

DESCRIPTION**Title: Liquefied natural gas tank aboard a ship**

The present invention relates to the domain of liquefied natural gas tanks used in sea transport.

Liquefied natural gas is transported by sea in sealed and thermally insulated storage tanks carried
5 on transport ships. The natural gas is kept in a liquid state to increase the quantity of natural gas that can be carried in the tank, since the volume of a liter of natural gas in a liquid state is considerably less than the volume of a liter of natural gas in a gas state. These tanks keep the liquefied natural gas at a very low temperature, more specifically at a temperature of less than - 163°C, at which temperature the natural gas is in a liquid state at atmospheric pressure.

10 Such liquefied natural gas tanks can also be used as fuel tanks in certain ships. In other words, the ships load and store liquefied natural gas in tanks, before using the liquefied natural gas as fuel.

The liquefied natural gas tanks are usually parallelepipedic and the walls thereof are carried by the inner hull of the ship in which the tank or tanks are installed. More specifically, the hull of
15 the ships on which the tanks are installed have an outer hull in contact with the environment outside the ship, and an inner hull used as a load-bearing structure for the tanks. Stiffening members are arranged between the outer hull and the inner hull to support the inner hull, as well as the walls of the tank or tanks.

Once loaded into the tank, the liquefied natural gas exerts pressure on the walls of the tank. The
20 aforementioned stiffening members enable the walls to withstand this pressure. The joining zones of the walls of the tank, in other words the corners of the parallelepipedic shape of said tank, are particularly susceptible to being weakened by this pressure and the seal of the tank in these joining zones of the walls should be guaranteed to prevent contamination of the tank wall by the liquefied natural gas, or even in some cases a leak from the storage tank resulting in a loss
25 of the stored liquefied natural gas.

In this context, the present invention first relates to a sealed and thermally insulating tank that is designed to rest on a load-bearing structure of a ship, the sealed tank comprising a plurality of tank walls, including a first tank wall and at least one second tank wall, the first tank wall extending primarily in a first plane and the second tank wall extending primarily in a second

plane, the first plane and the second plane being perpendicular in relation to one another, the first tank wall and the second tank wall being linked by an angular joining part, characterized in that the angular joining part has a first portion extending primarily in a plane parallel to the first plane, a second portion extending primarily in a plane parallel to the second plane, and at least one intermediate portion extending primarily in a plane intersecting the first plane and the second plane, the thickness of the first portion of the angular joining part being equal to the thickness of the first tank wall and being arranged to extend this first tank wall, and the thickness of the second portion of the angular joining part being equal to the thickness of the second tank wall and being arranged to extend this second tank wall.

- 10 The tank is designed to receive the liquefied natural gas, and the natural gas must be at a temperature no greater than -160°C to be kept in a liquid state at atmospheric pressure. The tank therefore comprises a succession of layers firstly to ensure that the liquefied natural gas is kept at a temperature no greater than -160°C and secondly to provide an optimum seal to reduce the risk of the liquefied natural gas leaking. This tank can notably be used to store
- 15 liquefied natural gas while sailing or when docked before unloading, for example, or to power the machines of the ship on which the tank is carried. Such a temperature of the liquefied natural gas can be increased if the liquefied natural gas is kept in the tank at a pressure above atmospheric pressure. By way of example, the tank may be used at a pressure of 1 bar gauge, in which case the natural gas can be kept in a liquid state at a maximum temperature of -152°C .
- 20 The tank is supported by the inner hull of the ship, which forms the load-bearing structure, since this tank with a membrane is not a self-supporting structure. The inner hull is designed to receive the tank and to withstand the pressure exerted by the liquefied natural gas stored in the tank on the walls of the tank.

The tank has at least two walls, and the two walls are perpendicular to one another. The stored liquefied natural gas exerts a pressure on each of these walls and the structure of the tank with the joining part according to the invention enables the pressure exerted on the joining zone between the two walls to be managed in order to limit the risk of liquefied natural gas leaking from this joining zone.

The joining part is noteworthy in that it comprises three portions, two of which (referred to herein as the first portion and the second portion) are arranged respectively in a plane parallel to the plane containing one of the tank side walls, and a third portion (referred to as the

intermediate portion) that is inclined in relation to each of the other portions. This third portion forms an intermediate portion that is arranged between the two other portions and is designed to distribute the pressures exerted by the liquefied natural gas towards each of the tank side walls. As specified, the thickness of the angular joining part and/or the angular joining element is similar or substantially similar, to within manufacturing tolerances, to the thickness of the first tank wall and/or to the thickness of the second tank wall such that the angular joining part provides structural continuity of the tank at a corner of the tank, providing a structural link between two perpendicular side walls that principally form the tank but that are not continuous with one another.

- 10 According to another optional feature of the invention, the sealed tank has at least one third tank wall extending primarily in a third plane perpendicular to the first plane, the second plane and the intersecting plane, and has a joining zone with the first tank wall and the second tank wall, in which the joining zone has an angular joining element, the angular joining element having a first portion and a second portion, the first portion having a first section extending
- 15 primarily in the first plane, a second section extending primarily in the second plane, and an intermediate section extending primarily in the intersecting plane, the second portion having a return wall that is perpendicular to the first portion and extends primarily in the third plane.

The third tank wall extends in a plane perpendicular to the plane containing the first tank wall, the plane containing the second tank wall, and the plane containing the first portion, the second

20 portion and the intermediate portion of the joining part.

The joining element thus provides the link between the third tank wall and the first tank wall, the second tank wall and the joining part, on account of a first portion lying in the planes extending the first tank wall, the second tank wall, and the angular joining part, and on account of a second portion lying in the plane containing the third tank wall.

- 25 The angular joining element also distributes the pressure exerted by the liquefied natural gas on the inner face of the tank at the linking zone of the first tank wall, the second tank wall and the third tank wall.

According to an optional feature of the invention, the angular joining part and/or the angular joining element each have an inner face and an outer face, the inner face forming an internal

30 chamfer at the intermediate portion or at the intermediate section and the outer face forming an external chamfer at the intermediate portion or at the intermediate section, the internal and

external chamfers being inclined at an angle of between 120° and 150° in relation to the first plane and to the second plane.

The third portion, i.e. the intermediate portion, of the joining part between the first tank wall and the second tank wall is advantageously inclined at an angle of 135°, plus or minus 15°, in relation to each of the planes extending the first portion and the second portion of the joining part, referred to respectively as the first portion and the second portion, such that the pressure exerted by the liquefied natural gas is equally well distributed on one or other of the side walls linked by the joining part.

Like the angular joining part, the third portion of the joining part between the first tank wall and the second tank wall is inclined at 135°, plus or minus 15°, in relation to each of the planes extending the first portion and the second portion of the joining part.

According to another optional feature of the invention, the dimension of the intermediate portion of the angular joining part measured between the first portion and the second portion of said part, and/or the dimension of the intermediate section of the angular joining element measured between the first section and the second section of said element, increases from the inner face towards the outer face.

Consequently, the inner surface, and more specifically the internal chamfer as mentioned above, is narrower than the outer surface, and more specifically the external chamfer, the width being the dimension perpendicular to the longitudinal direction in which the joining part principally extends.

According to another optional feature of the invention, the angular joining part and/or the angular joining element comprise, successively in the thickness direction from the outside towards the inside of the sealed tank, a secondary thermally insulating barrier that is designed to be in contact with the load-bearing structure, a secondary sealing membrane carried by the secondary thermally insulating barrier, a primary thermally insulating barrier resting on the secondary sealing membrane and a primary sealing membrane carried by the primary thermally insulating barrier that is designed to be in contact with the fluid contained in the sealed tank.

The tank walls and the joining parts of the liquefied natural gas storage tank comprise at least one secondary space and one primary space, the secondary space of the tank wall resting on the inner hull of the ship by means of mastic beads. The secondary space comprises a secondary

thermal insulation barrier and a secondary sealing membrane, successively from the outer face towards the inner face of the tank. The primary space comprises a primary thermal insulation barrier and a primary sealing membrane, successively from the outer face of the tank towards the inner face of the tank.

- 5 According to another optional feature of the invention, the secondary space of a joining part, comprising at least one secondary thermal insulation barrier and one secondary sealing membrane, is arranged to extend the secondary space of the tank wall extended by the joining part, these two secondary spaces having the same composition. Similarly, the primary space of a joining part, comprising at least one primary thermal insulation barrier and one primary sealing
10 membrane, is arranged to extend the primary space of the tank wall extended by the joining part, these two primary spaces having the same composition.

The thermally insulating barriers help to maintain the temperature of the liquefied natural gas stored in the storage tank by limiting the thermal exchanges between the environment outside the storage tank and the inside of the storage tank. The sealing membranes prevent all leakages
15 of liquefied natural gas.

According to another optional feature of the invention, the secondary thermally insulating barrier and the secondary sealing membrane of the angular joining part and/or the angular joining element each have, in a given direction, a dimension that is larger than the corresponding dimension, in the same direction, of the primary thermally insulating barrier and
20 of the primary sealing membrane.

The first portion of the angular joining part lies primarily in the first plane of the intermediate portion in a vertical direction. The dimension of the secondary space measured in the vertical direction is greater than the dimension of the primary space also measured in the vertical direction in the first portion. This applies similarly to the first section of the angular joining
25 element.

The second portion of the angular joining part lies primarily in the second plane of the intermediate portion in a transverse direction. The dimension of the secondary space measured in the transverse direction is greater than the dimension of the primary space also measured in the transverse direction in the second portion. This applies similarly to the second section of
30 the angular joining element.

The first portion, the second portion and the intermediate portion of the angular joining part extend in a longitudinal direction common to all three portions. The dimension of the secondary space measured in the longitudinal direction is greater than the dimension of the space also measured in the longitudinal direction in each of the portions of the angular joining part. This applies similarly to each of the sections of the angular joining element.

The secondary space is uncovered at the ends of the joining parts, leaving the secondary sealing membrane free. During assembly of the tank, a primary space panel is then positioned to simultaneously overlap the first portion of the joining part and the first tank wall, the panel rigidly connecting the joining element to said first tank wall. The same assembly is used between the second portion of the joining part and the second tank wall, as well as in the first section, the second section and the return wall of the angular joining element.

The return wall lies in a plane perpendicular to the first plane, to the second plane and to the intersecting plane, and parallel to the vertical and transverse directions. The dimension of the secondary space measured in the vertical direction is greater than the dimension of the primary space also measured in the vertical direction in the return wall. Furthermore, the dimension of the secondary space measured in the transverse direction is greater than the dimension of the primary space also measured in the transverse direction in the return wall.

According to another optional feature of the invention, a dimension of the first portion and/or of the second portion of the angular joining part is equal to the dimension of the intermediate portion.

The invention also relates to a ship including at least one sealed tank as described above.

According to an optional feature of the invention, the ship has an outer hull and a load-bearing structure, the load-bearing structure being designed to receive the sealed tank, the load-bearing structure having a first load-bearing wall extending primarily along the first plane and a second load-bearing wall extending primarily along the second plane, the first load-bearing wall and the second load-bearing wall being substantially perpendicular, characterized in that a clearance zone is provided between the load-bearing walls of the load-bearing structure in the joining zone and the intermediate portion of the angular joining part and in that the reinforcement element is seated in said clearance zone.

This reinforcement element provides a bearing face for the angular joining part that is substantially perpendicular to the direction of the pressure exerted by the liquefied natural gas present in the tank at the joining zone of the tank walls.

5 According to another optional feature of the invention, the reinforcement element has a triangular section, and the angle of the apex of the reinforcement element is equal to the right angle formed between the first load-bearing wall and the second load-bearing wall, the reinforcement element having a contact face with the intermediate portion opposite said apex.

10 The contact face of this reinforcement element can be flat and form a square such that following contact between the reinforcement element and the intermediate portion of the angular joining part, the stresses are evenly distributed over the entire contact face forming the bearing face. Alternatively, this contact face could have a faceted profile, being formed by a plurality of flat surfaces that are inclined in relation to one another such as to form a profile curving towards the inside of the reinforcement element. Alternatively, and notably to facilitate the construction of the reinforcement element arranged at the join of the load-bearing walls of
15 the load-bearing structure, this contact face can have a curved profile with a generally concave shape of the reinforcement element. With reference to a curved face, the reinforcing members and/or the filler material may be arranged in the space thus formed between the contact face and the intermediate portion of the angular joining part.

20 According to another optional feature of the invention, the outer hull has a plurality of stiffening members in contact with the load-bearing structure and the concentration of stiffening members is lesser in the vicinity of the angular joining part and/or in the vicinity of the angular joining element.

In other words, the distance between two neighboring stiffening members of a plurality of stiffening members arranged between the outer hull and the load-bearing structure varies as a
25 function of proximity to the angular joining part, this distance being greater closer to the angular joining part.

30 These stiffening members help to transmit the pressure exerted by the liquefied natural gas in the tank to the outer hull of the ship. The presence of the angular joining part and/or of the angular joining element helps to better distribute the pressure exerted by the liquefied natural gas towards the tank walls, thereby reducing the need for stiffening members in these joining zones.

According to another optional feature of the invention, a dimension of the intermediate portion of the angular joining part is determined as a function of the position of the stiffening member closest to a corner of the internal load-bearing structure in which the angular joining part is positioned, such that

5
$$D60 = \frac{2}{2 + \sqrt{2}} * d$$

in which D60 is the dimension of the intermediate portion and d is the distance between the first stiffening member and the corner of the internal load-bearing structure.

The aforementioned dimension of the intermediate portion is the length of the outer face of this intermediate portion between a first linked edge forming a join between the intermediate
10 portion and the first portion and a second linked edge forming a join between the intermediate portion and the second portion.

Other features, details and advantages of the invention are set out more clearly in the description below as well as in several example embodiments provided by way of non-limiting examples with reference to the schematic drawings attached, in which:

15 [Figure 1] is a side view of a transport ship showing at least one liquefied natural gas tank,

[Figure 2] is a cross section of the schematic view of a tank including at least one angular joining part arranged between the different tank side walls and a hull including an outer hull, stiffening members and an internal load-bearing structure containing the tank,

[Figure 3] is a view of the inside of a plurality of joining parts,

20 [Figure 4] is a cross section of a tank, the internal load-bearing structure and the outer hull at the link between two tank side walls,

[Figure 5] is a view from inside the tank of an angular joining element and a first transverse tank wall,

25 [Figure 6] is a view from inside the tank of at least one angular joining part and at least one angular joining element,

[Figure 7] is a cross section of a specific embodiment of the tank, the internal load-bearing structure, the stiffening members and the outer hull, in a view similar to the view in figure 4,

[Figure 8] shows a variant of the embodiment in figure 7.

The features, variants and different embodiments of the invention may be associated with one another in different combinations, where not incompatible with one another or mutually exclusive. Notably, variants of the invention that only include a selection of the features described below separately from other described features are also possible, where this selection of features is sufficient to provide a technical advantage and/or to differentiate the invention from the prior art.

Figure 1 shows a transport ship 200, for example a liquefied natural gas carrier, that has four tanks 26 for transporting or storing liquefied natural gas, in which one of these tanks is visible to facilitate comprehension. The transport ship 200 may be designed to store and transport this liquefied natural gas only, or to use the liquefied natural gas as fuel to operate the ship.

As shown in particular in figure 2, such a ship has a hull 2 including at least one outer hull 4 and an internal load-bearing structure 6, between which a plurality of stiffening members 8, 10 are arranged. The outer hull 4 is in contact with the environment outside the ship, usually a marine and/or river environment. The internal load-bearing structure 6 extends away from this outer hull. The dimension of the stiffening members determines the gap between the outer hull 4 and the internal load-bearing structure 6, each stiffening member being rigidly connected to the outer hull 4 at a first extremity 12 and in contact with the internal load-bearing structure 6 at a second extremity 14. Stiffening members are advantageously provided over the entire internal load-bearing structure 6.

The internal load-bearing structure 6 has a plurality of load-bearing walls, including a first load-bearing side wall 18 and at least one second load-bearing side wall 20 that lie in perpendicular planes. The first load-bearing side wall 18 has a first longitudinal side 21 and the second load-bearing side wall 20 has a second longitudinal side 23 where the second load-bearing side wall 20 is adjacent to the first load-bearing side wall 18.

In other words, the first load-bearing side wall 18 and the second load-bearing side wall 20 are perpendicular to one another at a joining zone 24 between the first longitudinal side 21 of the

first load-bearing side wall 18 and the second longitudinal side 23 of the second load-bearing side wall 20.

The internal load-bearing structure 6 contains at least one sealed and thermally insulating tank 26, said tank 26 being designed to contain liquefied natural gas. The sealed and thermally
5 insulating tank 26 has an inner face 27 that is in contact with the liquefied natural gas when the gas is stored in the sealed and thermally insulating tank, and an outer face 29 resting against the plurality of load-bearing walls, and notably the first or second load-bearing side wall 18, 20 of the internal load-bearing structure 6.

The sealed and thermally insulating tank 26 is advantageously a rectangular parallelepiped. The
10 sealed and thermally insulating tank 26 therefore has a plurality of tank walls, including a first tank side wall 30 and at least one second tank side wall 32.

Each of the tank side walls 30, 32 rests against a corresponding load-bearing side wall 18, 20. More specifically in the example illustrated, the outer face 29 of the first tank side wall 30 rests on the first load-bearing side wall 18 of the internal load-bearing structure 6 and the outer face
15 of the second tank side wall 32 rests against the second load-bearing side wall 20 of the internal load-bearing structure 6.

As a result of the foregoing, the second tank side wall 32 and the first tank side wall 30 lie in planes perpendicular to one another.

According to the invention, the first tank side wall 30 and the second tank side wall 32 are
20 linked to one another by being rigidly connected to at least one angular joining part 34 according to the invention that is arranged in the aforementioned joining zone 24.

As shown in particular in figures 2, 4, 7 and 8, the angular joining part 34 extends each of the tank side walls and is of a thickness similar or substantially similar (to within manufacturing tolerances) to the thickness of the first tank side wall 30 and/or the second tank side wall 32. In
25 other words, the angular joining part provides structural continuity to the tank by making a link between two perpendicular side walls that principally form the tank, but that are not continuous with one another.

The thickness of either one of the tank side walls 30, 32 is in this case measured in a direction perpendicular to the plane in which the tank side wall 30, 32 in question mainly lies, between
30 the inner face 27 and the outer face 29. Thus, in the example illustrated, the thickness of the

first tank side wall 30 is measured in a direction parallel to the transverse axis B and the thickness of the second tank side wall 32 is measured along the vertical axis C.

More specifically, a first portion of the angular joining part is arranged to extend the first tank side wall 30, said first portion and said first tank side wall having similar or substantially similar thickness values measured respectively along the axes parallel to one another, in this case parallel to the transverse axis B. Similarly, a second portion of the angular joining part is arranged to extend the second tank side wall 32, said second portion and said second tank side wall having similar or substantially similar thickness values measured respectively along the axes parallel to one another, in this case parallel to the vertical axis C.

Advantageously, the angular joining part 34 has a first thickness similar to the thickness of the first tank side wall 30 at least at a contact zone between the angular joining part 34 and the first tank side wall 30, and a second thickness similar to the thickness of the second tank side wall 32 at least at a contact zone between the angular joining part 34 and the second tank side wall 32.

The structure of this angular joining part 34 is described below in greater detail, with particular reference to figures 3 and 4. Depending on the structure of the tank walls 30, 32 linked by the angular joining part 34, said part comprises, successively from the outer face to the inner face, a secondary thermal insulation barrier 36, a secondary sealing membrane 38, a primary thermal insulation barrier 40 and a primary sealing membrane 42. The secondary thermal insulation barrier 36 and the secondary sealing membrane 38 form a secondary space 37 and the primary thermal insulation barrier 40 and the primary sealing membrane 42 form a primary space 41.

In accordance with the foregoing and as described in greater detail below, firstly the primary space, formed by the primary thermal insulation barrier 40 and the primary sealing membrane 42, of the angular joining part extends both an identical primary space of the first tank side wall 30 and an identical primary space of the second tank side wall 32, and secondly the secondary space, formed by the secondary thermal insulation barrier 36 and the secondary sealing membrane 38, of the angular joining part extends both an identical secondary space of the first tank side wall 30 and an identical secondary space of the second tank side wall 32.

The secondary thermal insulation barrier 36 comprises, successively from the outer face of the tank towards the secondary sealing membrane 38, a first insulating wall 44 and a first thermal insulation layer 46. The first insulating wall 44 is a board having a substantially rectangular parallelepipedic shape. The board is advantageously made of plywood, for example wooden

plywood. The dimensions of the board are adapted to the size of the blocks of the secondary thermal insulation barrier 36.

5 The first thermal insulation layer 46 can be made of a cellular plastic material, such as a polyurethane foam for example, providing effective, well distributed thermal insulation between the insulating walls.

Furthermore, the angular joining part 34 includes a second insulating wall 51 overlapping the first thermal insulation layer 46, between said first layer and the secondary sealing membrane 38. This second insulating wall 51, which is also formed by a board advantageously made of plywood, for example wooden plywood, is specifically arranged in the angular joining part,
10 without necessarily being provided for in the composition of the tank walls. This second insulating wall 51 is notably provided to better withstand the pressure generated on the wall joins by the natural gas in the tank.

The secondary thermal insulation barrier 36, and more specifically the second insulating wall 51, is rigidly connected to the secondary sealing membrane 38, for example by gluing.

15 The secondary sealing membrane 38 includes a flexible secondary sealing membrane 48 and a rigid secondary sealing membrane 49.

More specifically, there is a rigid secondary sealing membrane 49 for each portion 56, 58, 60 of the angular joining part 34 and a flexible secondary sealing membrane 48 that is common to all of the portions, at least partially covering each of the rigid secondary sealing membranes 49
20 covering the flat surfaces of the secondary thermally insulating barrier 36. The secondary thermally insulating barrier of each portion of the angular joining part 34 is covered by the rigid secondary sealing membrane 49, but the intersections between each of the portions remain uncovered. The flexible secondary sealing membrane 48 is positioned to cover the intersections between each of the portions 56, 58, 60 of the angular joining part 34 and between each rigid
25 secondary sealing membrane 49 covering said portions 56, 58, 60, reducing the risk of contamination in these risk zones. The flexible secondary sealing membrane 48 is a triplex strip comprising an aluminum sheet glued between two braided glass mats. These components of the triplex strip are not shown in all of the figures. The flexible secondary sealing membrane 48 is in contact with and glued to both the rigid secondary sealing membrane 49, and the primary
30 thermal insulation barrier 40.

The rigid secondary sealing membrane 49 comprises an aluminum sheet glued between two braided glass mats soaked in a polymer resin.

The primary thermal insulation barrier 40 includes a second thermal insulation layer 52 and a third insulating wall 54, and the composition and function of each of these layers is as described
5 above.

During assembly of the sealed and thermally insulating tank 26, the angular joining part 34 and the plurality of tank walls are mounted using assembly panels arranged beside one another, with each one including the different elements making up the angular joining part 34 and the plurality of tank walls. These assembly panels can be covered by the primary sealing membrane
10 42, which may be made of stainless steel and be corrugated. The primary sealing membrane 42 may alternatively be made of Invar® sheet.

Each of the tank side walls 30, 32 lies in a main extension plane, these extension planes being perpendicular to one another, and the angular joining part 34 extends in three different planes, the angular joining part 34 having at least three different portions extending respectively in one
15 of these three different planes.

According to the first embodiment, the angular joining part 34 has a first portion 56, a second portion 58, and at least one intermediate portion 60. The number of intermediate portions is not limiting, and the invention should be understood to include an angular joining part 34 having for example four portions, with two intermediate portions linking the first portion 56 to
20 the second portion 58.

As shown, the first portion 56 extends the intermediate portion 60 in a vertical direction that is substantially parallel to the vertical axis C, and the second portion 58 extends the intermediate portion in a perpendicular transverse direction that is substantially parallel to a transverse axis B.

The first portion 56 and the second portion 58 each have primary and secondary spaces 41, 37
25 that do not extend in the same dimension, in a given direction, from the intermediate portion. As shown in figure 3, the dimension of the primary space 41 of the first portion 56 measured in the vertical direction is shorter than the dimension of the secondary space 37 of this first portion 56 also measured in the vertical direction, such that the primary space 41 does not entirely cover the secondary space 37. Similarly, the dimension of the primary space 41 of the
30 second portion 58 measured in the transverse direction is shorter than the dimension of the

secondary space 37 of this second portion 58 also measured in the transverse direction, such that the primary space 41 also does not entirely cover the secondary space 37 in this case.

The first portion 56 of the angular joining part 34 extends primarily in the main extension plane of the first tank side wall 30 to extend this first tank side wall. The first portion 56 has a first
5 free edge 62 and a second free edge 64, these two free edges extending opposite the intermediate portion 60 and being differentiated by the difference in length of the primary and secondary spaces. More specifically, the primary space 41 of the first portion 56 helps to form the first free edge 62 and the secondary space 37 of the first portion 56 helps to form the
10 second free edge 64. Consequently, the secondary sealing membrane 38 is uncovered on the first portion 56 of the angular joining part 34, from the first free edge 62 to the second free edge 64, and is designed to be covered by the primary thermal insulation barrier 40 of the first tank side wall 30.

As mentioned above and as shown more specifically in figure 4, the first portion 56 structurally extends, and has a thickness similar to, the first tank side wall 30 at least along the vertical axis
15 C towards the intermediate portion 58. More specifically, the secondary space 37 forming the first portion 56 extends, in this case vertically, the secondary space 37 forming the first tank side wall 30, and the primary space 41 forming the first portion 56 extends, in the same vertical direction, the primary space 41 forming the first tank side wall 30. Furthermore, the primary sealing membrane 42 and the secondary sealing membrane 38 are continuous between the first
20 portion 56 of the angular joining part 34 and the first tank side wall 30.

The second portion 58 of the angular joining part 34 extends primarily in the main extension plane of the second tank side wall 32 to extend this second tank side wall. The description above relating to the first portion 56 also applies to the structure of the second portion 58, with
25 a third free edge 68 and a fourth free edge 70 respectively formed by the primary space 41 and the secondary space 37 of this second portion 58.

Furthermore, the second portion 58 of the angular joining part 34 structurally extends, and has a thickness similar to, the second tank side wall 32 along the transverse axis B towards the intermediate portion 58. More specifically, the secondary space 37 forming the second portion
30 58 extends, in this case transversely, the secondary space 37 forming the second tank side wall 32, and the primary space 41 forming the second portion 58 extends, in the same transverse direction, the primary space 41 forming the second tank side wall 32. Furthermore, the primary

sealing membrane 42 and the secondary sealing membrane 38 are continuous between the second portion 58 of the angular joining part 34 and the second tank side wall 32.

The first portion 56 and the second portion 58 of the angular joining part 34 extend in planes perpendicular to one another. The first portion 56 is not adjacent to the second portion 58 on account of the presence of the intermediate portion 60, which is rigidly connected to the first portion 56 and the second portion 58 of the angular joining part 34. The first portion 56 is rigidly connected to the intermediate portion 60 at a first linked edge 66, and the second portion 58 is rigidly connected to the intermediate portion 60 at a second linked edge 72.

The intermediate portion 60 extends primarily in an inclined plane that intersects firstly with the main extension plane of the first portion 56 and secondly with the main extension plane of the second portion 58. The aforementioned linked edges 66, 72 form the joins between each of the portions and each of the corresponding main planes.

Thus, according to the invention, the intermediate portion 60 forms a wall inclined in relation to the two portions respectively extending one of the tank side walls, which are perpendicular to one another.

More specifically, in the example illustrated in which a single intermediate portion 60 is arranged between the two portions 56, 58, the inclined plane in which the intermediate portion is primarily contained has an angle of approximately 135° with the first portion 56 and the first side wall 30 extended thereby on one side and the second portion 58 and the second side wall 32 extended thereby on the other side.

This arrangement of the different portions of the angular joining part 34 means that the dimension measured between the first portion 56 and the second portion 58 of the intermediate portion 60 increases from the inner face 27 towards the outer face 29 of the sealed and thermally insulating tank 26. In other words, the dimension of the intermediate portion 60 between the first linked edge 66 of the first portion 56 and the second linked edge 72 of the second portion 58 at the inner face 27 is smaller than the dimension of the intermediate portion between the first linked edge 66 of the first portion 56 and the second linked edge 72 of the second portion 58 at the outer face 29.

The angular joining part 34 according to the invention is intended to optimize the distribution of the pressure exerted by the liquefied natural gas, the pressure being represented by an arrow

D in figure 4, on the joining zones 24 of the walls making up the plurality of tank walls of the sealed and thermally insulating tank 26. The pressure exerted by the liquefied natural gas in the tank 26 on the inner face 27 at the first portion 56 or the second portion 58 is exerted on the first space 41 corresponding to the angular joining part 34, and is distributed towards the outer face 29 over the whole of the corresponding second space 37, i.e. over a larger area. The pressure exerted by the liquefied natural gas on the inner face 27 of the intermediate portion 60 is distributed over the entire outer face 29 of this intermediate portion 60, again over a larger area. The pressure forces from the liquefied natural gas are distributed over a larger bearing surface on the outer face 29, which is designed to be in contact with the internal load-bearing structure 6.

As shown in figure 3, the angular joining part 34 helps to form an angular joining module 74 that can be arranged sequentially with other similar modules one after the other along a longitudinal axis A that is the axis shared by the two tank side walls. Thus, the first portion 56, the second portion 58 and the intermediate portion 60 of each angular joining part 34 is aligned with the first portion, the second portion and the intermediate portion of the other angular joining parts 34 of an angular joining module 74.

Each angular joining module 74 has a first longitudinal end 75 and a second longitudinal end 77. The sealing membrane 38 of the secondary space 37 is uncovered at at least one of the longitudinal ends of the plurality of angular joining modules 74.

As shown in figure 4, each angular joining module 74 cooperates with the first tank wall 30 and the second tank wall 32. The first portion 56 of the angular joining parts 34 of each angular joining module 74 is designed to be in contact with the first tank wall 30 at the first free edge 62 and the second free edge 64. Thus, the secondary space 37 of the first portion 56 of each part forming an angular joining module 74 is arranged as a continuation of the secondary space 37 of the first tank wall 30, the primary space 41 of the first portion 56 of each part forming each angular joining module 74 also being arranged as a continuation of the primary space 41 of the first tank wall 30. The secondary space 37 of the first portion 56 of the parts forming each angular joining module 74, in the portion thereof not covered by the primary space, is covered by the primary space 41 of the first tank wall 30 up to the first free edge 62. Similarly, the secondary space 37 of the second portion 58 of each part forming an angular joining module 74 is arranged as a continuation of the secondary space 37 of the second tank wall 32, and the primary space 41 of the second portion 58 of each part forming an angular joining module 74 is

arranged as a continuation of the primary space 41 of the second tank wall 32. The secondary space 37 of the second portion 58 of the parts forming each angular joining module 74, in the portion thereof not covered by the primary space, is covered by the primary space 41 of the second tank wall 32 up to the third free edge 68.

- 5 The side walls 30, 32 of the sealed and thermally insulating tank 26 rest directly on the load-bearing walls 18, 20 of the internal load-bearing structure 6. The same is true of the outer face of the first and second portions of the angular joining part that extend substantially perpendicularly in relation to one another. More specifically, the outer face 29 of the first tank side wall 30 and the outer face of the first portion 56 of the angular joining part rest on the first
- 10 load-bearing wall 18 of the internal load-bearing structure 6 via mastic beads (not shown) and elsewhere the outer face 29 of the second tank side wall 32 and the outer face of the second portion 58 of the angular joining part rest on the second load-bearing wall 20 of the internal load-bearing structure 6 via mastic beads (not shown).

- The outer face 29 at the intermediate portion 60, that extends in a plane inclined in relation to
- 15 the main extension planes of the first and second tank side walls, forms a chamfer and therefore a clearance zone 76 between the intermediate portion 60 and the internal load-bearing structure 6 at the joining zone 24.

- As shown in figure 4, the internal load-bearing structure 6 has, in this joining zone 24, i.e. in the corner formed between the first load-bearing side wall 18 and the second load-bearing side wall
- 20 20, a reinforcement element 78 that is designed to be in contact with each of the load-bearing side walls and with the outer face 29 of the intermediate portion 60. In other words, the internal load-bearing structure 6 is provided with a reinforcement element 78 that is designed to fill the clearance zone 76. In this case, the reinforcement element 78 has a triangular section similar to the shape of the clearance zone, with a contact face 80 that forms a stop preventing the
- 25 intermediate portion from moving under the effect of the pressure exerted by the liquefied natural gas in the tank, and an opposing apex 82 having an angle substantially equal to 90° to fit the shape of the corner of the joining zone 24. Advantageously, the reinforcement element 78 extends primarily along the longitudinal axis A to form a reinforcing member for each of the angular joining parts 34. The reinforcement element 78 can notably be a plate forming a
- 30 longitudinal rib arranged at 135° from each of the load-bearing walls of the internal load-bearing structure.

As shown in particular in figure 4, the contact face 80 faces the intermediate portion 60 of the angular joining part 34. In a starting position, with no pressure being exerted on the angular joining part by the liquefied gas, the reinforcement element 78 and the angular joining part 34 help to delimit a space extending from the contact face 80 of the reinforcement element to the outer face 29 of the intermediate portion 60 of the angular joining part 34. This space is in this case regular along two faces, i.e. a dimension measured between the contact face 80 and the outer face 29 of the intermediate portion 60 along an axis perpendicular to the main plane containing the contact face 80 and the reinforcement element 78 and/or the outer face 29 of the intermediate portion 60 is constant. In other words, the contact face 80 of the reinforcement element 78 and the outer face 29 of the intermediate portion 60 each lie in a plane parallel to the plane containing the other face.

The pressure exerted on the inner face 27 of the intermediate portion 60 by the liquefied gas then involves a direct flat contact between the outer face 29 of the intermediate portion 60 and the contact face 80 of the reinforcement element 78.

Thus, the outer face 29 of the intermediate portion 60 of the plurality of angular joining parts 34 rests on the reinforcement element 78. The pressure exerted by the liquefied natural gas stored in the sealed and thermally insulating tank 26 on the inner face 27 of the intermediate portion 60 is then distributed more easily over the outer face 29 of each portion of the corresponding angular joining part 34, the reinforcement element 78 forming, at the contact face, a face substantially perpendicular to the general direction of the pressure of the liquefied natural gas in this joining zone 24 of the tank. The pressure exerted by the liquefied natural gas stored in the sealed and thermally insulating tank 26 is therefore better distributed and reduces the risk of leaks occurring in the primary sealing membrane 42.

Advantageously, this distribution of the pressure over different elements of the sealed and thermally insulating tank 26 and of the internal load-bearing structure 6 affects the aforementioned concentration of stiffening members 8, 10 and more specifically the concentration of a first plurality of stiffening members 8 arranged between the outer hull 4 and the first load-bearing wall 18 of the internal load-bearing structure 6 and the concentration of a second plurality of stiffening members 10 arranged between the outer hull 4 and the second load-bearing wall 20 of the internal load-bearing structure 6.

As shown in particular in figures 2 and 4, there is therefore less need for stiffening members 8, 10 in the vicinity of the joining zone 24, and only one first stiffening member 84, 90 from each plurality of stiffening members 8, 10 can be in contact with the corresponding load-bearing wall 18, 20 of the internal load-bearing structure 6 at the joining zone 24, while several stiffening members 86, 88, 92, 94 may be in contact with the load-bearing walls 18, 20 away from this joining zone 24. The concentration of stiffening members is therefore reduced in the vicinity of the angular joining part.

For each plurality of stiffening members, respectively facing one or other of the load-bearing walls 18, 20, a second stiffening member 86, 92 is positioned between the first stiffening member 84, 90 and a third stiffening member 88, 94. A reduced concentration of stiffening members at the joining zone and the angular joining part means that the distance separating the second stiffening member 86, 92 and the third stiffening member 88, 94 is smaller than the distance separating the second stiffening member 86, 92 from the first stiffening member 84, 90.

In the example shown in figure 4, the first stiffening member 84, 90 of each plurality of stiffening members is in contact with the load-bearing side wall of the internal load-bearing structure 6 at the reinforcement element 78, without this limiting the invention.

As shown in figures 2 and 7, this first stiffening member 84, 90 can be arranged in the joining zone away from the reinforcement element, and more specifically in a zone covered by the first portion or the second portion of the angular joining part.

Each side wall 18, 20 of the tank can have a proximal zone 101 and a distal zone 103 determined as a function of the positioning thereof in relation to the closest joining zone 24, both zones being delimited in relation to one another by a demarcation in the extension of the free edge of the secondary space of the angular joining part, specifically the second free edge 64 for the first tank side wall 18 and the fourth free edge 70 for the second tank side wall 20. The proximal zone 101 is the zone between the joining zone 24 and this demarcation, and the distal zone 103 is the zone beyond this demarcation in relation to the joining zone. As shown in figure 7, only the first stiffening member 84, 90 is advantageously positioned in the proximal zone 101, while several stiffening members 86, 88, 92, 94 are arranged in the distal zone 103. As described above, the distance between the first stiffening member 84, 90 and the

second stiffening member 86, 92 is greater than the distance separating the second stiffening member 86, 92 from the third stiffening member 88, 94.

The first stiffening member 84 of the first plurality of stiffening members 8 can notably be aligned transversally with the first free edge 62 of the angular joining part 34 and the first stiffening member 90 of the second plurality of stiffening members 10 can notably be aligned vertically with the third free edge 68 of the angular joining part 34.

As shown in figure 7, at least one first stiffening member of a plurality of stiffening members 8, 10 is positioned at a distance d from the corner of the internal load-bearing structure 6, i.e. from the apex 82 of the reinforcement element 78 and the first stiffening member 84, 90. More specifically, in the example shown, each first stiffening member of the pluralities of stiffening members is arranged at this distance d from the corner of the internal load-bearing structure 6.

According to a feature of the invention, the dimensions of the angular joining part are determined as a function of this positioning of the first stiffening members and of this distance d . More specifically, a dimension $D60$ of the intermediate portion 60 measured along the outer face 29 of the intermediate portion 60 between the first linked edge 66 and the second linked edge 72 can be calculated such that:

$$D60 = \frac{2}{2 + \sqrt{2}} * d$$

In the example illustrated, the dimensions $D56$, $D58$ of the first portion 56 and of the second portion 58, measured respectively between the intermediate portion and a zone corresponding to the position of the corresponding first stiffening member 84, 90, are equal to the previously determined dimension $D60$ of the intermediate portion. More specifically, a dimension $D56$ of the first portion 56, measured in this case vertically along the outer surface between the first linked edge 66 and the contact zone with the first stiffening member 84 of the first plurality of stiffening members 8, i.e. level with the first free edge 62, is equal to the dimension $D60$ of the intermediate portion. A dimension $D58$ of the second portion 58, measured in this case transversely along the outer surface between the second linked edge 72 and the contact zone with the first stiffening member 90 of the second plurality of stiffening members 10, i.e. level with the third free edge 68, is equal to the aforementioned dimensions $D60$ and $D56$.

Consequently, the forces exerted by the pressure of the liquefied gas are distributed more evenly between the reinforcement element in the joining zone and each of the tank side walls and the stiffening members supporting these side walls.

In a variant of the embodiments described above, and as shown in figure 8, the contact face 80 of the reinforcement element 78 has a shape other than the flat surface previously described, forming a fillet 91 rather than a square corner. More specifically, the contact face 80 has an advantageously concave curvature such that the space delimited between the contact face 80 and the reinforcement element 78 and the outer face 29 of the intermediate portion 60 is no longer constant and increases closer to the center of the intermediate portion 60. This space is filled by one or more shims 93, for example in the form of panels and/or cylinders made of plywood for example, and/or by filling material 95, such as mastic as illustrated in figure 8 by a shaded zone, this list not being exhaustive. It should be noted that the structure of the reinforcement element is easier to produce if the structure includes a fillet and is less likely to break at the joint with the load-bearing wall of the load-bearing structure under the effect of the pressure exerted by the liquefied gas, the additional presence of reinforcing material filling the space guaranteeing the correct transmission of forces.

A variant embodiment of the invention is described below with reference to figures 5 and 6. Each angular joining module 74 described above is arranged to provide a join between the first tank wall 30 and the second tank wall 32 of the sealed and thermally insulating tank 26. However, the tank 26 may have other tank walls and the angular joining modules 74 according to the invention may also be designed to be positioned to face a second tank wall joining zone.

In this example, the plurality of tank walls also includes a third tank wall, or a first transverse tank wall 96, extending in a plane perpendicular to the first side wall 30 and perpendicular to the second side wall 32. Furthermore, this first transverse tank wall 96 is perpendicular to the main extension axis of the plurality of angular joining parts 34, i.e. the longitudinal axis A.

According to the invention, each wall of the sealed tank 26 can be linked to another wall of the sealed tank 26 by an angular joining module 74. According to the example described here, the join between the third tank wall 96 and the first tank wall 30 can have an angular joining module 74, as can the joint between the third tank wall 96 and the second tank wall 32.

In this context, the sealed and thermally insulating tank 26 according to the invention includes an angular joining element 98 that differs from the angular joining part 34 in that it includes a return portion.

As shown in figure 5, the angular joining element 98 has a first portion 100 and a second portion 102. Each of the two portions 100 and 102 has a structure substantially identical to the structure described above, specifically, from an outer face 29 to an inner face 27, a secondary space 37, including the secondary thermal insulation barrier 36 and the secondary sealing membrane 38, and a primary space 41 including the primary thermal insulation barrier 40 and the primary sealing membrane 42.

- 10 The secondary thermal insulation barrier 36 includes, from the outer face 29 to the inner face 27, the insulating wall 44 covered by the first thermal insulation layer 46, then the second insulating wall 51 specifically present in the angular joining element as described above for the angular joining part. This secondary thermal insulation barrier 36 maintains the temperature inside the sealed and thermally insulating tank 26 in a first instance, advantageously when the liquefied natural gas is stored therein. The secondary thermal insulation barrier 36 is covered by the secondary sealing membrane 38.

The secondary sealing membrane 38 retains the liquefied natural gas stored in the sealed and thermally insulating tank 26 in the event of a leak of liquefied natural gas in the primary space 41.

- 20 The secondary sealing membrane 38 includes a flexible secondary sealing membrane 48 covering a plurality of rigid secondary sealing membranes 49.

- The triplex strip forming the first flexible sealing membrane 48 is designed to be glued firstly to the rigid secondary sealing membranes 49, more specifically covering the joining zones of these rigid membranes, and secondly to the primary thermal insulation barrier 40, thereby preventing contamination at the various different joins. The primary thermal insulation barrier 40 therefore includes, from the outer face 29 to the inner face 27, the second thermal insulation layer 52 and the third insulating wall 54. The primary thermal insulation barrier 40 is covered by the primary sealing membrane 42.

- 30 As specified above, the angular joining element 98 includes a first portion 100 and a second portion 102. The first portion 100 of the angular joining element 98 is arranged such as to be

aligned with and to cooperate with the plurality of angular joining modules or parts 74, 34 as well as with the first tank side wall 30 and the second tank side wall 32. The second portion 102 of the angular joining element 98 is perpendicular to the first portion 100 such as to face the first transverse tank wall 96.

- 5 The first portion 100 of the angular joining element 98 includes, as with the angular joining part 34, a first section 104, a second section 106, and at least one intermediate section 108.

The first section 104 of the angular joining element 98 lies primarily in a plane parallel to the main extension plane of the first tank side wall 30 and of the first portion 56 of the angular joining parts 34 and, as above, the primary space 41 and the secondary space 37 do not have the
10 same dimensions, both in relation to the longitudinal axis A and in relation to the vertical axis C, it being understood that the main extension plane of the first tank side wall 30 extends in this case longitudinally and vertically.

The first section 104 has a first free end edge 110 and a second free end edge 112, these end edges being perpendicular to one another. The secondary space 37 of the first section 104 is not
15 covered by the primary space 41 in the vicinity of the first free end edge 110 and in the vicinity of the second free end edge 112.

The shape of the second section 106 is identical to the shape of the first section 104, with a third free end edge 116 and a fourth free end edge 118. Again, the secondary space 37 is not covered by the primary space 41 in the vicinity of the third and fourth free end edges.

- 20 The first section 104 and the second section 106 of the angular joining element 98 extend primarily in planes perpendicular to one another. The first section 104 is not adjacent to the second section 106 on account of the presence of the intermediate section, which is rigidly connected to the first section 104 and the second section 106 at a respective linked side 114, 120.

- 25 The intermediate section 108 extends primarily in an inclined plane that intersects firstly the main extension plane of the first section 104 and secondly the main extension plane of the second section 106. The intersecting plane is parallel to the longitudinal axis A and is oriented to advantageously form an angle of approximately 135° with each of the aforementioned main extension planes. The intermediate section 108 therefore intersects the first section 104

advantageously at an angle of approximately 135° while also intersecting the second section 106 advantageously at an angle of approximately 135° .

The secondary space 37 is not covered by the primary space 41 at a fifth free side 115 of the intermediate section 108. Indeed, the primary space 41 and the secondary space 37 do not
5 extend over the same length along the longitudinal axis A. The primary space 41 is shorter than the secondary space 37 along the longitudinal axis A towards the fifth free side 115 of the intermediate section 108. The secondary sealing membrane 38 is therefore uncovered at the fifth free side 115 with no superposed or glued element.

Again, the intermediate section 108 has a dimension that increases further away from the inner
10 face 27, notably to better distribute the pressure exerted by the liquefied natural gas in the tank, as described above. It should be noted that, in this variant embodiment, the intermediate section 108 is again opposite a clearance zone that can be filled with a reinforcement element against which the joining element bears at the outer face of the intermediate section.

Furthermore, the reinforcement element can have a contact face extending in a plane or
15 forming a fillet, as described above, and the intermediate section 108 can include shims and/or filling material to fill the space between the outer face 29 and the contact face of the reinforcement element.

The second portion 102 of the joining element 98 extends mainly in a plane perpendicular to the longitudinal axis A, i.e. in a plane perpendicular to each of the sections of the first portion
20 100 of the joining element. In other words, the second portion 102 of the angular joining element 98 forms a return portion that extends the first portion 100 of the angular joining element 98 perpendicularly.

More specifically, the second portion 102 includes a return wall 121 with a free transverse side 122, a linked transverse side 124, a free vertical side 126, and a linked vertical side 128. The free
25 transverse side 122 and the linked transverse side 124 extend along a transverse axis B that is perpendicular to the longitudinal axis A and to the vertical axis C, while the free vertical side 126 and the linked vertical side 128 extend along the vertical axis C. The second portion 102 is rigidly connected to the first portion 100 at the linked transverse side 124 and the linked vertical side 128.

The secondary space 37 is not covered by the primary space 41 at the free transverse side 122 and the free vertical side 126 of the second portion 102 of the angular joining element 98.

Indeed, the primary space 41 and the secondary space 37 do not extend over the same length along the transverse axis B and along the vertical axis C. As above, the primary space 41 is shorter than the secondary space 37, in this case along the transverse axis B towards the free vertical side 126, and is also shorter along the vertical axis C towards the free transverse side 122.

The angular joining element 98 according to the invention is intended to optimize the distribution of the pressure exerted by the liquefied natural gas on the joining zones of the walls forming said tank 26, notably by virtue of the shape of the intermediate section 108 and the clearance zone between this intermediate section and the joining section of the load-bearing walls 18, 20, while forming a link between the first transverse tank wall 96 and the plurality of angular joining modules 74. The pressure exerted by the liquefied natural gas stored in the sealed and thermally insulating tank 26 on the inner face 27 at the intermediate section 108 of the angular joining element 98 is distributed over the entirety of the angular joining element 98 as far as the return wall 121, which extends opposite the first transverse tank wall 96.

The primary space 41 of the first portion 100 and the primary space of the second portion 102 of the angular joining element 98 can be integral with one another. In particular, the primary sealing membrane 42 of the first portion 100 can be welded to the primary sealing membrane 42 of the second portion 102, or be made as a single element.

As shown in figure 6, the first portion 100 of the angular joining element 98 is designed to be in contact with an angular joining part 34 of an angular joining module 74. The first portion 56, the second portion 58, and the intermediate portion 60 of the angular joining module 74 closest to the angular joining element 98 are aligned respectively with the first section 104, the second section 106, and the intermediate section 108 of the first portion 100 of the angular joining element 98. More specifically, the secondary space 37 of the angular joining element 98 is in contact with the secondary space of this angular joining module 74. To rigidly connect the angular joining element 98 to this angular joining module 74, primary space panels 41 (not shown) are fastened by gluing and welding to the secondary space 37 between the primary space 41 associated with the angular joining module 74 and the primary space 41 associated with the angular joining element 98.

The first section 104 of the angular joining element 98 and the first portion 56 of the angular joining parts 34 are designed to be in contact with the first tank side wall 30. The angular

joining element 98 and the angular joining parts 34 are fastened to the first tank side wall 30 in a manner similar to the fastening of the angular joining element 98 with the closest angular joining module 74. A panel of the primary space 41 is glued and welded at the link between the first tank side wall 30 and the angular joining element 98 and the plurality of angular joining parts 34.

The second section 106 of the angular joining element 98 and the second portion 58 of the angular joining parts 74 are designed to be in contact with the second tank side wall 32. The angular joining element 98 and the angular joining parts 34 are fastened to the second tank side wall 32 in a manner similar to the fastening of the angular joining element 98 with the closest angular joining module 74. A panel of the primary space 41 is glued and welded at the link between the second tank side wall 32 and the angular joining element 98 and the plurality of angular joining parts 34.

The first tank side wall 30, and respectively the second tank side wall 32, and the first transverse tank wall 98 are rigidly connected to one another via a first conventional joining element 130, and respectively a second conventional joining element 132, which are made in a known manner.

The first conventional joining element 130 and the second conventional joining element 132 each have two portions. Each of the portions of the joining elements are perpendicular to one another, and each one extends in a main plane containing one of the tank walls described above.

The angular joining element 98 is therefore in contact with at least one of the ends of at least one conventional joining element 130. In the example illustrated, the angular joining element 98 is in contact firstly with the closest angular joining module 74 and secondly with the first conventional joining element 130 and with the second conventional joining element 132.

According to a variant embodiment that is not shown, a sealed tank according to the invention can be made such that the third wall, or first transverse wall 96, perpendicular to the first side wall 30 and to the second side wall 32, is linked to each of these walls by an angular joining module 74. In this context, the angular joining element 98 arranged at the junction of these three walls is noteworthy in that an intermediate portion similar to that described above is arranged between sections of the angular joining element extending each of the walls. The angular joining element is therefore adapted to have a shape similar to the first portion as

described above at each junction of two walls, and it should be noted that the reinforcing member 78 provided to fill the gap between the angular joining element and the internal load-bearing structure 6 has a pyramidal shape in this case.

CLAIMS

1. A sealed and thermally insulating tank (26) that is designed to rest on a load-bearing structure (6) of a ship, the sealed tank (26) comprising a plurality of tank walls, including a first tank wall (30) and at least one second tank wall (32), the first tank wall (30) extending primarily in a first plane and the second tank wall (32) extending primarily in a second plane, the first plane and the second plane being perpendicular in relation to one another, the first tank wall (30) and the second tank wall (32) being linked by an angular joining part (34), characterized in that the angular joining part (34) has a first portion (56) extending primarily in the first plane, a second portion (58) extending primarily in the second plane, and at least one intermediate portion (60) extending primarily in a plane intersecting the first plane and the second plane, the thickness of the first portion (56) of the angular joining part (34) being equal to the thickness of the first tank wall (30) and being arranged to extend this first tank wall (30), and the thickness of the second portion (58) of the angular joining part (34) being equal to the thickness of the second tank wall (32) and being arranged to extend this second tank wall (32).
2. The sealed tank (26) as claimed in claim 1, in which the sealed tank (26) has at least one third tank wall (96) extending primarily in a third plane perpendicular to the first plane, the second plane and the intersecting plane, and has a joining zone with the first tank wall (30) and the second tank wall (32), and in which the joining zone has an angular joining element (98), the angular joining element (98) having a first portion (100) and a second portion (102), the first portion (100) having a first section (104) extending primarily in the first plane, a second section (106) extending primarily in the second plane, and an intermediate section (108) extending primarily in the intersecting plane, the second portion (102) having a return wall (121) that is perpendicular to the first portion (100) and extends primarily in the third plane.
3. The sealed tank (26) as claimed in claim 1 or 2, in which the angular joining part (34) and/or the angular joining element (98) each have an inner face (27) and an outer face (29), the inner face (27) forming an internal chamfer at the intermediate portion (60) or at the intermediate section (108) and the outer face (29) forming an external chamfer at the intermediate portion (60) or at the intermediate section (108), the internal and external chamfers being inclined at an angle of between 120° and 150° in relation to the first plane and to the second plane.
4. The sealed tank (26) as claimed in claim 3, in which the dimension of the intermediate portion (60) of the angular joining part (34) measured between the first portion (56) and the

second portion (58) of said part (34), and/or the dimension of the intermediate section (108) of the angular joining element (98) measured between the first section (104) and the second section (106) of said angular joining element (98), increases from the inner face (27) towards the outer face (29).

5. The sealed tank (26) as claimed in any one of the preceding claims, in which the angular joining part (34) and/or the angular joining element (98) comprise, successively in the thickness direction from the outside towards the inside of the tank, a secondary thermally insulating barrier (36) that is designed to be in contact with the load-bearing structure (6), a secondary sealing membrane (38) carried by the secondary thermally insulating barrier (36), a primary thermally insulating barrier (40) resting on the secondary sealing membrane (38) and a primary sealing membrane (42) carried by the primary thermally insulating barrier (40) that is designed to be in contact with the fluid contained in the sealed tank (26).

6. The sealed tank (26) as claimed in claim 5, in which the secondary thermally insulating barrier (36) and the secondary sealing membrane (38) of the angular joining part (34) and/or the angular joining element (98) each have, in a given direction, a dimension that is larger than the corresponding dimension, in the same direction, of the primary thermally insulating barrier (40) and of the primary sealing membrane (42).

7. The sealed tank (26) as claimed in one of the preceding claims, in which the dimension (D56, D58) of the first portion (56) and/or of the second portion (58) of the angular joining part (34) is equal to the dimension (D60) of the intermediate portion (60).

8. A ship (200) including at least one sealed tank (26) as claimed in any one of the preceding claims.

9. A ship as claimed in claim 8, having an outer hull (4) and a load-bearing structure (6), the load-bearing structure (6) being designed to receive the sealed tank (26), the load-bearing structure (6) having a first load-bearing wall (18) extending primarily along the first plane and a second load-bearing wall (20) extending primarily along the second plane, the first load-bearing wall (18) and the second load-bearing wall (20) being substantially perpendicular, characterized in that a clearance zone is provided between the load-bearing walls of the load-bearing structure in the joining zone (24) and the intermediate portion (60) of the angular joining part (34) and in that the reinforcement element (78) is seated in said clearance zone.

10. The ship as claimed in claim 9, in which the reinforcement element (78) has a triangular section, and the angle of the apex (82) of the reinforcement element (78) is equal to the right angle formed between the first load-bearing wall (18) and the second load-bearing wall (20), the reinforcement element having a contact face (80) with the intermediate portion (60) opposite said apex.
11. The ship as claimed in claim 10, in which the contact face (80) has a faceted profile, being formed by a plurality of flat surfaces that are inclined in relation to one another such as to form a profile curving towards the inside of the reinforcement element (78).
12. The ship as claimed in claim 10, in which the contact face (80) has a curved profile giving the reinforcement element (78) a general concave shape.
13. The ship as claimed in one of claims 9 to 12, in which the outer hull (4) has a plurality of stiffening members (8, 10) in contact with the load-bearing structure (6) and the concentration of stiffening members (8, 10) is lesser in the vicinity of the angular joining part (34) and/or in the vicinity of the angular joining element (98).
14. The ship as claimed in the preceding claim, in which a dimension (D60) of the intermediate portion (60) of the angular joining part (34) is determined as a function of the position of the stiffening member (84, 90) closest to a corner of the load-bearing structure (6) in which the angular joining part (34) is positioned.
15. A method for loading or unloading liquefied natural gas in a tank (26) as claimed in claims 1 to 7 or a liquefied natural gas ship (200). as claimed in one of claims 8 to 14.