

Tight tank wall comprising a sealing membrane

Technical field

The invention relates to the field of sealed tanks, in particular for the storage or transport of fluids, and in particular sealed and thermally insulating tanks for
5 liquefied gas at low temperature.

Sealed and thermally insulating tanks are used in particular for the storage of liquefied gas such as liquefied natural gas (LNG) or liquefied petroleum gas (LPG), which is stored at atmospheric pressure. These tanks may be installed onshore or on a floating structure.

10 Prior art

Storage or transport tanks for liquefied gas at low temperature, in which the or each sealing membrane, in particular a primary sealing membrane in contact with the product contained in the tank, consists of thin metal sheets, referred to as metal strakes, which are connected to one another in a sealed manner in order to ensure
15 the tank is sealed, are known, for example from WO2012072906 or FR3054872.

Said metal strakes are secured to the thermally insulating barrier in this type of tank. To be specific, an upper surface of the thermally insulating barrier has a groove hollowed out in a thickness direction from the upper surface and extending in a longitudinal direction of the thermally insulating barrier. A weld support, comprising
20 a base and an arm connected to the base, is slidably inserted in the groove. The base is housed in the groove so as to retain the weld support on the thermally insulating barrier in a direction perpendicular to the upper surface. The arm of the weld support protrudes above the upper surface.

Two metal strakes are arranged on either side of the weld support. These
25 metal strakes each have a flat middle portion resting on the upper surface. These metal strakes also have raised side edges. A raised edge of each of the two adjacent metal strakes is welded on either side of the weld support arm. The weld support is usually less thick than the strakes.

The raised edges thus form, with the weld support, deformable bellows making it possible to absorb the forces associated with the contraction of the sealed membrane, for example when cryogenic liquid is being loaded into the tank.

Such a membrane may be referred to as a membrane with inward bellows,
5 the bellows being oriented toward the interior of the vessel.

Membrane tanks are also known from WO2015022473, in which a first tank wall and an adjacent second tank wall form a corner joint, the tank further comprising a sealed corner piece located at the corner joint. The plates adjacent to the corner joint are in this case connected to one another with the aid of two reinforcing wings of
10 the corner piece inside the groove. Securing is thus on the outward side of the tank. However, a metal plate referred to as a corner angle iron also secures the two plates above the support surface so as to cover the securing zone and the reinforcing wings of the corner joint, such that it is not possible to have any deformable bellows at the connection between the two membrane plates.

15 **Summary**

During the transport of fluid contained in the sealed tank, in particular when the tank is not completely full, there is sloshing of the fluid, causing it to move from one wall to another. The sloshing of the fluid thus applies stresses on the walls of the tank and in particular on these protruding parts such as the raised edges. In prior art
20 tanks, these stresses on the raised edges can cause the raised edges to bend. Bent raised edges no longer effectively act as a bellows to absorb the contraction of the membrane and could lead to damage to the membrane which would impair the seal of the tank.

An idea forming the basis of the invention is to reduce or prevent the risk of
25 bending of the raised edges so as to prevent any damage to the sealed tank.

Another idea forming the basis of the invention is to keep deformable bellows on the sealing membrane so as to absorb the forces associated with the contraction of the membrane.

Another idea forming the basis of the invention is to provide a sealed membrane which can be used in a sealed tank for the transport or storage of a cold product and which maximizes the useful volume of the tank.

- According to one embodiment, the invention provides a sealed tank wall, for
 5 storage of a fluid, comprising:
- a support surface comprising at least one groove hollowed out in a thickness direction of the tank wall and extending in a longitudinal direction;
 - a metal sealing membrane borne by the support surface in the longitudinal direction, the metal sealing membrane comprising at least one metal support, preferably a
 10 plurality of metal supports, borne by the support surface, said metal support comprising a first anchoring wing and a second anchoring wing sealingly secured to one another, the anchoring wings each comprising an upper portion extending above the support surface in a transverse direction so that the upper portion of the first anchoring wing extends on one side of the groove and the upper portion of the second
 15 anchoring wing extends on the other side of the groove, the anchoring wings each also comprising a base retained in the groove of the support surface in a direction perpendicular to the support surface with a degree of freedom in the longitudinal direction, and the anchoring wings each comprising an arm connecting the upper portion to the base;
 - 20 wherein the arms of the anchoring wings are elastically deformable in flexion in the transverse direction so as to allow the upper portions of the anchoring wings to move relative to one another in the transverse direction.

By virtue of these features, the sealed tank wall does not have raised edges to constitute its sealing membrane but has at least one metal support, so there is no
 25 longer any protruding part affected by the sloshing of the fluid and no longer a risk of these raised edges bending. Furthermore, the metal support makes it possible to obtain a membrane with an outward bellows, the one or more bellows being oriented toward the outside of the tank, the one or more bellows making it possible to absorb the forces associated with the contraction of the membrane.

- 30 According to one embodiment, the support surface comprises a plurality of grooves, and the sealing membrane comprises a plurality of metal supports of which

at least one base of an anchoring wing of the plurality of metal supports is retained in each of the grooves.

According to one embodiment, the at least one metal support is made from any type of metal, such as stainless steel.

5 According to one embodiment, the at least one metal support is made from a metal having a low thermal expansion coefficient, for example this metal may be an iron-nickel alloy with a thermal expansion coefficient between 1.2 and $2.0 \times 10^{-6} \text{ K}^{-1}$, or an iron alloy with a high manganese content, the expansion coefficient of which is typically of the order of $7.5 \times 10^{-6} \text{ K}^{-1}$.

10 According to one embodiment, the groove comprises a flared part where it opens out. The flared part where the groove opens out may for example be made using chamfers on either side of the groove.

Thus, the flared part where the groove opens out makes it possible to increase the space where the anchoring wings can deform and thus enhance the
15 bellows effect by increasing the possible transverse movement of the upper portions of the anchoring wings.

According to one embodiment, the transverse dimension of the groove is greater than twice the thickness of an anchoring wing. The transverse dimension of the groove may for example be greater than five times the thickness of an anchoring
20 wing.

By virtue of these features, the transverse dimension of the groove makes it possible to leave a clearance between the metal support and the groove, allowing a space to be left where the anchoring wings can deform and thus enhancing the bellows effect of the membrane.

25 According to one embodiment, the anchoring wings are welded to one another by a primary longitudinal weld inside the groove.

Thus, the weld makes it possible to create the seal between the two anchoring wings. Furthermore, the weld is made inside the groove because the distance, in the thickness direction of the wall, between the upper portion of an
30 anchoring wing and the primary longitudinal weld makes it possible to create and

enhance the bellows effect that the membrane needs in order to contract. To be specific, the greater the distance between the upper portion of an anchoring wing and the primary longitudinal weld, the greater the transverse movement of the membrane will be.

- 5 According to one embodiment, the primary longitudinal weld is located at the arms of the anchoring wings.

 According to one embodiment, the distance, in the thickness direction of the wall, between the upper portion of an anchoring wing and the primary longitudinal weld is between 15 mm and 50 mm.

- 10 According to one embodiment, the metal support comprises a connecting part which sealingly connects the bases of the anchoring wings to one another inside the groove.

- By virtue of these features, the connecting part makes it possible to create the seal between the two anchoring wings. Moreover, because it connects the bases
15 of each of the anchoring wings, the connecting part is distanced from the upper portion by the length of an anchoring wing arm. The anchoring wing arms can therefore deform elastically in flexion over their entire length, which allows a potentially greater movement of the upper portions in the transverse direction.

- According to one embodiment, the metal sealing membrane comprises a
20 plurality of said metal supports arranged parallel to one another, wherein the upper portions of the anchoring wings of two adjacent metal supports are directly or indirectly connected in a sealed manner.

- According to one embodiment, the metal sealing membrane comprises a metal strip resting on the support surface, the metal strip being arranged parallel to
25 the metal supports, and wherein a first edge of the metal strip is welded to the upper portion of the first anchoring wing of a first of the metal supports by a first secondary longitudinal weld, and a second edge of the metal strip is welded to the upper portion of the second anchoring wing of a second of the metal supports by a second secondary longitudinal weld.

According to one embodiment, the metal sealing membrane comprises a plurality of metal strips, one or each of said metal strips being arranged parallel to the metal supports.

Therefore, the membrane comprises one or more metal strips as well as one
5 or more metal supports connecting each of the strips to one another so as to form a fluid-tight assembly.

According to one embodiment, the thickness of the metal support is greater than or equal to the thickness of a metal strip.

According to one embodiment, the thickness of the metal support is between
10 0.7 and 1.5 mm, the thickness of a strip being for example less than or equal to 0.7 mm.

According to one embodiment, said metal strip or strips are made from any type of metal, such as stainless steel.

According to one embodiment, said metal strip or strips are made from a
15 metal having a low thermal expansion coefficient, for example this metal may be an iron-nickel alloy with a thermal expansion coefficient between 1.2 and $2.0 \times 10^{-6} \text{ K}^{-1}$, or an iron alloy with a high manganese content, the expansion coefficient of which is typically of the order of $7.5 \times 10^{-6} \text{ K}^{-1}$.

According to one embodiment, one end of the metal strip is located between
20 the support surface and the upper portion of an anchoring wing and the secondary longitudinal weld is made on the upper portion, for example at one end of the upper portion, so as to connect the metal strip to the upper portion.

By virtue of these features, placing the upper portion of the anchoring wings
on the metal strips makes it possible to facilitate welding of metal sheets of different
25 thicknesses.

According to one embodiment, the cross section of the metal strip comprises a flat middle portion resting on the support surface and at least one offset portion parallel to and at a distance from the support surface, the upper portion of an anchoring wing being located between the support surface and the offset portion and

wherein the secondary longitudinal weld connecting a said upper portion and an edge of the metal strip is made on the offset portion of the metal strip.

These features make it easier to secure an anchoring wing to a strip because the overlap of the offset portion with the upper portion facilitates welding and also
5 allows a manufacturing tolerance for larger parts.

According to one embodiment, the offset portion is formed by stamping one end of the metal strip or by welding an attached plate onto one end of the metal strip.

According to one embodiment, one or more metal strips have two offset portions on either side of the flat middle portion.

10 According to one embodiment, the distance between the support surface and the offset portion is substantially equal to or greater than the thickness of the upper portion of the anchoring wing, preferably substantially equal.

According to one embodiment, the cross section of the upper portion of the or of a metal support comprises a flat portion resting on the support surface and at
15 least one offset portion parallel to and at a distance from the support surface, a part of a metal strip being located between the support surface and the offset portion and wherein the secondary longitudinal weld connecting a said upper portion and an edge of the metal strip is made on the offset portion of the upper portion.

According to one embodiment, the groove is the main groove, and the
20 support surface comprises at least one secondary groove hollowed out in the thickness direction and extending in the longitudinal direction in proximity, preferably in close proximity, to the main groove and wherein at least one part or the upper portion of an anchoring wing is located in the secondary groove. The at least one part or the upper portion of an anchoring wing located in the secondary groove may be,
25 for example, below a metal strip.

Thus, it is easier to secure an anchoring wing to a strip because the overlap of the strip with the upper portion located in the secondary groove facilitates welding and also allows a manufacturing tolerance for larger parts.

According to one embodiment, the sealed tank wall includes a thermal
30 insulation layer in the secondary groove below the upper portion of an anchoring wing.

According to one embodiment, the support surface comprises two secondary grooves on either side of the main groove.

According to one embodiment, the dimension of the secondary groove in the thickness direction is substantially equal to or greater than the thickness of the upper
5 portion of the anchoring wing.

According to one embodiment, the dimension of the secondary groove in the transverse direction is substantially equal to or greater than the dimension of the upper portion of the anchoring wing in the transverse direction.

According to one embodiment, the groove has an inlet zone which extends
10 in the thickness direction, the groove comprising a retaining zone arranged below the inlet zone and extending parallel to the support surface over a width greater than the inlet zone, and wherein the base of at least one anchoring wing of the metal support is housed in the retaining zone.

According to one embodiment, the retaining zone extends parallel to the
15 support surface, on either side of the inlet zone.

According to one embodiment, the base of one or each of the anchoring wings is flat in shape.

According to one embodiment, the groove comprises at least one fastener, the fastener being configured to retain one of the bases of the metal support in the
20 groove, preferably the groove comprises two fasteners so as to retain the base of the first anchoring wing and the base of the second anchoring wing.

According to one embodiment, one of the bases of the metal support has a rounded shape and the fastener has a complementary rounded portion so that the base of the metal support and the rounded portion of the fastener fit one inside the
25 other. Preferably, the two bases of the metal support each have a rounded shape and the two fasteners each have a complementary rounded portion so that the corresponding base of the metal support and rounded portion of the fastener fit one inside the other.

According to one embodiment, the sealed tank wall comprises a thermally
30 insulating barrier comprising a top panel including the support surface. Such a

thermally insulating barrier may be produced in many ways, according to the technique described for example in publications FR-A-2798902, WO-A-2017103500 or WO-A-2017207938.

According to one embodiment, the thermally insulating barrier is a primary
 5 thermally insulating barrier and the sealing membrane is a primary sealing membrane, and wherein the sealed tank wall comprises a secondary thermally insulating barrier and a secondary sealing membrane arranged under the primary thermally insulating barrier.

According to one embodiment, the invention provides a polyhedral sealed
 10 tank comprising a plurality of sealed tank walls secured to one another in a sealed manner to form a polyhedral interior space for the storage of a fluid, wherein one or more of said sealed tank walls is as mentioned above.

According to other advantageous embodiments, such a tank may have one or more of the following features.

15 According to embodiments, the tank may comprise one or more of the tank walls from the following list:

- a ceiling wall,
- a bottom wall,
- one or more cofferdam side walls connecting the bottom wall to the ceiling wall,
- 20 - one or more side walls connecting the cofferdam side wall or walls,
- one or more lower walls forming chamfers connecting the side wall or walls to the bottom wall and
- one or more upper walls forming chamfers connecting the side wall or walls to the ceiling wall;

25 One or more of the tank walls listed may be a tank wall as described above.

Such a tank may form part of an onshore storage facility, for example for storing LNG, or be installed on a floating structure, coastal or deep-water, in particular an LNG carrier, a floating storage and regasification unit (FSRU), a remote floating production and storage unit (FPSO), and the like. Such a tank may also be used as a
 30 fuel tank in any type of carrier.

According to one embodiment, the invention also provides a carrier for the transport of a liquid product, the carrier comprising a hull and a tank according to the invention arranged in the hull.

According to one embodiment, the invention provides a method for loading
5 or unloading such a carrier, wherein a liquid product is conveyed through insulated pipelines from or to a floating or onshore storage facility, to or from the sealed tank of the carrier.

According to one embodiment, the invention also provides a transfer system for transferring a liquid product, the system comprising the abovementioned carrier,
10 insulated pipelines arranged so as to connect the sealed tank installed in the hull of the carrier to a floating or onshore storage facility, and a pump for pumping a flow of cold liquid product through the insulated pipelines from or to the floating or onshore storage facility, to or from the sealed tank of the carrier.

Brief description of the figures

15 The invention will be better understood, and other objects, details, features and advantages thereof will appear more clearly during the following description of several particular embodiments of the invention, provided solely by way of non-limiting illustration, with reference to the attached drawings.

- **La figure 1** is a partial perspective view, with part cut away, of a wall of
20 a sealed and insulating tank according to the invention.

- **La figure 2** is a schematic sectional view of a metal support anchored in a support surface, the bases of the support being flat.

- **La figure 3** is a schematic sectional view of a metal support anchored in a support surface, the bases of the support being flat and the support being welded
25 below the metal strips.

- **La figure 4** is a schematic sectional view of a metal support anchored in a support surface, the bases of the support being rounded and secured to fasteners/fasteners and the support being welded to metal strips.

- **La figure 5** is a partial perspective view of a metal support anchored in
30 a support surface according to figure 4.

- **La figure 6** is a schematic sectional view of a metal support anchored in a support surface, the surface having a secondary groove.

- **La figure 7** is a schematic sectional view of a metal support anchored in a support surface, the support being welded above metal strips.

5 - **La figure 8** schematically depicts, with part cut away, a carrier comprising a sealed tank for storing a fluid and a terminal for loading/unloading this tank.

Detailed description of embodiments

10 In the description below, reference is made to a sealing membrane in the context of a sealed tank. Such a tank comprises an interior space, formed by a plurality of tank walls, intended to be filled for example with combustible or non-combustible gas. The gas may in particular be a liquefied natural gas (LNG), that is to say 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, 15 neopentane, and nitrogen in small proportions. The gas may also be ethane or liquefied petroleum gas (LPG), that is to say a mixture of hydrocarbons obtained from the refining of petroleum mainly comprising propane and butane.

20 By convention, the longitudinal direction is defined by the length direction of the tank wall. The thickness direction is defined by the thickness direction of the tank wall. The transverse direction is defined by the width direction of the tank wall. The longitudinal direction, the transverse direction and the thickness direction form a three-dimensional orthogonal coordinate system.

25 The sealing membrane 50, 52 rests on a support surface 11 formed by a thermally insulating barrier 51, 53 of the tank 71. This sealing membrane 50, 52 has a repetitive structure comprising alternately, on the one hand, sheet metal strips 22 arranged on the support surface 11 and, on the other hand, elongate metal supports 16 connected to the support surface 11 and extending parallel to the sheet metal strips 22 over at least part of the length of the sheet metal strips 22. One end of the sheet metal strips 22 is welded against the adjacent metal supports 16. Such a 30 structure is for example used in the NO96 tanks for LNG carriers, sold by the applicant.

Referring to figure 1, the supporting structure of a carrier in this case consists of the internal wall 1 of a double hull 72 of the carrier 70. In a manner known per se, the tank 71 comprises a secondary thermally insulating barrier 53 secured to the supporting structure of the carrier 70. This secondary thermally insulating barrier 53 consists of a plurality of parallelepiped secondary insulating compartments 2 which are arranged side by side, so as to substantially cover the internal surface of the supporting structure.

Each secondary insulating compartment 2 consists of a parallelepiped box made of plywood which internally comprises load-bearing partitions 3 and non-load-bearing partitions 4 which are only intended to ensure the relative positioning of the load-bearing partitions 3, said partitions being interposed between a plywood bottom panel 5 and a plywood top panel 6. The bottom wall 5 of the compartments 2 protrudes laterally on the two small sides of the compartment, so that in each corner of the compartment, on this protruding part, battens 7 are secured which have the thickness of said protruding part. The battens 7 interact with members for securing the compartments 2 to the supporting structure.

Each compartment 2 is filled with a thermally insulating particulate material, for example perlite or glass wool. The bottom plate 5 of each compartment 2 rests on beads of polymerizable resin 8 which are themselves resting on the supporting structure 1, by means of kraft paper 9 to prevent the resin of the glue bead from sticking to the supporting structure and to thus allow dynamic deformation of the supporting structure without the compartments 2 being subjected to the forces due to said deformation. The purpose of the beads of polymerizable resin 8 is to make up for differences between the theoretical surface provided for the supporting structure and the imperfect surface resulting from manufacturing tolerances. The top panels 6 of the secondary insulating compartments 2 also comprise a pair of parallel grooves 12, for example of substantially inverted I, L or T shape, to receive metal supports 16, for example of L, T or J shape.

The metal supports 16 have a first anchoring wing 17 and a second anchoring wing 18 secured to one another to form a sealed metal support 16. The anchoring wings 17, 18 each include an upper portion 21 extending above the support surface 11 in the transverse direction. The upper portion 21 of the first anchoring wing

17 extends on one side of the groove 12 while the upper portion 21 of the second anchoring wing 18 extends on the other side of the groove 12.

The anchoring wings 17, 18 also each include a base 19 retained in the groove 12 of the support surface 11 in a direction perpendicular to the support surface 11 with a degree of freedom in the longitudinal direction. The anchoring wings 17, 18 each further include an arm 20 connecting the upper portion 21 to the base 19.

A secondary sealing membrane 52 consists of a plurality of metal strips 22, having a thickness of the order of 0.7 mm. The ends of each metal strip 22 are welded to the aforementioned metal supports at the upper portions 21 of the anchoring wings 17, 18. The metal strips 22 are made either of a strong metal such as stainless steel or of a metal having a low thermal expansion coefficient, for example this metal may be an iron-nickel alloy with a thermal expansion coefficient between 1.2 and $2.0 \times 10^{-6} \text{ K}^{-1}$, or an iron alloy with a high manganese content, the expansion coefficient of which is typically of the order of $7.5 \times 10^{-6} \text{ K}^{-1}$.

On the secondary sealing membrane 52 is mounted the primary thermally insulating barrier 51 which also consists of a plurality of primary insulating compartments 10 having a structure similar to the secondary insulating compartments 2. Each primary insulating compartment 10 consists of a rectangular parallelepiped box made of plywood with a height less than the compartment 2, which is filled with particulate matter, such as perlite or glass wool. The primary insulating compartments 10 also include load-bearing internal partitions, a bottom panel and a top panel 11.

The top panels 11 have two grooves 12, for example of substantially inverted I, L or T shape, for receiving a metal support 16 on which the ends of the strips 22 of the primary sealing membrane 50 are welded.

The grooves 12 may have in the thickness of the thermally insulating barrier 51, 53 a retaining zone 13 which extends parallel to the support surface 11. This retaining zone 13 extends at an end of the groove 12 opposite to the support surface 11 in the thickness of the thermally insulating barrier 51, 53. The groove 12 then has an L-shaped section, the base of which is formed by the retaining zone 13.

In the case of a T-shaped metal support 16, the groove 12 has a T-shaped section, the base of which is formed by the retaining zone 14 located on either side of

the inlet zone 13 of the groove 12. The bases 17 of the metal support 16 are housed in the retaining zone 14 so as to retain the metal support 16 on the thermally insulating barrier in a direction perpendicular to the support surface 11.

In the case of a J-shaped metal support 16, the groove 12 has an I- or L-shaped section. The groove 12 may have a retaining zone 14, but this is optional. The groove may therefore have only an inlet zone 13. The groove 12 comprises a fastener/fastener 26 of inverted J shape having a rounded portion 27 complementary to one of the bases 19 of the metal support 16, which is also rounded so as to be secured in the rounded portion 27 of the fastener 26 to thus retain the metal support 16 on the thermally insulating barrier in a direction perpendicular to the support surface 11. Advantageously, the groove 12 includes two fasteners 26, on either side of the groove 12, so as to retain the base 19 of the first anchoring wing 17 and the base 19 of the second anchoring wing 18.

Figures 2 to 6 show a plurality of embodiments of a metal support 16 anchored in a support surface 11.

Each of the various embodiments may use a metal support 16 with bases 17 housed in a retaining zone 14 of the groove 12, shown for example in figure 2, or a metal support 16 with rounded bases 17 each interacting with a complementary rounded portion 27 of a fastener 26 secured in the groove 12, shown for example in figure 4, or a metal support 16 with rounded bases 17 each interacting with a complementary rounded portion 27 of a fastener 26 secured in the retaining zone 14 of the groove 12.

Figure 2 shows an embodiment of a metal support 16 anchored in a support surface 11. In this embodiment, the anchoring wings 17, 18 of the metal support 16 are welded to one another back to back so that the base 19 of an anchoring wing 17, 18 is facing in the direction away from the other anchoring wing 18, 17. The anchoring wings 17, 18 are welded using a primary longitudinal weld 28 inside the groove 12 and at a distance from the upper portions 21 of the anchoring wings 17, 18. The primary longitudinal weld 28 is made on the arms 20 of the anchoring wings 17, 18. The part of the arms 20 above the primary longitudinal weld 28 and the upper portions 21 of the metal support 16 form a deformable bellows which, when the metal support

16 forms part of a sealing membrane, makes it possible to absorb the forces associated with the thermal contraction of the membrane.

In the embodiment of figure 2, a sealing membrane 50, 52 may be composed of a plurality of metal supports 16 each placed in a groove 12 in the thermally
5 insulating barrier 51, 53 so that the metal supports 16 may be directly welded to one another by their adjacent upper portions 21 so as to form a sealed assembly.

Figure 3 shows a different embodiment of a metal support 16 anchored in a support surface 11. This embodiment differs from the embodiment of figure 2 in that the metal supports 16 are not directly welded to one another. To be specific, the
10 sealing membrane 50, 52 comprises a plurality of metal strips 22. The metal strips 22 are arranged parallel to one another on the support surface 11. The upper portion 21 of the first anchoring wing 17 is welded by a secondary longitudinal weld 29 to a metal strip 22 and the upper portion 21 of the second anchoring wing 18 is welded by a secondary longitudinal weld 29 to an adjacent metal strip 22.

15 Furthermore, the cross section of each metal strip 22 has a flat middle portion 23 resting on the support surface 11 and at least one offset portion 24 parallel and at a distance from the support surface 11. The offset portion 24 is located at one end of the flat middle portion 23. The upper portion 21 of an anchoring wing 17, 18 is thus located between the support surface 11 and the offset portion 24. The secondary
20 longitudinal welds 29 connecting one of said upper portions 21 and one of said metal strips 22 are thus produced on the offset portion 24 of the metal strips 22. The offset portion 24 then allows the overlap of a metal strip 22 with the metal support 16.

Figures 4 and 5 show a different embodiment of a metal support 16 anchored in a support surface 11. This embodiment differs from the embodiment of figure 3 by
25 the shape of the groove, the shape of the bases 19 and the connection between the bases 19 and the groove 12. To be specific, in this embodiment, the sealing membrane 50, 52 comprises a metal support 16 with rounded bases 17 each interacting with a complementary rounded portion 27 of a fastener 26 secured in the groove 12.

30 Figure 6 shows a different embodiment of a metal support 16 anchored in a support surface 11. This embodiment differs from the embodiment of figure 3 in that

the anchoring wings are not secured to one another by welding and that the metal strips 22 do not have an offset portion 24. To be specific, in this embodiment, the metal support 16 comprises a connecting part 30 which sealingly connects the bases 19 of the anchoring wings 17, 18 to one another inside the groove 12. It is therefore not necessary to weld the arms of the anchoring wings to one another. Moreover, the support surface 11 comprises two secondary grooves 15 hollowed out in the thickness direction and extending in the longitudinal direction in close proximity to the main groove 12. The upper portions 21 of the anchoring wings are thus located in the secondary grooves 15 so that at least part of the upper portions 21 pass under a metal strip 22. Thus, in this embodiment, it is not the offset portion 24 which allows the overlap of the metal strip 22 with the metal support 16, but the secondary grooves 15.

A thermal insulation layer 25 is placed in a secondary groove 15 below the upper portion 21 of an anchoring wing 17, 18. Furthermore, in the embodiment of figure 6, the main groove 12 comprises a flared part 31 made at the upper end of the main groove 12. The flared part 31 is formed by means of chamfers on the wall of the main groove 12. The flared part 31 makes it possible to increase the space where the anchoring wings 17, 18 can deform.

The technique described above for producing a sealed tank wall may be used in different types of tanks, for example to form the sealed tank wall of an LNG storage tank in an onshore facility or on a floating structure such as an LNG carrier or the like.

Figure 7 shows another embodiment of a metal support 16 anchored in a support surface 11. This embodiment differs from the embodiment of figure 3 in that the upper portion 21 of an anchoring wing 17, 18 is not located between the support surface 11 and the metal strip 22. To be specific, the sealing membrane 50, 52 comprises a plurality of metal strips 22. The metal strips 22 are arranged parallel to one another on the support surface 11. The upper portion 21 of the first anchoring wing 17 is welded by a secondary longitudinal weld 29 to a metal strip 22 and the upper portion 21 of the second anchoring wing 18 is welded by a secondary longitudinal weld 29 to an adjacent metal strip 22.

Unlike in figure 3, the metal strips 22 in this embodiment of figure 7 do not have an offset portion. The metal strips 22 are in this case substantially flat so that a part of the metal strip is located, after assembly, between the support surface 11 and

the upper portion 11 of an anchoring wing 17, 18. The secondary longitudinal weld 29 is then made on one end of the upper portion 21 so as to connect the metal strip 22 to the metal support 16.

During the assembly of the sealing barrier of the tank wall, the metal supports
5 16 are inserted in the main grooves 12 with the anchoring wings 17, 18 already welded to one another by the main longitudinal weld 28. Next, the metal strips 22 are then inserted below the upper portions 21 of two adjacent metal supports 16 on the support surface 11 which allows the metal strips 22 to be wedged laterally. The metal strips 22 are then welded to the upper portions 21 of the adjacent metal supports by the
10 secondary longitudinal weld 29 so as to form a sealing membrane.

The secondary longitudinal weld 29 may be made on the lateral end edge of the upper portion 21 as shown, or at a distance from this edge.

In an embodiment not shown, the embodiments shown in figures 3, 6 and 7 may for example be combined. To be specific, the metal strip 22 comprises a flat
15 middle portion resting on the support surface and an offset portion 23, like in figure 3, parallel to the support surface 11 but this time located in the secondary groove 15 of the figure 6. The metal support 16 is then placed on the offset portion 23 so that the offset portion is located between the upper portion 21 of an anchoring wing 17, 18 and the bottom of the secondary groove 15. The secondary longitudinal weld 29 is
20 then produced on the upper portion 21 and on the offset portion 23 so as to connect the metal support 16 to the metal strip 22.

With reference to figure 8, a view of an LNG carrier 70 with part cut away shows a sealed and insulated tank 71 of generally prismatic shape mounted in the double hull 72 of the carrier. The wall of the tank 71 comprises a primary sealed barrier
25 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 carrier, 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 pipelines 73 arranged on the upper deck of the carrier may be connected, by means of appropriate connectors, to a maritime or port terminal for transferring a cargo of LNG from or to the tank 71.

Figure 8 shows an example of a maritime terminal comprising a loading and unloading station 75, an underwater pipe 76 and an onshore facility 77. The loading and unloading station 75 is a fixed offshore facility comprising a movable arm 74 and a tower 78 which supports the movable arm 74. The movable arm 74 carries a bundle of insulated flexible pipes 79 which may be connected to the loading/unloading pipelines 73. The orientable movable arm 74 may be adjusted to suit all sizes of LNG carrier. A connecting pipe (not shown) extends inside the tower 78. The loading and unloading station 75 allows loading and unloading of the LNG carrier 70 from or to the onshore facility 77. This facility comprises tanks 80 for storing liquefied gas and connection pipes 81 connected by the underwater pipe 76 to the loading or unloading station 75. The underwater pipe 76 allows the transfer of the liquefied gas between the loading or unloading station 75 and the onshore facility 77 over a long distance, for example 5 km, which makes it possible to keep the LNG carrier 70 at a long distance from the shore during loading and unloading operations.

To generate the pressure necessary to transfer the liquefied gas, use is made of pumps on board the carrier 70 and/or pumps fitted to the onshore facility 77 and/or pumps fitted to the loading and unloading station 75.

Although the invention has been described in connection with several particular embodiments, it is obvious that it is in no way limited thereto and that it includes all technical equivalents of the means described as well as combinations thereof, if these fall within the scope of the invention.

The use of the verb “comprise” or “include” and conjugated forms thereof does not rule out the presence of other elements or other stages in addition to those stated in a claim.

In the claims, any reference sign in parentheses should not be interpreted as a limitation of the claim.

CLAIMS

1. A sealed tank wall, for storage of a fluid, comprising:
 - a support surface (11) comprising at least one groove (12) hollowed out in a thickness direction of the tank wall and extending in a longitudinal direction;
 - 5 - a metal sealing membrane (50, 52) borne by the support surface (11) and extending in the longitudinal direction, the metal sealing membrane (50, 52) comprising at least one metal support (16) borne by the support surface (11), said metal support (16) comprising a first anchoring wing (17) and a second anchoring wing (18) sealingly secured to one another, the anchoring wings (17, 18) each comprising an upper
10 portion (21) extending above the support surface (11) in a transverse direction so that the upper portion of the first anchoring wing (17) extends on one side of the groove (12) and the upper portion (21) of the second anchoring wing (18) extends on the other side of the groove (12), the anchoring wings (17, 18) each also comprising a base (19) retained in the groove of the support surface (11) in a direction
15 perpendicular to the support surface (11) with a degree of freedom in the longitudinal direction, and the anchoring wings (17, 18) each comprising an arm (20) connecting the upper portion (21) to the base (19);
wherein the arms (20) of the anchoring wings (17, 18) are elastically deformable in flexion in the transverse direction so as to allow the upper portions (21) of the
20 anchoring wings (17, 18) to move relative to one another in the transverse direction.
2. The sealed tank wall as claimed in claim 1, wherein the anchoring wings (17, 18) are welded to one another by a primary longitudinal weld (28) inside the groove (12).
3. The sealed tank wall as claimed in any one of the preceding claims,
25 wherein the metal support (16) comprises a connecting part (30) which sealingly connects the bases (19) of the anchoring wings (17, 18) to one another inside the groove (12).
4. The sealed tank wall as claimed in any one of the preceding claims,
wherein the metal sealing membrane (50, 52) comprises a plurality of said metal
30 supports (16) arranged parallel to one another, wherein the upper portions (21) of the

anchoring wings (17, 18) of two adjacent metal supports (16) are directly or indirectly connected in a sealed manner.

5. The sealed tank wall as claimed in claim 4, wherein the metal sealing membrane (50, 52) comprises a metal strip (22) resting on the support surface (11), the metal strip (22) being arranged parallel to the metal supports (16), and wherein a first edge of the metal strip (22) is welded to the upper portion (21) of the first anchoring wing (17) of a first of the metal supports by a first secondary longitudinal weld (29), and a second edge of the metal strip (22) is welded to the upper portion (21) of the second anchoring wing (18) of a second of the metal supports by a second secondary longitudinal weld (29).

6. The sealed tank wall as claimed in claim 5, wherein one end of the metal strip is located between the support surface (11) and the upper portion (21) of an anchoring wing (17, 18) and wherein the secondary longitudinal weld (29) is made on the upper portion (21) so as to connect the metal strip (22) to the upper portion (21).

7. The sealed tank wall as claimed in claim 5, wherein the cross section of the metal strip (22) comprises a flat middle portion (23) resting on the support surface (11) and at least one offset portion (24) parallel to and at a distance from the support surface (11), the upper portion (21) of an anchoring wing (17, 18) being located between the support surface (11) and the offset portion (24) and wherein the secondary longitudinal weld (29) connecting a said upper portion (21) and an edge of the metal strip (22) is made on the offset portion (24) of the metal strip (22).

8. The sealed tank wall as claimed in one of claims 5 to 7, wherein the groove (12) is the main groove (12), and the support surface (11) comprises at least one secondary groove (15) hollowed out in the thickness direction and extending in the longitudinal direction in proximity to the main groove (12) and wherein the upper portion (21) of an anchoring wing is located in the secondary groove (15) and below a metal strip (22).

9. The sealed tank wall as claimed in any one of the preceding claims, wherein the groove (12) has an inlet zone (13) which extends in the thickness

direction, the groove (12) comprising a retaining zone (14) arranged below the inlet zone (13) and extending parallel to the support surface (11) over a width greater than the inlet zone (13), and wherein the base (19) of at least one anchoring wing of the metal support (16) is housed in the retaining zone (14).

5 10. The sealed tank wall as claimed in any one of the preceding claims, wherein the groove (12) comprises at least one fastener (26), the fastener (26) being configured to retain one of the bases (19) of the metal support (16) in the groove (12).

 11. The sealed tank wall as claimed in the preceding claim, wherein at least one of the bases (19) of the metal support (16) has a rounded shape and the
10 fastener (26) has a complementary rounded portion (27) so that the base (19) of the metal support (16) and the rounded portion (27) of the fastener (26) fit one inside the other.

 12. The sealed tank wall as claimed in any one of the preceding claims, wherein the sealed tank wall comprises a thermally insulating barrier (51, 53)
15 comprising a top panel including the support surface (6, 11).

 13. The sealed tank wall as claimed in claim 12, wherein the thermally insulating barrier is a primary thermally insulating barrier (51) and the sealing membrane is a primary sealing membrane (50), and wherein the sealed tank wall comprises a secondary thermally insulating barrier (53) and a secondary sealing
20 membrane (52) arranged under the primary thermally insulating barrier (51).

 14. A polyhedral sealed tank (71) comprising a plurality of sealed tank walls secured to one another in a sealed manner to form a polyhedral interior space for the storage of a fluid, wherein one of said sealed tank walls is as claimed in any one of claims 1 to 13.

25 15. A carrier (70) for the transport of a liquid product, the carrier comprising a hull (72) and a sealed tank (71) as claimed in claim 14 arranged in the hull.

 16. A method for loading or unloading a carrier (70) as claimed in claim 15, wherein a liquid product is conveyed through insulated pipelines (73, 79, 76, 81)
30 from or to a floating or onshore storage facility (77) to or from the sealed tank of the carrier (71).

17. A transfer system for transferring a liquid product, the system comprising a carrier (70) as claimed in claim 15, insulated pipelines (73, 79, 76, 81) arranged so as to connect the sealed tank (71) installed in the hull of the carrier to a floating or onshore storage facility (77) and a pump for pumping a flow of liquid product
5 through the insulated pipelines from or to the floating or onshore storage facility, to or from the sealed tank of the carrier.