

## SEALED MEMBRANE AND METHOD FOR ASSEMBLING A SEALED MEMBRANE

### Technical field

5           The invention relates to the field of sealed and thermally insulating tanks for storing and/or transporting fluid such as a cryogenic fluid.

          The invention relates more particularly to the field of the manufacture of sealed membranes for such tanks.

### Technological background

10           Patent application FR3004416 discloses a method of manufacturing a sealed membrane. The method of assembly consists, first of all, in positioning a first, a second and a third rectangular plate on a support surface. The third rectangular plate is overlapped, on the one hand, by a transverse strip of the first plate and, on the other hand, by a longitudinal strip of the second plate. The transverse strip of the first plate  
15 and the longitudinal strip of the second plate each have a chamfered side. Thereafter, a first straight and continuous weld line is formed on the transverse strip of the first plate so as to assemble it with the third plate and a second straight and continuous weld line is formed on the longitudinal strip of the second plate so as to assemble it to the third plate. A fourth plate is then positioned in such a way as to overlap a  
20 longitudinal strip of the first plate and a transverse strip of the second plate. The fourth plate has a corner zone which overlaps the gap between the mutually-facing chamfered sides of the first plate and of the second plate. A third straight and continuous weld line is then produced on the zone of the fourth plate that overlaps the longitudinal strip of the first plate so as to assemble the first and fourth plates until the  
25 first weld line is intersected. Similarly, a fourth straight and continuous weld line is produced on the zone of the fourth plate which overlaps the transverse strip of the second plate so as to assemble the second and fourth plates until the second weld line is intersected. Finally, an oblique weld line is produced in the corner zone of the fourth plate in the gap between the mutually-facing chamfered sides of the first plate  
30 and of the second plate until the line intersects the first or third weld line on the one hand, and the second and fourth weld lines on the other.

Such a method of manufacture can be performed simply with high productivity, particularly given the straight and continuous nature of the weld lines produced. However, despite these advantages, this method is not entirely satisfactory. In particular, this method means that the zones of overlap between the plates have a large surface area, leading to the use of excess material and, accordingly, to additional expense.

### Summary

One idea underlying the invention is that of proposing a sealed membrane and a method of assembling such a sealed membrane which is simple to implement and makes it possible to reduce the quantity of material used.

According to one embodiment, the invention provides a sealed membrane comprising plates of a fluidtight material assembled in a sealed manner, the membrane comprising:

- a first plate, a second plate and a third plate which are arranged on a support surface, each of the said first, second and third plates comprising a longitudinal side and a transverse side which are orthogonal and meet in a corner zone; the first plate covering a zone of the support surface which is adjacent to the transverse side of the third plate and comprising a transverse strip which extends along the transverse side of the said first plate and overlaps the transverse side of the third plate;
- the second plate covering a zone of the support surface which is adjacent to the longitudinal side of the third plate and comprising a longitudinal strip which extends along the longitudinal side of the said third plate and overlaps the longitudinal side of the third plate; the corner zone of the first plate and the corner zone of the second plate being positioned facing one another with a gap uncovering the corner zone of the third plate;
- a first weld line extending continuously along the transverse strip of the first plate which overlaps the third plate, so as to assemble the first plate to the third plate;
- a second weld line extending continuously along the longitudinal strip of the second plate which overlaps the third plate, so as to assemble the second plate to the third plate;
- a fourth plate arranged on the support surface in such a way as to cover a zone of

- the support surface which is adjacent to the longitudinal side of the first plate and to the transverse side of the second plate, the fourth plate comprising a longitudinal side and a transverse side which are orthogonal and meet in a corner zone, the said corner zone having a convex curved portion, the fourth plate having a longitudinal strip which
- 5 overlaps the longitudinal side of the first plate and an end portion of the first weld line and a transverse strip which overlaps the transverse side of the second plate and an end portion of the second weld line,
- the corner zone of the fourth plate overlapping the gap between the corner zone of the first plate and the corner zone of the second plate;
- 10 - a third, fillet, weld line extending continuously along the longitudinal side, along the corner zone and along the transverse side of the fourth plate so as to assemble the fourth plate with the first, second and third plates; the third weld line intersecting the first and second weld lines.

According to one embodiment, the invention also provides an assembly

15 method for producing a sealed membrane by assembling plates made of a fluidtight material, the assembly method comprising:

- placing a first plate, a second plate and a third plate on a support surface, each of the said first, second and third plates comprising a longitudinal side and a transverse side which are orthogonal and meet in a corner zone;
- 20 the first plate being arranged in such a way as to cover a zone of the support surface which is adjacent to the transverse side of the third plate and in such a way that a transverse strip of the first plate which extends along the transverse side of the said first plate overlaps the transverse side of the third plate;
- the second plate being arranged in such a way as to cover a zone of the support
- 25 surface which is adjacent to the longitudinal side of the third plate and in such a way that a longitudinal strip of the second plate which extends along the longitudinal side of the said second plate overlaps the longitudinal side of the third plate; the corner zone of the first plate and the corner zone of the second plate being positioned facing one another with a gap uncovering the corner zone of the third plate;
- 30 - creating a first continuous weld line on the transverse strip of the first plate which overlaps the third plate, so as to assemble the first plate to the third plate;
- creating a second continuous weld line on the longitudinal strip of the second plate

which overlaps the third plate, so as to assemble the second plate to the third plate;  
- positioning a fourth plate on the support surface in such a way as to cover a zone of  
the support surface which is adjacent to the longitudinal side of the first plate and to  
the transverse side of the second plate, the fourth plate comprising a longitudinal side  
5 and a transverse side which are orthogonal and meet in a corner zone, the said corner  
zone having a convex curved portion, the fourth plate being positioned in such a way  
that a longitudinal strip of the fourth plate overlaps the longitudinal side of the first  
plate and an end portion of the first weld line, that a transverse strip of the fourth plate  
overlaps the transverse side of the second plate and an end portion of the second  
10 weld line and that the corner zone of the fourth plate overlaps the gap between the  
corner zone of the first plate and the corner zone of the second plate;  
- creating a third continuous, fillet, weld line along the longitudinal side, along the  
corner zone and along the transverse side of the fourth plate so as to assemble the  
fourth plate with the first, second and third plates; the third weld line intersecting the  
15 first and the second weld lines.

Thus, by virtue of the zone of curved shape of the fourth plate which overlaps  
the gap between the corner zone of the first plate and the corner zone of the second  
plate, the third weld line can be produced continuously, along the longitudinal side,  
along the corner zone and along the transverse side of the fourth plate.

20 Furthermore, by comparison with a corner zone of the fourth plate that has a  
chamfered straight side as in the aforementioned prior art, the rounded shape of the  
corner zone of the fourth plate makes it possible to limit the dimensions of the  
longitudinal and transverse strips of the plate which respectively overlap the first and  
the second plates.

25 According to other advantageous embodiments, such a sealed membrane or  
such an assembly method may exhibit one or more of the following features:

According to one embodiment, the convex curved portion of the fourth plate  
develops over an angular portion of  $90^\circ$ .

30 According to one embodiment, the convex curved portion of the fourth plate  
has a constant radius of curvature.

According to one embodiment, the radius of curvature of the convex curved portion is comprised between 1 and 2.4 cm and preferably between 1.9 and 2.1 cm.

According to one embodiment, the corner zone of the first plate has a chamfered side connecting the longitudinal side and the transverse side of the said  
5 first plate and the first weld line is a fillet weld extending along the transverse side and along the chamfered side of the first plate. This makes it possible on the one hand to limit the amount of overlap between the first plate and the third plate and, on the other hand, to limit the amount of overlap between the third and fourth plates.

According to one embodiment, the longitudinal side of the fourth plate  
10 extends along an axis intersecting the chamfered side of the first plate.

According to one embodiment, the corner zone of the second plate has a chamfered side connecting the longitudinal side and the transverse side of the said second plate and the second weld line is a fillet weld along the longitudinal side and along the chamfered side of the second plate. Such an arrangement makes it possible  
15 on the one hand to limit the amount of overlap between the second plate and the third plate and, on the other hand, to limit the amount of overlap between the second and fourth plates.

According to one embodiment, the transverse side of the fourth plate extends along an axis intersecting the chamfered side of the second plate.

According to one embodiment, the chamfered side of the first plate and the chamfered side of the second plate are parallel to one another.  
20

According to one embodiment, the convex curved portion of the fourth plate overlaps the chamfered side of the first plate and the chamfered side of the second plate.

According to one embodiment, the longitudinal sides of the first, second, third and fourth plates are parallel to one another and the transverse sides of the first, second, third and fourth plates are parallel to one another.  
25

According to one embodiment, the longitudinal side of the fourth plate is aligned with the longitudinal side of the second plate.

According to one embodiment, the transverse side of the fourth plate is aligned with the transverse side of the first plate.

According to one embodiment, the longitudinal strip of the fourth plate which is situated between the longitudinal side of the fourth plate and the longitudinal side of the first plate has a dimension in a direction orthogonal to the longitudinal side of the fourth plate which is less than 3.6 cm, and preferably comprised between 2.4 and 3.6 cm.

According to one embodiment, the transverse strip of the fourth plate which is situated between the transverse side of the fourth plate and the transverse side of the second plate has a dimension in a direction orthogonal to the transverse side of the fourth plate which is less than 3.6 cm, and preferably comprised between 2.4 and 3.6 cm.

According to one embodiment, the first, second, third and fourth plates are made of sheet metal.

According to one embodiment, the invention also provides a sealed and thermally insulating tank arranged in a bearing structure, the tank comprising a tank wall held on a wall of the bearing structure, the tank wall comprising a thermal insulation barrier held directly or indirectly on the bearing wall and an abovementioned sealed membrane arranged on the thermal insulation barrier.

A tank according to one of the aforementioned embodiments may form part of an on-shore storage facility, for example for storing LNG, or may be installed in an inshore or off-shore floating structure, notably an ethane or methane tanker, a floating storage and regasification unit (FSRU), a floating production storage and offloading (FPSO) unit and the like. In the case of a floating structure, the tank may be intended to receive liquefied natural gas used as a fuel for the propulsion of the floating structure.

According to one embodiment, a ship for transporting a fluid comprises a hull, such as a double hull and an abovementioned tank arranged in the hull.

According to one embodiment, the invention also provides a method for loading or unloading such a ship, in which method a fluid is conveyed through

insulated pipelines from or to an off-shore or on-shore storage facility to or from the tank of the ship.

According to one embodiment, the invention also provides a transfer system for a fluid, the system comprising the aforementioned ship, insulated pipelines  
5 arranged in such a way as to connect the tank installed in the hull of the ship to an off-shore or on-shore storage facility and a pump for causing a stream of fluid to flow along the insulated pipelines from or to the off-shore or on-shore storage facility to or from the tank of the ship.

### **Brief description of the figures**

10 The invention will be better understood, and other objects, details, features and advantages thereof will become more clearly apparent during the course of the following description of a number of particular embodiments of the invention which are given solely by way of nonlimiting illustration with reference to the attached drawings.

15 - **Figures 1 to 4** illustrate four successive steps in a method of manufacturing a sealed membrane involving four metal plates; and

- **Figure 5** is schematic cutaway depiction of a methane tanker tank comprising an aforementioned sealed membrane and of a terminal for the loading/unloading of this tank.

### **Detailed description of embodiments**

20 In the description which follows, the terms "transverse" and "longitudinal" denote two mutually perpendicular directions.

A method of manufacturing a sealed membrane for a sealed and thermally insulating tank is described with reference to Figures 1 to 4. Such a tank may notably  
25 comprise a multilayer structure comprising, from the outside towards the inside of the tank, a secondary thermally insulating barrier comprising insulating elements resting against a bearing structure, a secondary sealing membrane, a primary thermally insulating barrier comprising insulating elements resting against the secondary sealing membrane and a primary sealing membrane intended to be in contact with  
30 the liquefied gas contained in the tank. By way of example, such membrane tanks are

notably described in patent applications WO14057221 and FR2691520. The method as described hereinbelow is notably liable to apply to the secondary sealing membrane and/or to the primary sealing membrane of such a tank.

In the description hereinbelow a method is described that allows four plates  
5 of a sealing membrane, denoted by the reference numerals 1 to 4, to be assembled. The four plates 1, 2, 3, 4 are of substantially rectangular shape, which means to say that they each have four main sides, two longitudinal sides of which are parallel to one another and perpendicular to the two transverse sides.

Only the corner zones of the plates 1, 2, 3, 4 are illustrated in Figures 1 to 4.  
10 With reference to Figure 1, this partially depicts a plate 3 of which only the lower right-hand corner zone 3c is shown. This plate 3 is placed on a support surface, such as a secondary or primary thermally insulating barrier of a tank. By convention, the term "longitudinal" designates the side 3a of the plate 3 and the corresponding direction of the plane illustrated by the arrow L, and the term "transverse" designates the side 3b  
15 of the plate 3 and the corresponding direction of the plane, illustrated by the arrow T.

A plate 2, shown partially in Figure 2, is placed on the support surface next to the plate 3, partially overlapping the latter. In particular, the longitudinal side 2a of the plate 2 is arranged over the plate 1 the same as an entire longitudinal strip situated between the longitudinal side 2a of the plate 2 and the longitudinal side 1a of the plate  
20 1. In the embodiment depicted, the transverse side 2b of the plate 2 is placed in alignment with the transverse side 1b of the plate 1.

The corner zone 2c between the transverse side 2b and the longitudinal side 2a of the plate 2 has a chamfered side connecting the transverse side 2b and the longitudinal side 2a. The chamfered side is, for example, oriented at an angle of 45°  
25 with respect to the transverse side 2b and to the longitudinal side 2a.

Moreover, another plate 1, depicted partially in Figure 3, is also placed on the support surface next to the plate 3 partially overlapping the latter. In particular, the transverse side 1b of the plate 1 is positioned on the plate 1 the same as an entire transverse strip situated between the transverse side 1b of the plate 1 and the  
30 transverse side 3b of the plate 3.

In the embodiment depicted, the longitudinal side 1a of the plate is arranged in alignment with the longitudinal side 3a of the plate 3. The corner zone 1c between the transverse side 1b of the plate 1 and the longitudinal side 1a of the plate has a chamfered side connecting the transverse side 1b and the longitudinal side 1a. The  
 5 chamfered side is oriented for example at an angle of  $45^\circ$  with respect to the transverse side 1b and to the longitudinal side 1a. The chamfered side of the first plate 1 and the chamfered side of the second plate 2 are parallel to one another.

As depicted in Figure 3, a diagonal strip situated in the corner of the plate 3 between the chamfered sides of the plates 1 and 2 is not covered either by the plate  
 10 1 or by the plate 2.

A weld line 7, depicted in dotted line in Figures 2, 3 and 4, is produced along the longitudinal strip of the plate 2 that overlaps the plate 3 so as to assemble the plate 2 with the plate 3 in a sealed manner. This weld line 7 is advantageously a fillet weld along the longitudinal side 2a and the chamfered side of the plate 2.

15 Similarly, a welded line 6 depicted in dotted line in Figures 3 and 4 is also produced on the transverse strip of the plate 1 which overlaps the plate 3 so that the plate 1 can be assembled in fluidtight manner with the plate 3. This weld line 6 is advantageously a fillet weld along the transverse side 1b and the chamfered side of the plate 1.

20 In Figure 4, a fourth rectangular plate 4, depicted in part, is positioned on the support surface next to the plates 1 and 2, partially overlapping these. In particular, the longitudinal side 4a of the plate 4 overlaps the plate 1 and an entire longitudinal strip of the plate 1 situated between the longitudinal side 4a of the plate 4 and the longitudinal side 1a of the plate 1. Similarly, the transverse side 4b of the plate 4  
 25 covers the plate 2 and an entire transverse strip of the plate 2 situated between the transverse side 4b of the plate 4 and the transverse side 2b of the plate 2.

In the embodiment depicted, the longitudinal side 4a of the plate 4 is aligned with the longitudinal side of the plate 2 whereas the transverse side 4b of the plate 4 is aligned with the transverse side 1b of the plate 1. Furthermore, the longitudinal side  
 30 4a of the plate 4 extends along an axis that intersects the chamfered side of the plate

2 and the transverse side 4b of the plate 4 extends along an axis that intersects the chamfered side of the plate 1.

The corner zone 4c of the plate 4 has a convex curved portion which connects the longitudinal side 4a and the transverse side of the plate 4. The corner  
5 zone 4c of the plate 4 overlaps the gap 5 formed between the chamfered sides of the plates 1 and 2 so that the convex curved portion overlaps the weld line 6 and the weld line 7 on the chamfered sides of the plates 1, 2.

The curved portion extends over an angular portion of 90°. The radius of curvature of the convex curved portion is constant and is for example comprised  
10 between 1 and 2.4 cm and preferably between 1.9 and 2.1 cm.

In the embodiment depicted, the zones of overlap of the transverse strip of the plate 1 with the plate 2, of the longitudinal strip of the plate 2 with the plate 3, of the longitudinal strip of the plate 4 with the plate 2 and of the transverse strip of the plate 4 with the plate 2 have identical widths. By way of example, the width of these  
15 zones of overlap is less than 3.6 cm and preferably comprised between 2.4 and 3.6 cm.

Thereafter, a line of welding 8 is produced as a fillet weld along the longitudinal side 4a, along the corner zone 4c and along the transverse side 4b of the plate 4. This weld line 8 intersects the weld line 7 and the weld line 6. Thus, the plate  
20 4 is assembled in a sealed manner to the plate 1 along the longitudinal side 4a of the plate 4, to the plate 2 along the transverse side 4b of the plate 4, and to the plate 3, along the corner zone 4c of the plate 4, between the two chamfered sides of the plates 1, 2.

Because of the rounded shape of the corner zone 4c of the plate 4, the weld  
25 line 8 can be produced continuously, along the longitudinal side 4a, along the corner zone 4c and along the transverse side 4b of the plate 4. Furthermore, in comparison with a corner zone of the plate 4 that has a chamfered straight side, the rounded shape of the corner zone 4c makes it possible to limit the size of the longitudinal and transverse strips of the plate 4 which respectively overlap the plate 1 and the plate 2.

30 The assembly of the four plates in the corner zone depicted in Figure 4 is liquidtight, which means to say that a fluid on top of the assembly will find no gap

between the various plates through which to diffuse to underneath the assembly. It will be appreciated that a similar assembly may be produced at each of the corners of the plates 1, 2, 3, 4 of Figure 4.

According to one embodiment, the plates 1, 2, 3, 4 are metal sheets. By way of example, the plates 1, 2, 3, 4 may notably be made of stainless steel, of aluminium, of invar ®, namely an alloy of iron and nickel with a thermal expansion coefficient typically comprised between  $1.2 \cdot 10^{-6}$  and  $2 \cdot 10^{-6} \text{ K}^{-1}$ , or from an iron alloy with a high manganese content with a thermal expansion coefficient typically of the order of  $7 \cdot 10^{-6} \text{ K}^{-1}$ .

The thickness of the plates 1, 2, 3, 4 is, for example, comprised between 0.4 and 2 mm, typically of the order of 0.7 mm.

According to one embodiment, the plates 1, 2, 3, 4 each comprise at least two perpendicular corrugations so as to allow the membrane to deform under the effect of the thermal and mechanical stresses generated by the fluid stored in the tank.

The abovedescribed technique for creating a sealing membrane may be used in various types of reservoir, for example to constitute the primary sealing membrane and/or the secondary sealing membrane of an LNG storage tank in an on-shore facility or in a floating structure such as a methane tanker or the like.

With reference to Figure 5, a cutaway view of a methane tanker 70 shows a sealed and insulated tank 71 of prismatic overall shape mounted in the double hull 72 of the ship. The wall of the tank 71 comprises a primary sealed membrane intended to be in contact with the LNG contained in the tank, a secondary sealed membrane arranged between the primary sealed barrier and the double hull 72 of the ship, and two insulating barriers respectively arranged between the primary sealed membrane and the secondary sealed membrane and between the secondary sealed membrane and the double hull 72.

In the way known per se, loading/unloading pipelines 73 arranged on the top deck of the ship may be connected, by means of suitable connectors, to a maritime or harbour terminal in order to transfer a cargo of LNG from or to the tank 71.

Figure 5 depicts one example of a maritime terminal comprising a loading and offloading station 75, an underwater pipe 76 and an on-shore facility 77. The loading and offloading station 75 is a fixed off-shore facility comprising a mobile arm 74 and a tower 78 supporting the mobile arm 74. The mobile arm 74 carries a bundle of insulated flexible pipes 79 that can be connected to the loading/offloading pipelines 73. The orientable mobile arm 74 adapts to suit all sizes of methane tanker. A connecting pipe, not depicted, extends inside the tower 78. The loading and offloading station 75 allows the methane tanker 70 to be loaded and offloaded from or to the on-shore facility 77. The latter comprises liquefied gas storage tanks 80 and connecting pipes 81 connected by the underwater pipe 76 to the loading or offloading station 75. The underwater pipe 76 allows the transfer of liquefied gas between the loading or offloading station 75 and the on-shore facility 77 over a long distance, for example 5 km, making it possible to keep the methane tanker 70 a long way away from the shore during the loading and offloading operations.

In order to generate the pressure required for the transfer of the liquefied gas, use is made of pumps carried onboard the ship 70 and/or pumps with which the on-shore facility 77 is equipped and/or pumps with which the loading and offloading station 75 is equipped.

Although the invention has been described in conjunction with a number of particular embodiments it is quite obvious that it is not in any way restricted thereto and that it comprises all the technical equivalents of the means described and combinations thereof where these fall within the scope of the invention.

The use of the verbs "comprise", "have" or "include" and conjugated forms thereof does not exclude there being elements or steps other than those listed in a claim.

In the claims, any reference sign between parentheses should not be interpreted as placing a limit on the claim.

**CLAIMS**

1. Sealed membrane comprising plates of a fluidtight material assembled in a sealed manner, the membrane comprising:
- a first plate (1), a second plate (2) and a third plate (3) which are arranged on a support surface, each of the said first, second and third plates (1, 2, 3) comprising a longitudinal side (1a, 2a, 3a) and a transverse side (1b, 2b, 3b) which are orthogonal and meet in a corner zone (1c, 2c, 3c);  
the first plate (1) covering a zone of the support surface which is adjacent to the transverse side (3b) of the third plate (3) and comprising a transverse strip which extends along the transverse side (1b) of the said first plate (1) and overlaps the transverse side (3b) of the third plate (3);  
the second plate (2) covering a zone of the support surface which is adjacent to the longitudinal side (3a) of the third plate (3) and comprising a longitudinal strip which extends along the longitudinal side (2a) of the said second plate (2) and overlaps the longitudinal side (3a) of the third plate (3); the corner zone (1c) of the first plate (1) and the corner zone (2c) of the second plate (2) being positioned facing one another with a gap uncovering the corner zone of the third plate (3);
  - a first weld line (6) extending continuously along the transverse strip of the first plate (1) which overlaps the third plate (3), so as to assemble the first plate (1) to the third plate (3);
  - a second weld line (7) extending continuously along the longitudinal strip of the second plate (2) which overlaps the third plate (3), so as to assemble the second plate (2) to the third plate (3);
  - a fourth plate (4) arranged on the support surface in such a way as to cover a zone of the support surface which is adjacent to the longitudinal side (1a) of the first plate (1) and to the transverse side (2b) of the second plate (2), the fourth plate (4) comprising a longitudinal side (4a) and a transverse side (4b) which are orthogonal and meet in a corner zone (4c), the said corner zone (4c) having a convex curved portion, the fourth plate (4) having a longitudinal strip which overlaps the longitudinal side (1a) of the first plate (1) and an end portion of the first weld line (6) and a transverse strip which overlaps the transverse side (2b) of the second plate (2) and an end portion of the second weld line (7),

the corner zone of the fourth plate (4) overlapping the gap (5) between the corner zone (1c) of the first plate (1) and the corner zone (2c) of the second plate (2);  
 - a third, fillet, weld line (8) extending continuously along the longitudinal side (4a), along the corner zone (4c) and along the transverse side (4b) of the fourth plate (4)  
 5 so as to assemble the fourth plate (4) with the first, second and third plates (1, 2, 3); the third weld line (8) intersecting the first and second weld lines (6, 7).

2. Sealed membrane according to Claim 1, in which the corner zone (1c) of the first plate (1) has a chamfered side connecting the longitudinal side (1a) and the transverse side (1b) of the said first plate (1) and in which the first weld line  
 10 (6) is a fillet weld extending along the transverse side (1b) and along the chamfered side of the first plate (1).

3. Sealed membrane according to Claim 2, in which the longitudinal side (4a) of the fourth plate (4) extends along an axis intersecting the chamfered side of the first plate (1).

15 4. Sealed membrane according to any one of Claims 1 to 3, in which the corner zone (2c) of the second plate (2) has a chamfered side connecting the longitudinal side (2a) and the transverse side (2b) of the said second plate (2) and in which the second weld line (7) is a fillet weld extending along the longitudinal side (2a) and along the chamfered side of the second plate (2).

20 5. Sealed membrane according to Claim 4, in which the transverse side (4b) of the fourth plate (4) extends along an axis intersecting the chamfered side of the second plate (2).

6. Sealed membrane according to Claim 5 considered in combination with Claim 2 or 3, in which the chamfered side of the first plate (1) and the chamfered  
 25 side of the second plate (2) are parallel to one another.

7. Sealed membrane according to any one of Claims 1 to 6, in which the longitudinal sides (1a, 2a, 3a, 4a) of the first, second, third and fourth plates (1, 2, 3, 4) are parallel to one another and the transverse sides (1b, 2b, 3b, 4b) of the first, second, third and fourth plates (1, 2, 3, 4) are parallel to one another.

30 8. Sealed membrane according to any one of Claims 1 to 7, in which the longitudinal strip of the fourth plate (4) which is situated between the longitudinal

side (4a) of the fourth plate (4) and the longitudinal side (1a) of the first plate (1) has a dimension in a direction orthogonal to the longitudinal side (4a) of the fourth plate (4) which is less than 3.6 cm.

9. Sealed membrane according to any one of Claims 1 to 8, in which  
 5 the transverse strip of the fourth plate (4) which is situated between the transverse side (4b) of the fourth plate (4) and the transverse side (2b) of the second plate (2) has a dimension in a direction orthogonal to the transverse side (4b) of the fourth plate (4) which is less than 3.6 cm.

10. Sealed membrane according to any one of Claims 1 to 9, in which  
 10 the first, second, third and fourth plates (1, 2, 3, 4) are made of sheet metal.

11. Assembly method for producing a sealed membrane by assembling plates made of a fluidtight material, the assembly method comprising:  
 - placing a first plate (1), a second plate (2) and a third plate (3) on a support surface, each of the said first, second and third plates (1, 2, 3) comprising a longitudinal side  
 15 (1a, 2a, 3a) and a transverse side (1b, 2b, 3b) which are orthogonal and meet in a corner zone (1c, 2c, 3c);

the first plate (1) being arranged in such a way as to cover a zone of the support surface which is adjacent to the transverse side (3b) of the third plate (3) and in such a way that a transverse strip of the first plate (1) which extends along the transverse  
 20 side (1b) of the said first plate (1) overlaps the transverse side (3b) of the third plate (3);

the second plate (2) being arranged in such a way as to cover a zone of the support surface which is adjacent to the longitudinal side (3a) of the third plate (3) and in such a way that a longitudinal strip of the second plate (2) which extends along the  
 25 longitudinal side (2a) of the said second plate (2) overlaps the longitudinal side of the third plate (3); the corner zone (1c) of the first plate (1) and the corner zone (2c) of the second plate (2) being positioned facing one another with a gap (5) uncovering the corner zone (3c) of the third plate (3);

- creating a first continuous weld line (6) on the transverse strip of the first plate (1)  
 30 which overlaps the third plate (3), so as to assemble the first plate (1) to the third plate (3);

- creating a second continuous weld line (7) on the longitudinal strip of the second

plate (2) which overlaps the third plate (3), so as to assemble the second plate (2) to the third plate (3);

- positioning a fourth plate (4) on the support surface in such a way as to cover a zone of the support surface which is adjacent to the longitudinal side (1a) of the first plate (1) and to the transverse side (2b) of the second plate (2), the fourth plate (4) comprising a longitudinal side (4a) and a transverse side (4b) which are orthogonal and meet in a corner zone (4c), the said corner zone (4c) having a convex curved portion, the fourth plate (4) being positioned in such a way that a longitudinal strip of the fourth plate (4) overlaps the longitudinal side (1a) of the first plate (1) and an end portion of the first weld line (6), that a transverse strip of the fourth plate (4) overlaps the transverse side (2b) of the second plate (2) and an end portion of the second weld line (7) and that the corner zone (3c) of the fourth plate (4) overlaps the gap (5) between the corner zone (1c) of the first plate (1) and the corner zone (2c) of the second plate (2);
- creating a third, continuous, fillet weld line (8) along the longitudinal side (4a), along the corner zone (4c) and along the transverse side (4b) of the fourth plate (4) so as to assemble the fourth plate (4) with the first, second and third plates (1, 2, 3); the third weld line (8) intersecting the first and the second weld lines (6, 7).

12. Sealed and thermally insulating tank (71) arranged in a bearing structure, the tank comprising a tank wall held on a wall of the bearing structure, the tank wall comprising a thermal insulation barrier held directly or indirectly on the bearing wall and a sealed membrane according to any one of Claims 1 to 10 arranged on the thermal insulation barrier.

13. Ship (70) for transporting a cold liquid product, the ship comprising a double hull (72) and a tank (71) according to Claim 12 arranged inside the double hull.

14. Method for loading or unloading a ship (70) according to Claim 13, in which method a cold liquid product is conveyed through insulated pipelines (73, 79, 76, 81) from or to an off-shore or on-shore storage facility (77) to or from the tank of the ship (71).

15. Transfer system for a cold liquid product, the system comprising a ship (70) according to Claim 13, insulated pipelines (73, 79, 76, 81) arranged in such

a way as to connect the tank (71) installed in the hull of the ship to an off-shore or on-shore storage facility (77) and a pump for causing a stream of cold liquid product to flow along the insulated pipelines from or to the off-shore or on-shore storage facility to or from the tank of the ship.