

CORNER STRUCTURE OF A SEALED AND THERMALLY INSULATING TANK AND METHOD FOR ASSEMBLING SAME

Technical field

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

Sealed and thermally insulating membrane tanks are particularly used for storing liquefied natural gas (LNG), which is stored, at atmospheric pressure, at approximately -162°C. These tanks can be installed on the ground or on a floating
10 structure. In the case of a floating structure, the tank can be intended to transport liquefied natural gas or to receive liquefied natural gas used as fuel for propelling the floating structure.

More specifically, the invention relates to a corner structure for such a tank, as well as to its assembly method.

15 **Technological background**

Patent application FR 2691520 discloses a sealed and thermally insulating tank integrated in a support structure, such as the double hull of a vessel. Each wall of the tank comprises a multilayer structure successively having, in the direction of thickness from the outside to the inside of the tank, a secondary thermally insulating
20 barrier held on the support structure, a secondary sealing membrane, a primary thermally insulating barrier and a primary sealing membrane intended to be in contact with the fluid contained in the tank.

The corner zones of the tank are produced from preassembled corner structures in the shape of a dihedron. Each preassembled corner structure
25 comprises:

- two beveled insulating panels that are bonded to each other and form the corner of the secondary thermally insulating barrier;
- a flexible sealed strip resting on the insulating panels of the secondary thermally insulating barrier and forming the corner of the secondary sealing membrane;
- 30 - a plurality of insulating blocks fixed onto the insulating panels of the secondary thermally insulating barrier and forming the corner of the primary thermally insulating barrier; and

- metal angle brackets fixed onto the insulating blocks and forming the corner of the primary thermally insulating barrier.

Such corner structures do not allow the dimensional manufacturing tolerances of the secondary thermally insulating barrier of each wall to be compensated, particularly due to the tolerance margins that are permitted for the manufacture of the support structure. However, by way of an example, the manufacturing tolerances of the support structure are likely to be tolerances of up to several centimeters.

Summary

The invention is based on a concept of proposing a method for assembling a corner structure of a sealed and thermally insulating tank that allows the manufacturing tolerances of the support structure to be compensated.

According to one embodiment, the invention provides a method for assembling a corner structure intended to be disposed at an intersection between a first wall and a second wall of a sealed and thermally insulating tank, the first and the second walls each comprising, in a direction of thickness from the outside to the inside of the tank, a support structure, a secondary thermally insulating barrier held on the support structure, a secondary sealing membrane, a primary thermally insulating barrier and a primary sealing membrane intended to be in contact with the fluid contained in the tank, the support structure of the first and the second walls meeting at an edge,

the assembly method comprising:

- providing a first and a second insulating panel of rectangular parallelepipedal shape and each having a first face intended to be disposed parallel to the edge and intended to follow said edge, a second face opposite said first face and an internal face joining the first face to the second face, the first and the second insulating panels being intended to be placed in a respective destination location, the first and the second insulating panels respectively being intended to be respectively disposed against the support structure of the first and the second walls, so as to form a corner between the secondary thermally insulating barriers of the first and the second walls;
- providing a first and a second insulating block, the first insulating block being capable of being fixed onto the internal face of the first insulating panel by means for

anchoring the first insulating block on the first insulating panel, the second insulating block being capable of being fixed onto the internal face of the second insulating panel by means for anchoring the second insulating block on the second insulating panel, at least the means for anchoring the first insulating block on the first

5 insulating panel being adjustable-positioning anchoring means;

- determining a first setpoint for a dimension of said first insulating panel in a direction orthogonal to the first face of said first insulating panel, as a function of a first in situ dimensional measurement of the support structure of the first wall in a direction orthogonal to the edge, the first dimensional measurement representing

10 the space between the edge and an insulating element of the secondary thermally insulating barrier of the first wall that is adjacent to the destination location of said first insulating panel;

- cutting the first insulating panel along the first face of the first insulating panel by adjusting, to the first setpoint, the dimension of said first insulating panel in the

15 direction orthogonal to the first face, so as to adjust the position of the corner between the secondary thermally insulating barriers of the first and the second walls relative to the second face of the first insulating panel;

- fixing the first and the second insulating panels respectively against the support structure of the first and the second walls in their respective destination location, so

20 as to form the corner between the secondary thermally insulating barriers of the first and the second walls, the first face of each of the first and the second insulating panels being disposed parallel to the edge, along said edge;

- fixing the first and the second insulating blocks respectively on the first and the second insulating panels by adjusting the relative position of the first insulating block

25 on the first insulating panel by means of said adjustable-positioning anchoring means, so as to form a corner between the primary thermally insulating barriers of the first and of the second walls, said adjustable-positioning anchoring means enabling a plurality of positions for said first insulating block on the first insulating panel, the positions being spaced apart from each other in a direction orthogonal to

30 the edge and parallel to the support structure of the first wall.

By virtue of such an assembly method, the dimensional manufacturing tolerances of the support structure of the first wall can be easily compensated in the vicinity of the secondary thermally insulating barrier of the corner zone.

Furthermore, by virtue of the adjustable-positioning anchoring means, the modifications of the relative positioning of the first insulating block on the first insulating panel that result from cutting the first insulating panel are easy to compensate.

- 5 According to one embodiment, the invention also provides a corner structure disposed at an intersection between a respective support structure of a first and a second wall of a sealed and thermally insulating tank, the first and the second wall each comprising, in a direction of thickness, a secondary thermally insulating barrier held on the support structure of said first or second wall, a
- 10 secondary sealing membrane, a primary thermally insulating barrier and a primary sealing membrane intended to be in contact with the fluid contained in the tank, the support structure of the first and the second wall meeting at an edge, the corner structure comprising:
- a first and a second insulating panel forming a corner between the secondary
 - 15 thermally insulating barriers of the first and the second wall and that are respectively fixed onto the support structure of the first and the second wall;
 - a first and a second insulating block forming a corner between the primary thermally insulating barriers of the first and the second wall and that are respectively fixed onto the first and the second insulating panels via anchoring means;
 - 20 - at least the anchoring means of the first insulating block on the first insulating panel being adjustable-positioning anchoring means enabling a plurality of positions for said first insulating block on the first insulating panel, the positions being spaced apart from each other in a direction orthogonal to the edge and parallel to the first wall.

- 25 According to embodiments, such an assembly method and/or a corner structure can comprise one or more of the following features.

According to one embodiment, the first insulating panel is cut along a cutting plane parallel to a straight line formed at the intersection between the first face and the internal face of the first insulating panel.

- 30 According to one embodiment, the first setpoint corresponds to the distance in the direction orthogonal to the edge between the second face of the first insulating panel and the corner arranged between the internal faces of the first and the second insulating panels.

Advantageously, the adjustable-positioning anchoring means are arranged so that the various enabled positions extend over a range greater than 30 mm, advantageously greater than 50 mm, for example, of approximately 80 mm.

According to one embodiment, the adjustable-positioning anchoring means
5 are fixedly anchored on the first or the second insulating panel prior to the step of cutting said first or second insulating panel.

According to one embodiment, the means for anchoring the second insulating block on the second insulating panel are adjustable-positioning anchoring means enabling a plurality of positions for said second insulating block on the
10 second insulating panel, the positions being spaced apart from each other in a direction orthogonal to the edge and parallel to the second wall, wherein a second setpoint is determined for a dimension of said second insulating panel in a direction orthogonal to the first face of said second insulating panel, as a function of a second in situ dimensional measurement of the support structure of the
15 second wall in a direction orthogonal to the edge, the second dimensional measurement representing the space between the edge and an insulating element of the secondary thermally insulating barrier of the second wall that is adjacent to the destination location of said second insulating panel,
wherein the second insulating panel is cut along the first face of the second
20 insulating panel by adjusting, to the second setpoint, the dimension of said second insulating panel in the direction orthogonal to the first face, so as to adjust the position of the corner between the secondary thermally insulating barriers of the first and the second walls relative to the second face of the second insulating panel, and wherein the second insulating block is fixed onto the second insulating panel by
25 adjusting the relative position of the second insulating block on the second insulating panel by means of the adjustable-positioning anchoring means for adjusting the second insulating block on the second insulating panel, said adjustable-positioning anchoring means enabling a plurality of positions for said second insulating block on the second insulating panel, the positions being spaced apart from each other in a
30 direction orthogonal to the edge and parallel to the support structure of the second wall.

According to one embodiment, the second insulating panel is cut in a cutting plane parallel to a straight line formed at the intersection between the first face and the internal face of the second insulating panel.

According to one embodiment, the first and the second insulating panels are each beveled so that the first face of each of the first and second insulating panels comprises a beveled portion that is adjacent to the internal face of said insulating panel, the method comprising bringing the beveled portions of the first and the second insulating panels into contact with each other.

According to one embodiment, the angles α_1 and α_2 respectively formed by the beveled portion of the first and the second insulating panels relative to the internal face of said insulating panel are associated by the following relation: $\alpha_1 + \alpha_2 = 360 - \beta$, where β is the angle in degrees formed between the support structures of the two walls. The angles α_1 and α_2 are determined, for example, by the following relation: $\alpha_1 = \alpha_2 = 180 - 0.5 \beta$. Furthermore, the dimensions a_1 and a_2 of the first and the second insulating panels, taken from an end of their beveled portion that is opposite their internal face, in a direction orthogonal to said internal face, are determined by the following relations:

$$a_2 = x_1 - L_1 \text{ init} - i;$$

$$a_1 = x_2 - L_2 \text{ init} - i;$$

with:

- β : being the angle in degrees formed between the support structures of the two walls;
- α_1 and α_2 being in degrees;
- e : being the thickness of the first panel and the second panel;
- x_1 : being the measurement representing the space between the edge and the insulating panel adjacent to the destination location of the first insulating panel;
- x_2 : being the measurement representing the space between the edge and the insulating panel adjacent to the destination location of the second insulating panel;
- i : being the width setpoint of a void between one of the first and second insulating panels and the adjacent insulating panel; and

- L1 init, L2 init: being the initial respective dimension of the first and second insulating panel in a direction orthogonal to the first face of said insulating panels.

According to another embodiment, the first insulating panel is cut along the first face of the first insulating panel perpendicular to the internal face of said first insulating panel. Advantageously, the second insulating panel is also cut along the first face of the second insulating panel perpendicular to the internal face of said second insulating panel.

According to one embodiment, an insulating corner element is fixed against the edge, in a space intended to be arranged between the first face of the first insulating panel and the first face of the second insulating panel.

According to one embodiment, the first and the second insulating blocks have a rectangular parallelepipedal shape and each have a first face and a second face opposite said first face, and a third setpoint is determined for a dimension of said first insulating block in a direction orthogonal to the first face of said first insulating block, as a function of the first dimensional measurement, the first insulating block is cut along the second face of the first insulating block by adjusting, to the third setpoint, the dimension of said first insulating block in a direction orthogonal to the first face of said first insulating block; and the first and the second insulating blocks are respectively disposed on the first and the second insulating panels such that the first face of the first and the second insulating blocks is respectively facing the internal face of the second and the first insulating panels.

According to one particular embodiment, the first insulating block comprises an internal plate, an external plate and a polymer foam layer sandwiched between the internal plate and the external plate, the polymer layer having two portions that are formed by two distinct polymer materials and are juxtaposed one after the other in a direction orthogonal to the first face of said first insulating block.

According to one embodiment, a fourth setpoint is determined for a dimension of said second insulating block in a direction orthogonal to the first face of said second insulating block, as a function of the second dimensional measurement, and

the first insulating block is cut along the second face of the first insulating block by adjusting, to the fourth setpoint, the dimension of said second insulating block in a direction orthogonal to the first face of said second insulating block.

According to one embodiment, the first insulating block and the second
 5 insulating block are supplied in a preassembled state by means of a metal angle bracket, said angle bracket being fixed onto an internal face of the first and the second insulating blocks and being intended to form a corner between the primary sealing membranes of the first and the second walls.

According to one embodiment, the means for anchoring the second
 10 insulating block on the second insulating panel are adjustable-positioning anchoring means enabling a plurality of positions for said second insulating block on the second insulating panel, the positions being spaced apart from each other in a direction orthogonal to the intersection and parallel to the second wall.

According to one embodiment, the first insulating block comprises an
 15 internal plate, an external plate and a polymer foam layer sandwiched between the internal plate and the external plate, the internal plate of the first insulating block having a lateral edge that laterally projects from the polymer layer, the adjustable-positioning anchoring means for adjusting the first insulating block on the first insulating panel comprising a stud provided with a threaded end that is anchored on
 20 the first insulating panel, a nut that is screwed onto the threaded end of the stud and a retention element that is pressed against the lateral edge of the internal plate by the nut. According to one embodiment, the second insulating block and the means for anchoring the second insulating block on the second insulating panel have identical technical features.

According to one embodiment, the internal plate of the first insulating block
 25 comprises two lateral edges laterally projecting either side of the polymer foam layer, the adjustable-positioning anchoring means for adjusting the first insulating block on the first insulating panel comprising two studs that are each provided with a threaded end and are anchored on the first insulating panel either side of the first
 30 insulating block, a nut screwed onto the threaded end of each of the studs and two retention elements that are respectively pressed against each of the two lateral edges of the internal plate by one of the nuts. According to one embodiment, the

second insulating block as well as the means for anchoring the second insulating block on the second insulating plate have identical technical features.

According to one embodiment, the retention element is a bearing plate.

According to another embodiment, the retention element is a U-shaped
5 section.

According to one embodiment, the dimension of the first and the second insulating blocks in an orientation parallel to the edge is identical to a dimension in an orientation parallel to the edge of the first and second insulating panels.

According to one embodiment, the first insulating block has a rectangular
10 parallelepipedal shape and has a first face disposed facing an internal face of the second insulating panel and a second face opposite said first face, the stud being disposed in the vicinity of the second face of the first insulating block and the retention element also being capable of being pressed against a lateral edge of an internal plate of an insulating panel of the primary thermally insulating barrier of the
15 first wall that is adjacent to said first insulating block.

According to one embodiment, the first insulating block comprises an internal plate, an external plate and a polymer foam layer sandwiched between the internal plate and the external plate, the internal plate of the first insulating block having a lateral edge that laterally projects from the polymer layer and that has an
20 oblong orifice extending in a direction orthogonal to the edge, the adjustable-positioning anchoring means for adjusting the first insulating block on the first insulating panel comprising a stud, which is provided with a threaded end, is anchored on the first insulating panel and which passes through the oblong orifice and a nut screwed onto the threaded end of the stud.

According to one embodiment, the corner structure further comprises a first
25 anchoring strip that extends over an internal face of the first insulating block, parallel to the edge, and has two lugs that laterally project either side of the first insulating block toward the support structure of the first wall, each of the lugs having an anchoring portion that is connected to the second insulating panel by an anchoring
30 rod, each anchoring rod comprising an internal end that is connected to the second insulating panel by means of a first spherical joint, an external end that is connected to one of the anchoring portions by means of a second spherical joint and means for

adjusting the length of each anchoring rod between the first and the second spherical joints.

According to one embodiment, the anchoring strip is housed in a countersink arranged in the internal face of the first insulating block.

5 According to one embodiment, the internal end of each anchoring rod passes through an orifice arranged in one of the anchoring portions, is threaded and cooperates with a nut, said nut pressing two washers threaded onto the internal end against the anchoring portion, the two washers cooperating with each other by means of bearing surfaces that are inscribed in a sphere and have matching
10 shapes.

 According to one embodiment, the internal end of the anchoring rod passes inside a ring that is held on the second insulating panel, is threaded and cooperates with a nut, said nut pressing a washer press-fitted onto the internal end against the ring, said washer and the ring cooperating with each other by means of bearing
15 surfaces that are inscribed in a sphere and have matching shapes.

 According to one embodiment, the corner structure further comprises a second anchoring strip that extends over an internal face of the second insulating block, parallel to the edge, and has two lugs that laterally project either side of the second insulating block toward the support structure of the second wall, each of the
20 lugs having an anchoring portion that is connected to the first insulating panel by an anchoring rod, each anchoring rod comprising an internal end that is connected to the first insulating panel by means of a first spherical joint, an external end that is connected to one of the anchoring portions by means of a second spherical joint and means for adjusting the length of each anchoring rod between the first and the
25 second spherical joints.

 According to one embodiment, the corner structure further comprises a metal corner piece comprising two wings that are respectively welded onto the first and the second anchoring strips, so as to form a corner between the primary sealing membranes of the first and the second wall.

30 According to one embodiment, the invention relates to a sealed and thermally insulating tank comprising a corner structure of the aforementioned type.

Such a tank can form part of an onshore storage installation, for example, for storing LNG, or can be stored in a coastal or deep sea floating structure, particularly an LNG tanker vessel, a floating storage and regasification unit (FSRU), a floating production storage and offloading unit (FPSO) and others.

5 According to one embodiment, the invention provides a vessel for transporting a fluid comprising a double hull and an aforementioned tank disposed in the double hull.

 According to one embodiment, the invention also provides a method for loading or offloading such a vessel, in which a fluid is routed through insulated pipes
10 from or to a floating or onshore storage installation to or from the tank of the vessel.

 According to one embodiment, the invention also provides a fluid transfer system, the system comprising the aforementioned vessel, insulated pipes arranged so as to connect the tank installed in the hull of the vessel to a floating or onshore storage installation and a pump for feeding a fluid through the insulated pipes from
15 or to the floating or onshore storage installation to or from the tank of the vessel.

Brief description of the figures

 The invention will be better understood, and further aims, details, features and advantages thereof will become more clearly apparent, throughout the following description of several particular embodiments of the invention, which are provided
20 solely by way of a non-limiting illustration, with reference to the accompanying drawings, in which:

 - **figure 1** is a cutaway perspective view of a wall of a sealed and thermally insulating tank;

 - **figure 2** is a section view of a corner structure according to a first
25 embodiment, disposed at the intersection of two walls of a sealed and thermally insulating tank;

 - **figure 3** is a section view of a corner structure, similar to the view of figure 2, in which one of the insulating panels of the thermally insulating barrier has been cut in order to compensate for the manufacturing tolerances of the support structure;

30 - **figure 4** is a partial perspective view of the corner structure of figure 3 showing the thermally insulating barrier and partially showing the secondary sealing membrane of the corner structure;

- **figure 5** is a perspective view of the corner structure of figure 2;

- **figure 6** is a partial perspective view showing the sealed welding of the metal sheets of the primary sealing membrane of one of the walls on angle brackets of the corner structure of figure 1;

5 - **figure 7** is a perspective view of a corner structure according to a second embodiment;

- **figure 8** is a perspective view of a corner structure according to a third embodiment;

10 - **figure 9** is a perspective view of a corner structure according to a fourth embodiment;

- **figure 10** is a detailed view of the corner structure of figure 8 showing an adjustable-positioning anchoring means;

- **figure 11** is a detailed view of the zone XI of figure 10;

- **figure 12** is a detailed view of the zone XII of figure 10;

15 - **figure 13** is a partial perspective view showing the sealed welding of the metal sheets of the primary sealing membrane of one of the walls on the anchoring strips of the corner structure of figure 8;

20 - **figure 14** is a schematic illustration of the insulating panels of the secondary thermally insulating barrier of the corner structure according to another variation;

- **figure 15** is a partial perspective view of a corner structure according to a fifth embodiment;

25 - **figure 16** is a partial view showing a detailed view of the anchoring of the primary thermally insulating barrier on the primary thermally insulating barrier in the corner structure of figure 15;

- **figure 17** is a partial perspective view of a corner structure according to a sixth embodiment;

- **figure 18** is a partial perspective view of an insulating block of the corner structure of figure 17;

- **figure 19** is a cutaway schematic representation of a tank of an LNG tanker vessel and a terminal for loading/offloading this tank.

Detailed description of embodiments

By convention, the terms “external” and “internal” are used to define the relative position of one element relative to another, with reference to the inside and to the outside of the tank.

The multilayer structure of a sealed and thermally insulating tank for storing liquefied natural gas is described with reference to figure 1. Each wall of the tank comprises, from the outside to the inside of the tank, a secondary thermally insulating barrier 1 comprising insulating panels 2 juxtaposed and anchored on a support structure 3 by secondary retention elements, a secondary sealing membrane 4 borne by the insulating panels 2 of the secondary thermally insulating barrier 1, a primary thermally insulating barrier 5 comprising insulating panels 6 juxtaposed and anchored on the insulating panels 2 of the secondary thermally insulating barrier 1 by primary retention elements and a primary sealing membrane 7 supported by the insulating panels 6 of the primary thermally insulating barrier 5 and intended to be in contact with the liquefied natural gas contained in the tank.

The support structure 3 particularly can be formed by self-supporting metal sheets or, more generally, by any type of rigid partition having suitable mechanical properties. The support structure 3 particularly can be formed by the hull or the double hull of a vessel. The support structure 3 comprises a plurality of walls defining the general shape of the tank, commonly a polyhedral shape.

The secondary thermally insulating barrier 1 comprises a plurality of insulating panels 2 anchored on the support structure 3 by means of resin beads, not shown, and studs, not shown, welded onto the support structure 3. Advantageously, the insulating panels 2 each comprise an insulating polymer foam layer 10 sandwiched between an internal plate 11 and an external plate 12. The internal 11 and external 12 plates are, for example, plywood boards bonded to said insulating polymer foam layer 10. The insulating polymer foam 10 particularly can be a polyurethane based foam. The insulating polymer foam 10 advantageously is reinforced with glass fibers that help to reduce its thermal contraction coefficient.

In a flat zone of a wall, as shown in figure 1, the insulating panels 2 are substantially in the shape of a rectangular parallelepiped and are juxtaposed in

parallel rows and are separated from each other by voids 8 providing a functional assembly clearance. The voids 8 are filled with an insulating liner 9 such as glass wool, rock wool or open-cell flexible synthetic foam, for example.

5 In order to fix the insulating panels 2 to studs welded onto the support structure 3, the insulating panels 2 are provided with cylindrical shafts 19 that pass through the entire thickness of the insulating panels 2 and are arranged at least in the vicinity of each of the four corners of the insulating panels 2. The cylindrical shafts 19 have an altered section, not shown, defining bearing surfaces for nuts cooperating with the threaded ends of the studs.

10 The internal plate 11 of the insulating panels 2 has two series of grooves 13, 14, perpendicular to each other, so as to form a set of grooves. Each series of grooves 13, 14 is parallel to two opposite sides of the insulating panels 2. The grooves 13, 14 are intended to receive corrugations 15, projecting toward the outside of the tank, formed on the metal sheets 16 of the secondary sealing
15 membrane 4.

Furthermore, the internal plate 11 is provided with metal fixtures 17 for anchoring the edge of the metal sheets 16 of the secondary sealing membrane 4 on the insulating panels 2. The metal fixtures 17 extend in two perpendicular directions, which are each parallel to two opposite sides of the insulating panels 2. The metal
20 fixtures 17 are fixed onto the internal plate 11 of the insulating panels 2 by screws, rivets or staples, for example. The metal fixtures 17 are placed in recesses arranged in the internal plates 11 so that the internal surface of each metal fixture 17 is flush with the internal surface of one of the internal plates 11.

Each internal plate 11 is also provided with threaded studs 18 projecting
25 toward the inside of the tank and intended to fix the primary thermally insulating barrier 5 on the insulating panels 2 of the secondary thermally insulating barrier 1.

Furthermore, the internal plate 11 has, along its edges, in each gap between two successive grooves 13, 14, a break 20 receiving bridging plates 21 that are each straddled between two adjacent insulating panels 2, spanning the void 8
30 between the insulating panels 2. Each bridging plate 21 is fixed against each of the two adjacent insulating panels 2, by bonding and/or by stapling, so as to oppose their mutual separation. The bridging plates 21 are of rectangular parallelepipedal

shape and are formed by a plywood board, for example. The external face of the bridging plates 21 is fixed against the bottom of the breaks 20.

The secondary sealing membrane 4 comprises a plurality of corrugated metal sheets 16, each having a substantially rectangular shape. The metal sheets 16 are disposed offset relative to the insulating panels 2 of the secondary thermally insulating barrier 1, so that each of said metal sheets 16 jointly extends over four adjacent insulating panels 2. Each metal sheet 16 has a first series of parallel corrugations 15 extending in a first direction and a second series of parallel corrugations 15 extending in a second direction. The directions of the series of corrugations are perpendicular. Each series of corrugations 15 is parallel to the two opposite edges of the metal sheet 16. The corrugations 15 project toward the outside of the tank, i.e. toward the support structure 3. The corrugations 15 of the metal sheets 16 are housed in the grooves 13, 14 arranged in the internal plate 11 of the insulating panels 2. The adjacent metal sheets 16 are lap-welded together. The metal sheets 16 are anchored on the metal fixtures 17 by tack welds.

The metal sheets 16 comprise, along their longitudinal edges and in the vicinity of their four corners, cuts allowing the passage of the studs 18 intended to fix the primary thermally insulating barrier 5 on the secondary thermally insulating barrier 1. The metal sheets 16 are made of Invar[®], for example: i.e. a nickel-iron alloy with an expansion coefficient that is typically between $1.2 \cdot 10^{-6}$ and $2 \cdot 10^{-6} \text{ K}^{-1}$, or a high manganese content iron alloy, the expansion coefficient of which is typically approximately $7 \cdot 10^{-6} \text{ K}^{-1}$. Alternatively, the metal sheets 16 also can be made of stainless steel or aluminum.

The primary thermally insulating barrier 5 comprises a plurality of insulating panels 6 of rectangular parallelepipedal shape. In the embodiment shown, the dimensions of the insulating panels 6 of the primary thermally insulating barrier 5 are equal to the dimensions of an insulating panel 2 of the secondary thermally insulating barrier 1, except their thickness, which is less than that of the insulating panel 2. The insulating panels 6 in this case are offset relative to the insulating panels 2 of the secondary thermally insulating barrier 1, so that each insulating panel 6 extends over four insulating panels 2 of the secondary thermally insulating barrier 1.

In other embodiments, the dimensions of the insulating panels 6 of the primary thermally insulating barrier 5 differ from those of the insulating panels 2 of the secondary thermally insulating barrier 1. In other embodiments, the insulating panels 6 of the primary thermally insulating barrier 5 and/or the insulating panels 2 of the secondary thermally insulating barrier 1 have a substantially rectangular parallelepipedal shape, the internal and external faces of which are squares.

The insulating panels 6 comprise a structure similar to that of the insulating panels 2 of the secondary thermally insulating barrier 1, namely a sandwich structure formed by an insulating polymer foam layer sandwiched between two rigid plates made of plywood, for example.

The internal plate of an insulating panel 6 of the primary thermally insulating barrier 5 is provided with metal fixtures 22 for anchoring metal sheets 23 of the primary sealing membrane 7. The metal fixtures 22 extend in two perpendicular directions that are each parallel to two opposite edges of the insulating panels 6. The metal fixtures 22 are fixed in recesses arranged in the internal plate of the insulating panels 6 and are fixed thereto by screws, rivets or staples or by bonding, for example.

The insulating panels 6 of the primary thermally insulating barrier 5 are fixed onto the insulating panels 2 of the secondary thermally insulating barrier 1 by means of studs 18. To this end, each insulating panel 6 comprises a plurality of cuts 24 along its edges and at its corners, inside which a stud 18 extends. The external plate of the insulating panels 6 projects inside the cuts 24 so as to form a bearing surface for a retention element 25 that comprises a threaded bore threaded onto each stud 18. The retention element 25 comprises lugs housed inside the cuts 24 and coming into abutment against the portion of the external plate projecting inside the cut 24. Thus, the external plate of each insulating panel 6 is sandwiched between a lug of the retention element 25 and an insulating panel 2 of the secondary thermally insulating barrier 1, which thus allows each insulating panel 6 to be fixed onto the insulating panels 2 that it overlaps.

The primary thermally insulating barrier 5 comprises a plurality of closure plates 26 allowing the bearing surface of the primary sealing membrane 7 to be completed at the cuts 24.

The primary sealing membrane 7 is obtained by assembling a plurality of metal sheets 23. Each metal sheet 23 comprises two series of parallel corrugations that are perpendicular to each other. The corrugations project toward the inside of the tank. The metal sheets 23 are made of stainless steel or aluminum, for example.

5 With reference to figures 2 to 5, a corner structure will be described hereafter that is disposed at the intersection between a first and a second wall 27, 28 of the tank. The support structure of the first wall 27 and that of the second wall 28 meet at an edge 92. The angle formed between the support structure of the first wall 27 and that of the second wall 28 is approximately 90° in the embodiment
10 shown. However, the angle can have any other value, for example, it can be approximately 135°.

The corner structure comprises two insulating panels 29, 30 that are respectively disposed against the support structure 3 of the first wall 27 and of the second wall 28 and a corner insulating element 31, shown in figure 2, which is
15 disposed in the corner, between the two insulating panels 29, 30.

The two insulating panels 29, 30 are in the shape of a rectangular parallelepiped. Each of the insulating panels 29, 30 has a first face 93 that is parallel to the intersection 92 and is disposed facing the insulating corner element 31, as well as a second face 94 opposite said first face 93. The insulating corner element
20 31 also has a rectangular parallelepipedal shape, the two opposite lateral faces of which are square. The insulating corner element 31 is made of polymer foam, glass wool or rock wool, for example.

The insulating panels 29, 30 have a sandwich structure identical to that of the other insulating panels 2 of the secondary thermally insulating barrier 1, i.e.
25 comprising an insulating polymer foam layer 32 sandwiched between an internal plate 33 and an external plate 34.

With reference to figure 4, it can be seen that the internal plate 33 of the insulating panels 29, 30 has a set of perpendicular grooves 35. Furthermore, the internal plate 33 of the insulating panels 29, 30 comprises a plurality of metal
30 fixtures 36, 37, 38. The metal fixtures 36, 37, 38 of each insulating panel 29, 30 extend in three directions, namely two directions parallel to the edge 92 between the two walls 27, 28 and a third direction perpendicular to the other two directions. The metal fixtures 36, 37, 38 are placed in recesses arranged in the internal plates 33 of

the insulating panels 29, 30 and are fixed thereto by screws, rivets or staples, for example.

The metal fixtures 36, 37, 38 are intended to anchor the edge of the metal sheets 16, 43 of the secondary sealing membrane 4 and to anchor metal angle brackets 39 forming the secondary sealing member 4 of the corner structure.

The metal fixtures 38 follow the edge of the insulating panels 29, 30 that is adjacent to the edge 92 between the two walls 27, 28. Each metal fixture 38 is disposed in a gap between two grooves 35 orthogonal to the edge 92. Each metal angle bracket 39 has two wings 40, 41 that are respectively parallel to each of the two adjacent walls 27, 28. Each metal angle bracket 39 has a corrugation 42 extending from one end of the metal angle bracket 39 to the next along its two wings 40, 41, so as to allow deformation of the metal angle bracket 39 in a direction parallel to the edge 92. The metal angle brackets 39 are lap-welded onto two sets of first metal sheets 43 that respectively extend either side of the metal angle brackets and parallel to each of the two adjacent walls 27, 28 (in figure 4, only one of the two sets of first metal sheets 43 is shown). The metal angle brackets 39 are also lap-welded together along their lateral edges. The metal angle brackets 39 are advantageously made of a material identical to that of the other metal sheets 16 of the secondary sealing membrane 4.

The two sets of first metal sheets 43 respectively extend parallel to each of the support structures 3 of the two adjacent walls 27, 28. Each of the first metal sheets 43 straddles two first adjacent insulating panels 29 or 30 bearing against the support structure 4 of the same wall 27, 28 and is anchored on each of them by being welded at its edges on the metal fixtures 36, 37. The first metal sheets 43 are lap-welded along their lateral edges. The first metal sheets 43 each have a single corrugation 44 extending in a direction parallel to the intersection between the two walls 27, 28 and a plurality of corrugations 45 perpendicular to said corrugation 44 and each extending in the extension of the corrugation 42 of one of the metal angle brackets 39. The corrugations 44, 45 of the first metal sheets 43 are received in the grooves 35. The edge 58 of each of the first metal sheets 43 on which metal angle brackets 39 are lap-welded has a joggle, i.e. a raised section, by virtue of which the metal angle brackets 39 can superpose the metal sheets.

According to one embodiment, the dimension, in the direction orthogonal to the edge 92, of each wing 40, 41 of the metal angle brackets 39 is adjusted as a function of an in situ measurement of the support structure 3, so as to compensate for the manufacturing tolerances of the support structure, as described hereafter.

- 5 According to another embodiment, the dimension of the joggled edge 58 in a direction orthogonal to the intersection between the two walls is able to compensate for the manufacturing tolerances of the support structure 3. The width of the joggle is approximately 80 mm, for example.

- 10 Furthermore, standard metal sheets, not shown in figure 4, are straddled between two insulating panels 29 or 30 of the corner structure and two adjacent insulating panels 6 and are also anchored on the metal fixtures 22, 36.

- The internal plate 33 of the insulating panels 29, 30 is also provided with anchoring fixtures 46 intended to fix the insulating blocks 47, 48 of the primary thermally insulating barrier 5 of the corner structure against the insulating panels 29, 30 of the secondary thermally insulating barrier 1 of the corner structure. The anchoring fixtures 46 are fixed in a dimpling arranged in the internal plate 33, for example, by screwing, stapling and/or bonding. The anchoring fixtures 46 each have a threaded bore. Furthermore, the first metal sheets 43 of the secondary sealing membrane 4 have orifices, through each of which a blind nut 61 passes, as shown in figure 4. The blind nut 61 has a thread on its outer periphery that cooperates with the threaded bore arranged in one of the anchoring fixtures 46. The blind nut 61 further comprises a collar allowing one of the first metal sheets 43 to be sandwiched between said collar and the anchoring fixture 46. Each collar is welded onto the first metal sheet 43 on the periphery of the orifice in order to provide the seal for the secondary sealing membrane 4. Furthermore, each blind nut 61 has a threaded internal bore intended to receive a stud 49, shown in figures 2, 3 and 5, intended to fix an insulating block 47, 48 of the primary thermally insulating barrier 5 of the corner structure.

- 30 As shown in figures 2, 3 and 5, the primary thermally insulating barrier 5 of the corner structure comprises insulating blocks 47, 48. Each insulating block 47, 48 comprises a rectangular parallelepipedal shape and has a first face 96 facing the other adjacent wall and a second face 97 opposite the first face 96. The insulating blocks 47, 48 are preassembled in pairs, one of which bears against one of the first metal sheets 43 of the first wall 27 and is anchored on one of the insulating panels

29 fixed against the support structure 3 of the first wall 27, whereas the other bears against one of the first metal sheets 43 of the second wall 28 and is anchored on one of the insulating panels 30 fixed against the support structure 3 of the second wall 28. The insulating blocks 47, 48 have a composite structure and each comprise
 5 a polymer foam layer 62 sandwiched between two internal 50 and external 51 plywood boards bonded to said polymer foam layer 62.

The insulating blocks 47, 48 comprise an internal face, against which an angle bracket 52 bears, and an external face bearing against one of the first metal sheets 43. The angle brackets 52 are metal angle brackets made of stainless steel,
 10 for example. The angle brackets 52 have two wings 53, 54 respectively bearing against the internal face of each of the insulating blocks 47, 48 of a pair of insulating blocks. Each wing 53, 54 of an angle bracket 52 has studs, not shown, for fixing the angle bracket 52 to the insulating blocks 47, 48. The studs project toward the inside of the tank and pass through orifices arranged in the internal plate 50 of the
 15 insulating blocks 47, 48. The orifices communicate with larger diameter cylindrical shafts emerging on the external face of the insulating blocks 47, 48. Nuts screwed onto the studs bear against the internal plate 50 of the insulating blocks 47, 48 and thus provide the rigid connection of the bracket 52 to said insulating blocks 47, 48. Each angle bracket 52 thus allows the insulating blocks 47, 48 to be connected
 20 pairwise so as to form preassembled modules.

A corner connection 55 made of insulating material, such as a polymer foam, is disposed between the first faces 96 of the two insulating blocks 47, 48 and thus allows continuous thermal insulation to be provided at the corner of the tank. Furthermore, insulating joint elements, not shown, are inserted between two pairs of
 25 adjacent insulating blocks 47, 48, so as to provide continuous thermal insulation.

The external plate 51 of each of the insulating blocks 47, 48 comprises lateral edges that laterally project either side of the polymer foam layer 62 and the internal plate 50, so as to form a bearing surface for a retention element that holds the internal plate 50 against one of the first metal sheets 43. In the embodiment of
 30 figures 2, 4 and 5, the retention element is formed by a bearing plate 56 that has an orifice, through which one of the studs 49 passes. A nut 57 is screwed onto the threaded end of the stud 49 so that the bearing plate 56 comes into abutment against the lateral edges of the external plates 51 of two adjacent insulating blocks 47, 48, so as to sandwich the external plates 51 of the two adjacent insulating

blocks 47, 48 against one of the first metal plates 43 of the secondary sealing membrane 4. The insulating blocks 47, 48 are thus anchored on the insulating panels 29, 30 by anchoring means that enable a plurality of positions for the insulating blocks 47, 48 relative to the insulating panels 29, 30, in a direction
 5 orthogonal to the edge 92. According to an optional embodiment, a set of Belleville washers is threaded onto each of the studs 49 and is interposed between one of the nuts 57 and the bearing plate 56, which allows flexible anchoring to be provided for the insulating blocks 47, 48 on the insulating panels 29, 30.

As shown in figure 6, the metal sheets 23 of the primary sealing membrane
 10 7 that border the corner zone are welded along their edge that is directed toward the intersection of the tank on the angle brackets 52.

Furthermore, the primary sealing membrane 7 has a plurality of metal corner pieces 86 that are each welded straddling two adjacent angle brackets 52. The corner pieces 86 are made of a material identical to that of the other metal
 15 sheets 23 of the primary sealing membrane 1. Each corner piece 86 comprises two wings that are respectively parallel to each of the support structures 3 of the two adjacent walls 27, 28. Each corner piece 86 comprises a corrugation 87 extending from one end of the corner piece 86 to the next along two wings, so as to allow the corner piece 86 to deform in a direction parallel to the intersection of the walls. The
 20 corrugation 87 of each of the corner pieces 86 extends in the extension of one of the directions of the corrugations of the primary sealing membrane 7, so as to provide continuity for the corrugation network of the primary sealing membrane 7 at the corner of the tank. The corner pieces 86 are also lap-welded onto the metal sheets 23 of the primary sealing membrane 7.

25 The edge of each of the corner pieces 86 that is lap-welded onto the metal sheets 23 of the primary sealing membrane 7 has a joggle, i.e. a raised section, by virtue of which said corner pieces 86 superpose the metal sheets 23.

According to one embodiment, the dimension of the metal sheets 23 that are lap-welded onto the angle brackets 52, in the direction orthogonal to the edge
 30 92, is adjusted as a function of an in situ measurement of the support structure 4, as described hereafter, so as to compensate for the manufacturing tolerances of the support structure 3.

According to another embodiment, the dimension of the joggled edge in a direction orthogonal to the edge 92 is such that it is able to compensate for the manufacturing tolerances of the support structure 3. The width of the joggle is approximately 80 mm, for example.

5 The assembly of the walls of a tank as previously described will be described hereafter by more specifically focusing on the method for assembling a corner structure.

10 Initially, the position of the studs is defined, which studs are intended to anchor insulating panels 2 of the secondary thermally insulating barrier 1 on the support structure 3, relative to a reference point of each of the walls 27, 28, this reference point being a corner of the wall 27, 28 or its center, for example. Said studs are then welded onto the support structure 3 in the previously determined position.

15 A setpoint is determined on each corner structure for the width of each of the insulating panels 29, 30 of the secondary thermally insulating barrier 1, i.e. the dimension between the face 93 of each of the insulating panels 29, 30 that follows the edge 92 and the opposite face 94. This setpoint is established on the basis of an in situ measurement of the support structure 4 that represents the space between the edge 92 and the insulating panel 2 of the flat zone that is adjacent to the destination location of said insulating panel 29, 30, the width setpoint of which must be determined.

By way of an example, the width setpoint L of an insulating panel 29 can be determined using the following relation:

$$L = x - i - e;$$

25 with:

x: being the measurement representing the space between the edge 92 and the insulating panel 2 adjacent to the destination location of the insulating panel 29;

i: being the width setpoint of a void between said insulating panel 29 and the adjacent insulating panel 2; and

30 e: being the thickness of the insulating panels 29, 30.

This setpoint also can be established as a function of a measurement of the distance between the edge 92 and the position of the studs intended to fix the

insulating panel 2 that is adjacent to the insulating panel 29, 30, the setpoint of which must be determined, or even a measurement of the dimension of the support structure 3 of one of the walls 27, 28 in the direction orthogonal to the intersection between the two walls 27, 28.

5 Subsequently, the insulating panels 29, 30 are cut so as to adjust their width to the previously determined setpoint. To this end, the insulating panels 29, 30 are cut in their longitudinal direction, along their face 93 intended to be disposed along the edge 92, perpendicular to their internal 95 and external faces. The cut of one of the insulating panels 29 is shown by a dashed line in figure 3. The insulating
10 panels 29, 30 can be cut in situ in the tank or advantageously outside the tank, so as to limit polluting the tank with cutting residues. Thus, the width of the insulating panels 29, 30 is adapted in order to compensate for the manufacturing tolerances of the support structure 3.

 Subsequently, the insulating panels 29, 30 are fixed onto the support
15 structure 30, then the metal angle brackets 39, as well as the first metal sheets 43, are fixed onto said insulating panels 29, 30. As previously mentioned, the metal angle brackets 39 are previously sized as a function of the in situ measurement of the aforementioned support structure 4.

 The insulating blocks 47, 48 are then fixed onto their respective insulating
20 panels 29, 30 by means of the anchoring means enabling a wide relative positioning range for the insulating blocks 47, 48 relative to their respective insulating block 29, 30, as described above.

 Furthermore, advantageously, the insulating blocks 47, 48 are also previously cut so as to adjust their dimension in the direction orthogonal to the
25 intersection and to thus compensate for the manufacturing tolerances of the support structure 3 on the primary thermally insulating barrier 5. The setpoint for the dimension of the insulating blocks 47, 48 in the direction orthogonal to the intersection between the support structure of the two walls 27, 28 advantageously is established as a function of the aforementioned in situ measurement, the width to be
30 removed from the insulating blocks 47, 48 being equal to the width to be removed from the insulating panels 29, 30.

 Unlike the cut made on the insulating panels 29, 30, the insulating blocks 47, 48 are cut along their face 97 that is opposite the edge 92. Thus, by virtue of this

feature, the insulating blocks 47, 48 can be preassembled in pairs by means of the angle brackets 52 before being cut to the required dimension.

The dimension, in a direction orthogonal to the edge, of the metal sheets 23 that are welded onto the angle brackets 52 is adjusted as a function of the
5 aforementioned measurement of the support structure, then the corner pieces 86, as well as said metal sheets 23, are welded onto the angle brackets 52.

Figure 7 shows a corner structure according to a second embodiment. This embodiment only differs from the preceding embodiment in that the bearing element that comes into abutment against the lateral edges of the external plates 51 of the
10 insulating blocks 47, 48, so as to retain said external plates 51 of the two adjacent insulating blocks 47, 48 and one of the first metal plates 43 of the secondary sealing membrane 4, has a U-shaped section 59.

Figure 8 shows a corner structure according to a third embodiment of the invention. This embodiment particularly differs from the preceding embodiments in
15 terms of the structure of the means for anchoring the insulating blocks 47, 48 of the primary thermally insulating barrier 5 on the insulating panels 29, 30 of the secondary thermally insulating barrier 1. Indeed, in this embodiment, the lateral edges of the external plates 51 are each provided with an oblong orifice 60. The largest dimension of said oblong orifice 60 is oriented in a direction orthogonal to the
20 edge 92. Furthermore, two studs 49, anchored on one of the insulating panels 29, 30 as previously described, pass through each of the oblong orifices 60. A nut 57, to which a set of Belleville washers can be added, is threaded onto each of the studs 49 so as to exert, on the lateral edges of the external plates 51, a force that is capable of holding the insulating blocks 47, 48 of the primary thermally insulating
25 barrier 5 against the respective insulating panel 29, 30 of the secondary thermally insulating barrier 1.

The embodiment of figure 8 also differs from the preceding embodiments in that the polymer layer 62 of each of the insulating blocks 47, 48 in this case comprises two distinct portions 62a, 62b that are juxtaposed one after the other in a
30 direction orthogonal to the intersection between the two walls 27, 28. The two portions 62a, 62b in this case are made of distinct polymer materials. Thus, the portion 62a of the polymer layer 62 that is farthest from the edge 92 and is intended to be cut in order to adjust the dimension of the considered insulating block 47, 48

can be made of a lower grade polymer material, which limits the economic impact of cutting insulating blocks 47, 48. By way of an example, the portion 62b can be made of high density polyurethane foam, for example, of approximately 130 kg/m^3 , whereas the portion 62a is made of a lower density polyurethane foam, and which
 5 therefore is less expensive. Advantageously, the polyurethane foam of the portion 62a is nevertheless greater than or equal to 100 kg/m^3 .

The application of such a dual-component structure for the insulating blocks 47, 48 is not limited to the embodiment of figure 7 and also can be applied to the insulating blocks 47, 48 of the other embodiments, or even to the insulating panels
 10 29, 30.

Figures 9 to 13 show a corner structure according to a fourth embodiment. This embodiment particularly differs from the preceding embodiments in terms of the structure of the means for anchoring the insulating blocks 47, 48 of the primary thermally insulating barrier 5 on the insulating panels 29, 30 of the secondary
 15 thermally insulating barrier 1.

In this embodiment, the external plate 51 of each of the insulating blocks 47, 48 also comprises lateral edges that laterally project either side of the polymer foam layer 62 and of the internal plate 50 and a bearing plate 52 comes into abutment against each of the lateral edges of the external plate 51. As in the
 20 embodiment of figures 1 to 5, a nut 57 is screwed onto the threaded end of a stud 49 anchored to one of the insulating blocks 29, 30 and holds said bearing plate 52 against the lateral edges of the external plates 51 of two adjacent insulating blocks 29 or 30.

Anchoring each insulating block 47, 48 of the primary thermally insulating
 25 barrier 5 is also performed by means of an anchoring strip 63 associated with the insulating block 47, 48 and of two anchoring rods 64 connecting said anchoring strip 63 to an insulating panel 29, 30 of the secondary thermally insulating barrier 1.

The anchoring rods 64 are each disposed so as to connect an insulating block 47, 48, which bears against one of the two insulating panels 29, 30 of the corner structure, to the other one of the two insulating panels 29, 30 of the corner
 30 structure. Each anchoring strip 63 extends over the internal face of an insulating block 47, 48 in a direction parallel to the intersection between the two walls 27, 28 and is housed in a countersink that is arranged on the internal face of said insulating

block 47, 48. Furthermore, each anchoring strip 63 has, at each of its two ends, a lug 65 projecting along one of the lateral edges of the insulating block 47, 48, in the void separating two adjacent insulating blocks 47 or 48, toward the support structure 3. Each lug 65 is in the shape of a trihedron formed by three flat portions that intersect pairwise. One of the three flat portions forms an anchoring portion 66, on which one of the ends of the anchoring rod 64 is anchored. The anchoring portion 66 extends in a plane substantially orthogonal to the axis of the anchoring rod 64. In the embodiment shown, the anchoring rods 64 extend substantially orthogonal to the plane of the wall 27, 28 against which the insulating panel 29, 30 on which they are anchored is disposed. Moreover, the anchoring portion 66 extends in a plane substantially parallel to the adjacent wall 27, 28. Each anchoring rod 64 comprises an internal end that is connected to one of the insulating panels 29, 30 by means of a spherical joint and an external end that is connected to one of the anchoring portions 66 by means of a spherical joint. Furthermore, at least one of the spherical joints allows the length of the link between the two aforementioned spherical joints to be adjusted. Thus, such means for anchoring insulating blocks 47, 48 also enable a plurality of relative positions for the insulating blocks 47, 48 relative to the insulating panels 29, 30.

A more detailed description of the structure of the spherical joints will be provided hereafter with reference to figures 10, 11 and 12. The internal end of the anchoring rod 64, shown in detail in figure 11, is threaded and cooperates with a nut 67. Furthermore, the anchoring rod 64 passes through an orifice arranged in the anchoring portion 66. The nut 67 presses two washers 68, 69, which are threaded onto the anchoring rod 64, against the anchoring plate 66. The two washers 68, 69 cooperate with one another by means of bearing surfaces that are inscribed in a sphere and have matching shapes. Thus, such an arrangement forms a spherical joint having three degrees of freedom. Furthermore, the position of the nut 67 along the anchoring rod 64 can be modified in order to adapt the length of the link.

The external end of the anchoring rod 64, shown in detail in figure 12, also has a thread cooperating with a nut 82. Thus, the position of the nut 82 along the anchoring rod 64 also can be modified in order to adapt the length of the link. The nut 82 presses a washer 83, press-fitted on the anchoring rod 64, against a ring 84 that is held on one of the insulating panels 29, 30. The washer 83 and the ring 84 cooperate with each other by means of bearing surfaces that are inscribed in a

sphere and have matching shapes, so as to form a spherical joint. The ring 84 comprises a cylindrical skirt 85 axially extending along the axis of the anchoring rod 64, from the bearing surface of said ring 84. The cylindrical skirt 85 defines a housing, in which the nut 82 and the washer 83 are housed. The cylindrical skirt 85 has a thread on its outer periphery that cooperates with a threaded bore arranged in a blind nut 61. As in the embodiment shown and described with reference to figure 4, the blind nut 61 is fixed to an anchoring fixture 46, which is fixed to an insulating panel 29, 30 of the secondary thermally insulating barrier 1. The anchoring fixture 46 is fixed, for example, by screwing, in a dimpling arranged in the internal plate 33 of an insulating panel 29, 30. Each anchoring fixture 46 comprises a threaded bore, inside which one of the blind nuts 61 is screwed. To this end, each blind nut 61 has a thread on its outer periphery that cooperates with a threaded bore arranged in the anchoring fixture 46. Furthermore, each blind nut 61 passes through an orifice arranged in one of the first metal sheets 43 of the secondary sealing membrane 4 and further comprises a collar allowing the first metal sheet 43 to be sandwiched between said collar and the anchoring fixture 46. Each collar is also welded onto the first metal sheet 43, on the periphery of the orifice, in order to provide the seal for the secondary sealing membrane 4.

As shown in figure 13, the metal sheets 23 of the primary sealing membrane 7 that border the corner zone are welded along their edge directed toward the intersection between the support structures 3 of the two walls 27, 28 on the anchoring strips 63. Furthermore, the primary sealing membrane 7 has a plurality of metal corner pieces 88. Each corner piece 88 comprises two wings that are respectively parallel to each of the support structures 3 of the two adjacent walls 27, 28. Each wing is welded straddling the anchoring strips 63 of two adjacent insulating blocks 47 or 48. The corner pieces 88 are made of an identical material to that of the other metal sheets 23 of the primary sealing membrane 7. Furthermore, each corner piece 88 comprises a corrugation 89 extending from one end of the corner piece 88 to the next along two wings, so as to allow the corner piece 88 to deform in a direction parallel to the intersection between the two walls 27, 28. The corrugation 89 of each of the corner pieces 88 extends in the extension of one of the directions of the corrugations of the primary sealing membrane 7, so as to provide continuity for the set of corrugations of the primary sealing membrane 7 at the corner of the tank. The corner pieces 88 are also lap-welded onto the metal sheets

23 of the primary sealing membrane 7. The dimension, in the direction orthogonal to the edge 92, of the metal sheets 23 that are lap-welded onto the corner pieces 88 is adjusted as a function of the in situ measurement of the support structure 4.

Figures 15 and 16 show a corner structure according to a fifth embodiment.

5 This embodiment particularly differs from the first embodiment described with reference to figures 2 to 5 in terms of the means for anchoring insulating blocks 47, 48 on the insulating panels 29, 30. In this embodiment, two retention elements, shown in figure 16, each retain two lateral edges of the internal plate 51 of each of the insulating blocks 47, 48. Each retention element comprises a bearing plate 98,
10 99. Each bearing plate 98, 99 has an orifice, through which a respective stud 100, 101 passes, which is anchored on one of the insulating panels 29, 30. Each bearing plate 98, 99 comes into abutment against the lateral edges of the external plates 51 of two adjacent insulating blocks 47, 48.

Furthermore, in order to allow insulating blocks 47, 48 to be cut when they
15 are preassembled in pairs by means of angle brackets 52, before being cut to the required dimensions, the dimension of each of the wings 53, 54 of the brackets 52 in a direction orthogonal to the edge 92 is less than that of the insulating blocks 47, 48, so that each insulating block 47, 48 has a portion that is not covered by one of the angle brackets 52. Advantageously, plywood boards 102 are fixed onto the internal
20 plate 50 of each of the insulating blocks 47, 48, in the zone thereof that is not covered by one of the angle brackets 52. The thickness of the plywood boards 102 is such that the internal surface of each of the plywood boards 102 is flush with the internal surface of one of the wings 53, 54 of the angle brackets 52. Such an arrangement provides continuity with respect to supporting the primary sealing
25 membrane 7.

Figures 17 and 18 show a corner structure according to a sixth embodiment. In this embodiment, the dimension of each of the insulating blocks 147, 148 in a direction parallel to the edge 92 is identical to the equivalent dimension of a standard insulating panel 6 of the primary thermally insulating barrier
30 5. In the embodiment shown, the considered dimension of the insulating blocks is identical to the corresponding dimension of the insulating panels 29, 30. Furthermore, the insulating blocks 147, 148 are disposed in line with the rows of standard insulating panels 6. Thus, in the embodiment shown, the dimension of each of the insulating blocks 147, 148, taken parallel to the edge 92, is substantially

equivalent to three inter-corrugation distances. The insulating blocks 147, 148 have a composite structure and each comprise a polymer foam layer 162 sandwiched between two internal 150 and external 151 plywood boards, bonded to said polymer foam layer 162. The external plate 151 of each of the insulating blocks 147, 148 also
 5 comprises lateral edges that laterally project either side of the polymer foam layer 162 and of the internal plate 150.

A stud 104, anchored to one of the insulating panels 29, 30, is disposed in each intersection between a void separating two adjacent insulating blocks 147 or 148 and a void separating said two insulating blocks 147, 148 and said two adjacent
 10 standard insulating panels 6. Each of the studs 104 cooperates with a retention element 105 that comprises a bore, through which said stud passes 104, and comprises lugs that come into abutment against the corner zones of the external plates 151 of two adjacent insulating blocks 147, 148, on the one hand, and against the corner zones of two adjacent standard insulating panels 6, on the other hand.
 15 Thus, the number of studs 104 required to anchor the insulating blocks 147, 148 and the standard insulating panels 6 is limited.

As shown in figure 18, each of the insulating blocks 147, 148 in this case has relief slots 103 that extend from one end of the insulating block 147, 148 to the next in a direction orthogonal to the edge 92. Each of the corrugations of the primary
 20 sealing membrane 7, orthogonal to the edge 92, is disposed facing one of the relief slots 103 or facing the void arranged between two adjacent insulating blocks 147, 148. Each relief slot 103 fully passes through the thickness of the internal plate 150 and is also arranged in part of, or even in all of, the thickness of the polymer foam layer 162. By virtue of said relief slots 103, the corrugations of the primary sealing
 25 membrane 8 can deform without imposing significant mechanical constraints on the insulating blocks 147, 148.

Furthermore, the insulating blocks 47, 48 are assembled pairwise by means of a plurality of angle brackets 52 with an identical structure to that of figures 2, 3 and 5 to 8. Each gap that is arranged either between two relief slots 103 or
 30 between one of the relief slots 103 and a lateral edge of the insulating block 147, 148 receives the wing of one of the angle brackets 52.

As in the embodiment of figures 15 and 16, each insulating block 147, 148 has a portion that is not covered by one of the angle brackets 52 and plywood

boards 102 are fixed onto the internal plate 150 of each of the insulating blocks 147, 148, in the zone thereof that is not covered by one of the angle brackets 52, so as to provide continuity with respect to supporting the primary sealing membrane 7.

Figure 13 schematically shows the insulating panels 29, 30 of the secondary thermally insulating barrier 1 of the corner structure. According to this embodiment, the first faces 93 of the insulating panels 29, 30 that follow the edge 92 are not cut perpendicular to the internal and external faces of said insulating panels 29, 30. Indeed, the first faces 93 of the adjacent insulating panels 29, 30 are beveled so as to form a beveled portion 91 that is adjacent to the internal face 95 of said insulating panels 29, 30. Thus, the relative position of the insulating panels 29, 30 can be adjusted by limiting the losses of materials associated with cutting insulating panels 29, 30.

The dimensions $a1$ and $a2$ that respectively correspond to the lowest thickness of the first and the second insulating panels 29, 30, i.e. taken from an end of the beveled portion 91, in a direction orthogonal to the internal and external faces of said insulating panel 29, 30, as well as the angles $\alpha1$ and $\alpha2$ respectively formed by the beveled portion 91 of the first and second insulating panels 29, 30 relative to the internal face of said insulating panel 29, 30, can, for example, be determined by means of the following formulae:

$$\alpha1 = \alpha2 = 180 - 0.5 \beta; \text{ and}$$

$$a2 = x1 - L1 \text{ init} - i;$$

$$a1 = x2 - L2 \text{ init} - i;$$

with:

- β : being the angle in degrees formed between the support structures of the two walls 27, 28;
- $\alpha1$ and $\alpha2$ being in degrees;
- e : being the respective maximum thickness of the first panel 29 and the second panel 30;
- $x1$: being the measurement representing the space between the edge 92 and the insulating panel 2 adjacent to the destination location of the first insulating panel 29;

- x2: being the measurement representing the space between the edge 92 and the insulating panel 2 adjacent to the destination location of the second insulating panel 29;
- i: being the width setpoint of a void between one of the first and second insulating panels 29, 30 and the adjacent insulating panel 2; and
- L1 init, L2 init: being the initial respective dimension of the first and second insulating panel 29, 30 in a direction orthogonal to the first face of said insulating panels 29, 30.

With reference to figure 19, which is a cutaway view of an LNG tanker vessel 70, a sealed and insulated tank 71 is shown of generally prismatic shape mounted in the double hull 72 of the vessel. The wall of the tank 71 comprises a primary sealed barrier intended to be in contact with the LNG contained in the tank, a secondary sealed barrier arranged between the primary sealed barrier and the double hull 72 of the vessel and two insulating barriers respectively arranged between the primary sealed barrier and the secondary sealed barrier and between the secondary sealed barrier and the double hull 72.

In a manner per se known, loading/offloading pipes 73 disposed on the upper bridge of the vessel can be connected, by means of suitable connectors, to a maritime or harbor terminal for transferring an LNG cargo from or to the tank 71.

Figure 19 also shows an example of a maritime terminal comprising a loading and offloading station 75, a submarine pipeline 76 and a ground installation 77. The loading and offloading station 75 is a fixed offshore installation comprising a movable arm 74 and a tower 78, which supports the movable arm 74. The movable arm 74 supports a bundle of insulated flexible tubes 79 that can be connected to the loading/offloading pipes 73. The orientable movable arm 74 adapts to all types of LNG tanker vessel gauges. A connecting pipeline, not shown, extends inside the tower 78. The loading and offloading station 75 allows the LNG tanker vessel 70 to be loaded and offloaded from or to the ground installation 77. This installation comprises liquefied gas storage tanks 80 and connecting pipelines 81 connected by the submarine pipeline 76 to the loading and offloading station 75. The submarine pipeline 76 allows the liquefied gas to be transferred between the loading or offloading station 75 and the ground installation 77 over a significant distance, for example, 5 km, which allows the LNG tanker vessel 70 to be maintained a

significant distance away from the coast during the loading and offloading operations.

In order to generate the pressure required to transfer the liquefied gas, pumps on board the vessel 70 and/or pumps provided on the ground installation 77
5 and/or pumps provided on the loading and offloading station 75 are implemented.

Even though the invention has been described with reference to several particular embodiments, it is clear that it is by no means limited thereto and that it comprises all the technical equivalents of the means described, as well as their combinations, if they fall within the scope of the invention.

10 The use of the verbs "comprise" or "include" and their conjugated forms does not exclude the presence of elements or steps other than those described in a claim.

In the claims, any reference sign between brackets must not be interpreted as being a limitation of the claim.

15

CLAIMS

1. A method for assembling a corner structure intended to be disposed at an intersection between a first wall (27) and a second wall (28) of a sealed and thermally insulating tank, the first and the second walls (27, 28) each comprising, in a direction of thickness from the outside to the inside of the tank, a support structure (3), a secondary thermally insulating barrier (1) held on the respective support structure (3), a secondary sealing membrane (4), a primary thermally insulating barrier (5) and a primary sealing membrane (7) intended to be in contact with the fluid contained in the tank, the support structure (3) of the first and the second walls (27, 28) meeting at an edge (92),
the assembly method comprising:
 - providing a first and a second insulating panel (29, 30) of rectangular parallelepipedal shape and each having a first face (93) intended to be disposed parallel to the edge (92) and intended to follow said edge (92), a second face (94) opposite said first face (93) and an internal face (95) joining the first face (93) to the second face (94), the first and the second insulating panels (29, 30) being intended to be placed in a respective destination location, the first and the second insulating panels (29, 30) respectively being intended to be disposed against the support structure (3) of the first and the second walls (27, 28), so as to form a corner between the secondary thermally insulating barriers (1) of the first and the second walls (27, 28);
 - providing a first and a second insulating block (47, 48, 147, 148), the first insulating block (47, 147) being capable of being fixed onto the internal face (95) of the first insulating panel (29) by means for anchoring the first insulating block on the first insulating panel, the second insulating block (48, 148) being capable of being fixed onto the internal face of the second insulating panel (30) by means for anchoring the second insulating block on the second insulating panel, the means for anchoring the first insulating block (47, 147) on the internal face of the first insulating panel (29) being adjustable-positioning anchoring means;
 - determining a first setpoint for a dimension of said first insulating panel (29) in a direction orthogonal to the first face (94) of said first insulating panel (29), as a function of a first in situ dimensional measurement of the support structure (3) of the first wall (27) in a direction orthogonal to the edge (92), the first dimensional measurement representing the space between the edge (92) and an insulating

element (2) of the secondary thermally insulating barrier (1) of the first wall (27) that is adjacent to the destination location of said first insulating panel (29);

- cutting the first insulating panel (29) along the first face (93) of the first insulating panel (29) in a cutting plane parallel to a straight line formed at the intersection between the first face (93) and the internal face (95) of the first insulating panel (29) by adjusting, to the first setpoint, the dimension of said first insulating panel (29) in the direction orthogonal to the first face (93), so as to adjust the position of the corner between the secondary thermally insulating barriers (1) of the first and the second walls (27, 28) relative to the second face (94) of the first insulating panel (29);
- fixing the first and the second insulating panels (29, 30) respectively against the support structure (3) of the first and the second walls (27, 28) in their respective destination location, so as to form the corner between the secondary thermally insulating barriers (1) of the first and the second walls (27, 28), the first face (93) of each of the first and the second insulating panels (29, 30) being disposed parallel to the edge (92), along said edge;
- fixing the first and the second insulating blocks (47, 48, 147, 148) respectively on the first and the second insulating panels (29, 30) by adjusting the relative position of the first insulating block (47, 147) on the first insulating panel (29) by means of said adjustable-positioning anchoring means, so as to form a corner between the primary thermally insulating barriers (5) of the first and of the second walls (27, 28), said adjustable-positioning anchoring means enabling a plurality of positions for said first insulating block (47, 147) on the first insulating panel (29), the positions being spaced apart from each other in a direction orthogonal to the edge (92) and parallel to the support structure of the first wall (27).

2. The assembly method as claimed in claim 1, wherein the means for anchoring the second insulating block on the second insulating panel are adjustable-positioning anchoring means, wherein a second setpoint is determined for a dimension of said second insulating panel (30) in a direction orthogonal to the first face (93) of said second insulating panel (30), as a function of a second in situ dimensional measurement of the support structure (3) of the second wall (28) in a direction orthogonal to the edge (92), the second dimensional measurement representing the space between the edge (92) and an insulating element (2) of the secondary thermally insulating barrier

(1) of the second wall (28) that is adjacent to the destination location of said second insulating panel (30), wherein the second insulating panel (30) is cut along the first face (93) of the second insulating panel (30) in a cutting plane parallel to a straight line formed at the intersection between the first face (93) and the internal face (95) of the second insulating panel (30) by adjusting, to the second setpoint, the dimension of said second insulating panel (30) in the direction orthogonal to the first face (93), so as to adjust the position of the corner between the secondary thermally insulating barriers (1) of the first and of the second walls (27, 28) relative to the second face (94) of the second insulating panel (30), and wherein the second insulating block (48, 148) is fixed onto the second insulating panel (30) by adjusting the relative position of the second insulating block (48, 148) on the second insulating panel (30) by means of the adjustable-positioning anchoring means of the second insulating block on the second insulating panel, said adjustable-positioning anchoring means enabling a plurality of positions for said second insulating block (48, 148) on the second insulating panel (30), the positions being spaced apart from each other in a direction orthogonal to the edge (92) and parallel to the support structure of the second wall.

3. The assembly method as claimed in claim 2, wherein the first and the second insulating walls (29, 30) are each beveled so that the first face (94) of each of the first and second insulating panels (29, 30) comprises a beveled portion (91) that is adjacent to the internal face (95) of said insulating panel (29, 30), the method comprising bringing the beveled portions (91) of the first and the second insulating panels (29, 30) into contact with each other.

4. The assembly method as claimed in claim 1, wherein the first insulating panel (29) is cut along the first face (94) of the first insulating panel (29) perpendicular to the internal face (95) of said first insulating panel (29).

5. The assembly method as claimed in any of claims 1 to 4, wherein an insulating corner element (31) is fixed against the edge (92), in a space intended to be arranged between the first face (93) of the first insulating panel (29) and the first face (93) of the second insulating panel (30).

6. The assembly method as claimed in any of claims 1 to 5, wherein the first and the second insulating blocks (47, 48, 147, 148) have a rectangular parallelepipedal shape and each have a first face (96) and a second face (97)

opposite said first face (96), wherein a third setpoint is determined for a dimension of said first insulating block (47, 147) in a direction orthogonal to the first face (96) of said first insulating block (47, 147), as a function of the first dimensional measurement,

5 wherein the first insulating block (47, 147) is cut along the second face (97) of the first insulating block (47, 147) by adjusting, to the third setpoint, the dimension of said first insulating block (47, 147) in a direction orthogonal to the first face (96) of said first insulating block (47, 147); and

10 wherein the first and the second insulating blocks (47, 48, 147, 148) are respectively disposed on the first and the second insulating panels (29, 30) such that the first face (96) of the first and the second insulating blocks (47, 48, 147, 148) is respectively facing the internal face of the second and the first insulating panels (29, 30).

7. The assembly method as claimed in claim 6, wherein the first
15 insulating block (47, 147) comprises an internal plate (50), an external plate (51) and a polymer foam layer (62) sandwiched between the internal plate (50) and the external plate (51), the polymer layer (62) having two portions (62a, 62b) that are formed by two distinct polymer materials and are juxtaposed one after the other in a direction orthogonal to the first face (96) of said first insulating block (47, 147).

20 8. The assembly method as claimed in either claim 6 or claim 7 in combination with claim 2, wherein a fourth setpoint is determined for a dimension of said second insulating block (48, 148) in a direction orthogonal to the first face (96) of said second insulating block (48, 148), as a function of the second dimensional measurement, and

25 wherein the first insulating block (48, 148) is cut along the second face (97) of the first insulating block (48, 148) by adjusting, to the fourth setpoint, the dimension of said second insulating block (48, 148) in a direction orthogonal to the first face (96) of said second insulating block (48, 148).

9. The assembly method as claimed in any of claims 6 to 8, wherein
30 the first insulating block (47, 147) and the second insulating block (48, 148) are supplied in a preassembled state by means of a metal angle bracket (52), said angle bracket (52) being fixed onto an internal face of the first and the second insulating blocks (47, 48, 147, 148) and being intended to form a corner between the primary sealing membranes (7) of the first and the second walls (27, 28).

10. The assembly method as claimed in any of claims 1 to 9, wherein the first insulating block (47, 147) comprises an internal plate (50, 150), an external plate (51, 151) and a polymer foam layer (62, 162) sandwiched between the internal plate (50, 150) and the external plate (51, 151), the internal plate (50, 150) of the first insulating block (47, 147) having a lateral edge that laterally projects from the polymer layer (62, 162), the adjustable-positioning anchoring means for adjusting the first insulating block (47, 147) on the first insulating panel (29) comprising a stud (49, 104) provided with a threaded end that is anchored on the first insulating panel (29), a nut (57) that is screwed onto the threaded end of the stud (49, 104) and a retention element (56, 59, 61, 105) that is pressed against the lateral edge of the internal plate (50) by the nut (57).

11. The assembly method as claimed in any of claims 1 to 10, wherein the dimension of the first and the second insulating blocks (147, 148) in an orientation parallel to the edge (92) is identical to a dimension of the first and second insulating panels (29, 30) in an orientation parallel to the edge (92).

12. The assembly method as claimed in claim 10 or claim 11 in combination with claim 10, wherein the first insulating block (147) has a rectangular parallelepipedal shape and has a first face (96) disposed facing an internal face of the second insulating panel (30) and a second face (97) opposite said first face (96), the stud (104) being disposed in the vicinity of the second face of the first insulating block (147) and the retention element also being capable of being pressed against a lateral edge of an internal plate of an insulating panel (6) of the primary thermally insulating barrier (5) of the first wall (27) that is adjacent to said first insulating block (147).

13. The assembly method as claimed in any of claims 1 to 9, wherein the first insulating block (47, 147) comprises an internal plate (50), an external plate (51) and a polymer foam layer (62) sandwiched between the internal plate (50) and the external plate (51), the internal plate (50) of the first insulating block (47, 147) having a lateral edge that laterally projects from the polymer layer (62) and that has an oblong orifice (60) extending in a direction orthogonal to the edge (92), the adjustable-positioning anchoring means for adjusting the first insulating block (47, 147) on the first insulating panel (29) comprising a stud (49), which is provided with a threaded end, is anchored on the first insulating panel (29) and which passes

through the oblong orifice (60) and a nut (57) screwed onto the threaded end of the stud (49).

14. The assembly method as claimed in any of claims 1 to 9, wherein the corner structure further comprises a first anchoring strip (63) that extends over an internal face of the first insulating block (47, 147), parallel to the edge (92), and has two lugs (65) that laterally project either side of the first insulating block (47, 147) toward the support structure (3) of the first wall (27), each of the lugs (65) having an anchoring portion (66) that is connected to the second insulating panel (30) by an anchoring rod (64), each anchoring rod (64) comprising an internal end that is connected to the second insulating panel (30) by means of a first spherical joint, an external end that is connected to one of the anchoring portions (66) by means of a second spherical joint and means for adjusting the length of each anchoring rod (64) between the first and the second spherical joints.

15. The assembly method as claimed in claim 14, wherein the corner structure further comprises a second anchoring strip (63) that extends over an internal face of the second insulating block (48, 148), parallel to the edge (92), and has two lugs (65) that laterally project either side of the second insulating block (48, 148) toward the support structure (3) of the second wall (28), each of the lugs (65) having an anchoring portion (66) that is connected to the first insulating panel (29) by an anchoring rod (64), each anchoring rod (64) comprising an internal end that is connected to the first insulating panel (29) by means of a first spherical joint, an external end that is connected to one of the anchoring portions (66) by means of a second spherical joint and means for adjusting the length of each anchoring rod (64) between the first and the second spherical joints.

16. The assembly method as claimed in claim 15, wherein the corner structure further comprises a metal corner piece (88) comprising two wings that are respectively welded onto the first and the second anchoring strips (63), so as to form a corner between the primary sealing membranes (7) of the first and the second wall (27, 28).