61 is inscribed, the second plane X2 in which the second docking zone 62 is inscribed and parallel with the third plane X3 in which the body 61 of the support 60 is inscribed.

More particularly, Fig. 8 illustrates an assembly that comprises two supports 60, each connected to the base 27, and more particularly to a box 47 borne by this base. As mentioned above, at least part of the pump 18, 19, 20 extends through the recess 52 of the box 47 and at least another part of the pump 18, 19, 20
5 in turn extends in a sump 30 formed through the bottom wall 23 of the tank.

As shown, the sump 30 receives the suction member of the pump 18, 19, 20. This sump 30 comprises a primary cylindrical bowl 32 that provides a first container in communication with the inside of the tank and a secondary cylindrical bowl 33 that provides a second container surrounding the lower part of the primary
10 cylindrical bowl 32. The primary cylindrical bowl 32 is continuously connected to the bottom wall 23 of the tank, which it thus completes in a sealed manner. Thus, an inlet 300 of the sump 30, that is to say an opening through which the fluid present in the tank can reach the inside of this sump 300, is formed flush with the bottom wall 23 of the tank.

15 The primary cylindrical bowl 32 is continuously connected to the primary sealing membrane of the bottom wall 23 of the tank and the secondary cylindrical bowl 33 is in turn continuously connected to the secondary sealing membrane of the bottom wall 23 of the tank. However, this secondary sealing membrane of the bottom wall 23 of the tank is not illustrated in Fig. 8. Furthermore, the sump 30 is
20 centered on the main axis Z of the pump 18, 19, 20 that it receives.

It will be understood from this Fig. 8 that the use of supports 60 as described above makes it possible to provide a non-zero distance between the base 27, and more particularly the box 47, and the primary insulating membrane of the bottom wall 23. It follows that a space W is cleared between the box 47 and the inlet 300 of
25 the sump 30 that partially receives the pump 18, 19, 20. Thus, the fluid present in the tank can easily reach this sump 30 in order to be pumped there by the pump 18, 19, 20 that extends there. Furthermore, the openings 612 formed in the body 61 of the support 60 allow the fluid present in the tank to pass through the support 60 and thus to further facilitate the access of the fluid to the sump 30, by
30 flowing along the pump 18, 19, 20 until reaching the inside of this sump 30.

Furthermore, a discharge tube 150 is fluidly connected to the pump 18, 19, 20

so as to allow the discharge of the fluid sucked by this pump 18, 19, 20. Advantageously, a retaining arm 151 of this discharge tube 150 is fixed to the box 47, and more particularly, this retaining arm 151 is fixed to the first docking zone 62 of one of the supports 60 fixed to the box 47. According to the example illustrated in
5 Fig. 8, this retaining arm 151 is fixed on the first docking zone 62 of the support 60 fixed on the upper face of the first wall 50. In any event, this retaining arm 151 makes it possible to take up the force of the discharge tube 150.

As mentioned above, the positioning of the pump 18, 19, 20 outside the perimeter delimited by the masts of the loading and/or unloading tower makes it
10 possible to maintain a minimum flexibility of the bottom wall of the tank.

Fig. 9 thus illustrates, in perspective, a zone of the tank 1 in which the loading and/or unloading tower is intended to be arranged, this tower not being shown in Fig. 9. As mentioned above, the primary sealing membrane of the bottom wall 23 and of the rear side wall 8 are corrugated membranes that impart sufficient
15 flexibility to these walls to enable them to withstand the various mechanical stresses that they experience. It is thus noted that the corrugations 230 extend at least in the transverse and longitudinal directions of the vessel. This Fig. 9 also illustrates the first stress zone formed by the wedge 24 situated at the junction between the bottom wall 23 and the rear side wall 8 and the second stress zone formed by the support
20 foot 31 that passes through the bottom wall 23.

An interruption of the corrugations 230, like that generated by the production of the sump 30 described and illustrated above, causes a loss of elasticity of the bottom wall 23, which risks weakening the tank. Advantageously, the support foot 31 is placed between the guidelines of two transverse corrugations 230, and
25 more particularly centered between them. This makes it possible to interrupt the corrugations 230 over the shortest possible distance, given that these interruptions are liable to locally reduce the flexibility of the bottom wall 23 and therefore to locally promote its fatigue and its wear.

Furthermore, in order to limit a reduction in the flexibility of the bottom
30 wall 23 as much as possible, a minimum of three corrugation pitches is left between each of the stress zones described above. Thus, at least three corrugation pitches are

for example left between the wedge 24 formed between the bottom wall 23 and the rear side wall 8 and the sump 30 and three corrugation pitches are also left between the support foot 31 and the sump 30. Such arrangements advantageously make it possible not to degrade the mechanical behavior of the bottom wall 23 of the tank.

5 Finally, Fig. 10 is a cut-away view of a vessel 70 that shows the sealed and insulated tank 1 of generally prismatic shape mounted in the double hull 72 of the vessel. The wall of the tank 1 comprises a primary sealing membrane intended to be in contact with the liquefied gas contained in the tank, a secondary sealing
10 membrane arranged between the primary sealing membrane and the double hull 72 of the vessel, and two insulating barriers respectively arranged between the primary sealing membrane and the secondary sealing membrane and between the secondary
 sealing membrane and the double hull 72.

 Loading and/or unloading pipes 73 arranged on the upper deck of the vessel can be connected, by means of suitable connectors, to a marine or port terminal to
15 transfer the cargo of natural gas in the liquid state from or to the tank 1.

 Fig. 10 also shows an example of a maritime terminal comprising a loading and/or unloading station 75, an underwater duct 76 and an onshore facility 77. The loading and/or unloading station 75 is a fixed off-shore facility comprising a moving
20 arm 74 and a tower 78 that supports the moving arm 74. The moving arm 74 bears a bundle of insulated pipes 79 that can be connected to the loading and/or unloading pipes 73. The adjustable moving arm 74 adapts to all vessel sizes. The loading and unloading station 75 allows the loading and/or unloading of the vessel 70 from or to the onshore facility 77. This comprises liquefied gas storage tanks 80 and connecting
 ducts 81 connected by the underwater duct 76 to the loading or unloading station 75.
25 The underwater duct 76 allows the transfer of the liquefied gas between the loading or unloading station 75 and the onshore facility 77 over a great distance, for example 5 km, which makes it possible to keep the vessel 70 at a great distance from the coast during loading and/or unloading operations.

 In order to generate the pressure necessary for the transfer of the liquefied gas,
30 the unloading pump(s) mentioned above and borne by the loading and/or unloading tower of the tank 1 and/or the pumps equipping the onshore facility 77 and/or

pumps fitted to the loading and unloading station 75 are implemented.

Of course, the invention is not limited to the examples that have just been described, and numerous modifications can be made to these examples without departing from the scope of the invention.

- 5 The use of the verb “have,” “comprise” or “include” and its conjugated forms does not exclude the presence of elements or steps other than those stated in a claim.

- 10 The invention, as it has just been described, thus achieves the aim it had set itself, and makes it possible to propose a tank equipped with a loading and/or unloading tower bearing at least one pump at least partially housed in a sump and situated outside a perimeter of the loading and/or unloading tower. Variants not described here could be implemented without departing from the context of the invention, since, in accordance with the invention, they include such an arrangement in accordance with the aspect of the invention.

CLAIMS

1. Storage and/or transport tank (1) for a fluid cargo intended for a vessel (70), the tank (1) comprising at least one loading and/or unloading tower (2) for the fluid, at least one sump (30) being formed in a bottom wall (23) of the tank (1), the loading and/or unloading tower (2) comprising at least one base (27) situated at a lower end (201) of this loading and/or unloading tower (2), the loading and/or unloading tower (2) comprising at least three masts (11, 12, 13) secured to the base (27), the loading and/or unloading tower (2) bearing at least one pump (18, 19, 20), the masts (11, 12, 13) delimiting a perimeter (P) by axial projection onto the bottom wall (23) of the tank (1), characterized in that the pump (18, 19, 20) is entirely arranged outside the perimeter (P) and in that it extends, at least partially, into the sump (30).

5

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2. Tank (1) according to the preceding claim, wherein the bottom wall (23) has at least one corrugation (230).

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3. Tank (1) according to the preceding claim, comprising at least one side wall (8) that extends substantially perpendicular to the bottom wall (23) of this tank (1), and wherein the bottom wall (23) having at least three corrugation pitches between the side wall (8) of the tank (1) and the sump (30).

20
4. Tank (1) according to any one of claims 2 or 3, wherein the bottom wall (23) comprises a support foot (31) for the loading and/or unloading tower (2), and wherein the bottom wall (23) has at least three corrugation pitches between the support foot (31) of the loading and/or unloading tower (2) and the sump (30).

25
5. Tank (1) according to any one of the preceding claims, wherein the pump (18, 19, 20) situated outside the perimeter (P) is an auxiliary pump configured to supply an engine of the vessel (70) with fluid and/or to cool the tank (1) by spraying it with the fluid and/or to completely empty the tank (1).

6. Tank (1) according to any one of claims 1 to 4, wherein the pump (18, 19, 20) situated outside the perimeter (P) is an unloading pump (18, 19, 20) configured to unload at least part of the fluid contained in the tank (1).
7. Tank (1) according to any one of the preceding claims, wherein at least one support (60) is arranged between the base (27) and the pump (18, 19, 20).
8. Tank (1) according to the preceding claim, wherein the at least one support (60) comprises at least a first docking zone (62) on which the base (27) is fixed and at least a second docking zone (63) on which the pump (18, 19, 20) is fixed, the first docking zone (62) and the second docking zone (63) being interconnected by a body (61) of the support (60), the first docking zone (62) extending in a first plane (X1), the second docking zone (63) extending in a second plane (X2), the first plane (X1) and the second plane (X2) being distinct.
9. Tank (1) according to the preceding claim, wherein the first plane (X1) in which the first docking zone (62) of the support (60) extends is parallel to the second plane (X2) in which the second docking zone (63) of the support (60) extends.
10. Tank (1) according to one of claims 8 or 9, wherein the body (61) of the support (60) comprises at least one opening (612).
11. Tank (1) according to one of claims 8 to 10, wherein the base (27) comprises at least one side flange (45, 46) that projects from the loading and/or unloading tower (2), the support (60) being fixed to this side flange (45, 46).
12. Tank (1) according to the preceding claim, wherein the at least one side flange (45, 46) comprises a perforated box (47, 48), the box (47, 48) comprising at least three walls (49, 50, 51) that define a recess (52) through which the support (60) extends, at least partially.
13. Tank (1) according to the preceding claim, wherein the box (47, 48) is welded to the side flange (45, 46) of the base (27).

- 14.** Tank (1) according to claim 12, wherein the box (47, 48) is bolted to the side flange (45, 46) of the base (27).
- 15.** Tank (1) according to one of claims 12 to 14, wherein each wall (49, 50, 51) of the box (47, 48) comprises at least one lower face (490, 500, 510) turned towards the bottom wall (23) of the tank (1) and at least one upper face (491, 501, 511) turned away from the lower face (490, 500, 510), the first docking zone (62) of the support (60) being fixed against the upper face (491, 501, 511) of one of the walls (49, 50, 51) of the box (47, 48).
- 16.** Tank (1) according to one of the preceding claims, wherein at least one fluid discharge tube (150) is in fluid communication with the pump (18, 19, 20) arranged outside the perimeter (P), the tank (1) comprising at least one retaining arm (151) configured to take up the force of the discharge tube (150).
- 17.** Vessel (70) comprising at least one tank (1) according to one of the preceding claims and at least one support structure (3), the tank (1) being anchored in the support structure (3).
- 18.** Method for loading or unloading a vessel (70) according to the preceding claim, wherein a fluid is conveyed through insulated pipes (79) from or to a floating or onshore storage facility (77) to or from the tank (1) of the vessel (70).
- 19.** Transfer system for a fluid, the system comprising a vessel (70) according to claim 19, pipes (79) arranged so as to connect the tank (1) of the vessel (70) to a floating or onshore storage facility (77) and a pump for driving a fluid through the pipes (79) from or to the floating or onshore storage facility (77) to or from the tank (1) of the vessel (70).