Description

Title of the invention: Thermally insulating sealed tank built into a load-bearing structure

Technical field

[1] The invention relates to the field of thermally insulating sealed tanks built into a load-bearing structure to contain a cold fluid, in particular to membrane tanks for containing liquefied gases, in particular combustible gases.

[2] Thermally insulating sealed tanks may be used in various industries to store cold products. For example, in the energy field liquefied natural gas (LNG) is a liquid with a high content of methane that can be stored at atmospheric pressure at approximately -163°C in terrestrial storage tanks or in tanks onboard floating structures. Liquefied petroleum gas (LPG) can be stored at a temperature between -50°C and 0°C.

[3] In the case of a floating structure the tank may be intended for the transport of the liquefied gas or to receive liquefied gas serving as fuel for the propulsion of the floating structure.

Prior art

[4] Thermally insulating sealed membrane tanks built into the double hull of a ship are known in the art. For example, the publication WO-A-2014096600 teaches a tank of this kind in which a thermally insulating barrier includes an assembly of thermal insulation elements of parallelepipedal general shape juxtaposed on the load-bearing structure to form a substantially uniform supporting surface for the sealed membrane and retaining members attached to the load-bearing structure between the juxtaposed thermal insulation elements and cooperating with the thermal insulation elements to retain the thermal insulation elements against the load-bearing structure. Each thermal insulation element is retained by four mechanical couplers disposed at the corners of the thermal insulation elements.

[5] The above publication indicates that the thermal gradient in the thermal insulation elements can cause phenomena of differential expansion in glued assemblies of polymer foam with other, rigid materials, for example plywood, liable to cause stresses tending to cause the thermal insulation elements to bend.

Summary of the invention

[6] One object of the invention is to design a tank wall structure and in particular an insulating barrier structure offering advantageous properties in terms of thermal insulation, mechanical strength and support for a taut sealed membrane.

[7] To this end the invention provides a thermally insulating sealed tank built into a load-bearing structure, said tank including a tank wall fixed to a supporting wall of the load-bearing structure,
in which the tank wall includes a thermally insulating barrier fixed to the supporting wall and a sealed membrane carried by said thermally insulating barrier,
in which the thermally insulating barrier includes a plurality of rows parallel to a first direction, a row including a plurality of juxtaposed parallelepipedal insulating panels, the rows being juxtaposed in a second direction perpendicular to the first direction in a repeated pattern,
in which the sealed membrane includes a plurality of metal strakes parallel to the first direction, a strake including a plane central portion resting on an upper surface of the insulating panels and two raised edges projecting toward the interior of the tank relative to the central portion, the strakes being juxtaposed in the second direction in a repeated pattern and welded together in sealed manner at the level of the raised edges,
in which the dimension of the repeated pattern of the rows is an integer multiple greater than or equal to two of the dimension of the repeated pattern of the strakes in the second direction, the strakes that rest on a row being arranged in such a manner that at least one said strakes rests entirely on said row and at least two strakes straddle the row and two adjacent rows situated on either side of said row, the raised edges of said strakes being offset in the second direction relative to the edges of said row,
and in which the supporting wall carries first and second retaining members cooperating with first and second edges of the insulating panels of said row to retain the insulating panels of said row on the supporting wall, the first retaining members being disposed at the level of the first edges, the first edges being parallel to the first direction, the first retaining members being disposed in line with the strakes straddling the row and the adjacent rows, the second retaining members being disposed at the level of the second edges, the second edges being parallel to the second direction, and the second retaining members being disposed at a distance from the corners of the insulating panels of the row and in line with said or each strake that rests entirely on said row.

[8] Retaining members are therefore arranged in line with each of the strakes that rest on the rows, namely the first retaining members in line with two strakes straddling the row and the two adjacent rows and the second retaining members in line with each strake that rests entirely on the row. This arrangement of the retaining members enables

uniform distribution of forces exerted on the insulating panels and limitation of flatness defects of the support surface that they form for the sealed membrane. These flatness defects can have diverse causes, in particular deformation of the hull on loading ballast. Moreover, the differential thermal expansion or differential thermal contraction is liable to create small deformations of the insulating panels in bending, as described in WO-A-2014096600, if the tank wall is subjected to a temperature gradient in the direction of thickness. Arranging at least the second retaining members at a distance from the corners rather than at the corners of the insulating panel limits the length liable to be subjected to bending, which limits the sag, that is to say the displacement that results from this bending in the direction of thickness of the tank wall. This distribution of the retaining members therefore enables reduction of the deformation of the insulating panels and the vertical steps between adjacent insulating panels.

[9] This arrangement of the retaining members may be applied to one row or to each row or to a subset of the rows, for example one row in two in the thermally insulating barrier.

[10] Embodiments of a tank of this kind may have one or more of the following features.

[11] The first retaining members are preferably disposed at a distance from the corners of the insulating panels of the row.

[12] Likewise, arranging the first retaining members at a distance from the corners rather than at the corners of the insulating panel limits the length liable to be subjected to bending, which limits the sag, that is to say the displacement that results from this bending in the direction of thickness of the tank wall.

[13] In accordance with one embodiment, the raised edges of said strakes are offset in the second direction by a distance equal to half the dimension of the repeated pattern of the strakes relative to the edges of the row, the second retaining members being distant from the corners of the insulating panels by a distance equal to the dimension of the repeated pattern of the strakes or to an integer multiple of that dimension.

[14] The retaining members disposed at the level of the second edges of the insulating panels are therefore in line with a median line of the strakes resting entirely on the row which renders uniform the distribution of forces exerted on the insulating panels.

[15] In accordance with one embodiment, the dimension of the repeated pattern of the rows is twice the dimension of the repeated pattern of the strakes in the second direction, the second retaining members being arranged in the middle of the second edges.

[16] In accordance with another embodiment, the dimension of the repeated pattern of the rows is greater than twice the dimension of the repeated pattern of the strakes in the

second direction and second retaining members spaced from one another by a distance equal to the dimension of the repeated pattern of the strakes are arranged along a second edge.

[17] In accordance with one embodiment, the parallelepipedal insulating panels of the row are juxtaposed in accordance with a repeated pattern in the first direction, the dimension of the repeated pattern in the first direction is twice the dimension of the repeated pattern of the strakes in the second direction, and the first retaining members are arranged in the middle of the first edges.

[18] In accordance with another embodiment, the parallelepipedal insulating panels of the row are juxtaposed in a pattern repeated in the first direction. The dimension of the pattern repeat in the first direction is an integer multiple greater than two of the dimension of the repeated pattern of the strakes in the second direction and a plurality of first retaining members spaced from one another by a distance equal to the dimension of the repeated pattern of the strakes are arranged along a first edge.

[19] Thanks to these features the retaining members can be distributed on the supporting wall in the form of a regular array, for example in the form of an array of the face-centred cubic type, which facilitates construction and renders uniform the distribution of forces exerted on the insulating panels and on the sealed membrane that they support.

[20] The parallelepipedal insulating panels may have various structures. In accordance with one embodiment, the parallelepipedal insulating panels have a square shape. In accordance with one embodiment, an insulating panel includes a bottom plate resting against the supporting wall, for example via beads of polymerizable mastic, a cover plate parallel to the bottom plate and a layer of insulating polymer foam sandwiched between the bottom plate and the cover plate. In accordance with one embodiment, an intermediate plate parallel to the bottom plate is inserted within the thickness of the layer of insulating polymer foam and divides the latter into two layers. A structure of this kind is advantageous in that it makes it possible to limit the bending forces generated by differential contraction of the materials of the insulating panel.

[21] Thanks to the beads of polymerizable mastic the flatness of the parallelepipedal insulating panel is improved and its seating is assured. In accordance with one embodiment a non-adhesive film is inserted between the supporting wall and the beads of polymerizable mastic to prevent the beads of polymerizable mastic from adhering to the supporting wall. Conversely, in another embodiment this non-adhesive film is omitted so that the parallelepipedal insulating panels are glued to the supporting wall by means of the beads of polymerizable mastic.

[22] The retaining members may be produced in various ways. In accordance with one embodiment, the second retaining member includes a stud fixed perpendicularly to the supporting wall in an interstice between two parallelepipedal insulating panels of the row and an elongate attachment part having a central part mounted to pivot on the stud and two end parts extending transversely to the stud on either side of the latter, the attachment part being pivotable between a release position in which the attachment part is oriented parallel to the second direction and a retaining position in which the attachment part is oriented parallel to or obliquely to the first direction, said two parallelepipedal insulating panels having lateral housings to receive the end parts of the attachment part in the retaining position so that the attachment part in the retaining position immobilizes the two parallelepipedal insulating panels in the direction of thickness of the tank wall.

[23] In accordance with one embodiment, the first retaining member includes a stud fixed perpendicularly to the supporting wall in an interstice between two rows and an elongate attachment part having a central part mounted to pivot on the stud and two end parts extending transversely to the stud on either side of the latter, the attachment part being pivotable between a release position in which the attachment part is oriented parallel to the first direction and a retaining position in which the attachment part is oriented parallel to or obliquely to the second direction, two parallelepipedal insulating panels situated on either side of the interstice having lateral housings to receive the end parts of the attachment part in the retaining position so that the attachment part in the retaining position immobilizes the two parallelepipedal insulating panels in the direction of thickness of the tank wall.

[24] In accordance with one embodiment, the end parts of the attachment part in the retaining position cooperate with an upper surface of a bottom plate of the parallelepipedal insulating panels.

[25] In accordance with one embodiment, the stud also carries a nut screwed onto an end portion of the stud opposite the supporting wall and spring washers arranged between the nut and the central part of the attachment part.

[26] In accordance with one embodiment, anchor flanges anchored to the insulating panels and parallel to the first direction are arranged between the juxtaposed strakes to retain the sealed membrane on the insulating barrier.

[27] In accordance with one embodiment, the thermally insulating barrier is a secondary insulating barrier and the sealed membrane is a secondary sealed membrane, the tank wall further including a primary sealed membrane intended to be in contact with a

product contained in the tank and a primary insulating barrier arranged between the primary sealed membrane and the secondary sealed membrane.

[28] In accordance with one embodiment, the first and second retaining members are first and second secondary retaining members, the tank further including primary retaining members placed on the insulating panels of said row at places situated on a first line parallel to the first direction and situated in line with said one second secondary retaining member and a second line parallel to the second direction and situated in line with said one first secondary retaining member. The primary retaining members are preferably placed at the intersections of the first and second lines.

[29] A tank of this kind may form part of a terrestrial storage insulation or a storage installation placed on the seabed, for example to store LNG, or be installed in a coastal or deep-water floating structure, in particular a methane tanker ship, a floating storage and regassification unit (FSRU), a floating production storage and offloading (FPSO) unit or other structure.

[30] In accordance with one embodiment, a ship for the transport of a cold liquid product includes a double hull and an aforementioned tank built into the double hull. In accordance with one embodiment, the double hull includes an inner hull forming the load-bearing structure of the tank.

[31] In accordance with one embodiment, the invention also provides a method for loading or offloading a ship of this kind in which a cold liquid product is routed through insulated pipes from or to a floating or terrestrial storage installation to or from the tank of the ship.

[32] In accordance with one embodiment, the invention also provides a transfer system for a cold liquid product, the system including the aforementioned ship, insulated pipes arranged in such a manner as to connect the tank installed in the hull of the ship to a floating or terrestrial storage insulation and a pump for driving a cold liquid product through the insulated pipes from or to the floating or terrestrial storage insulation to or from the tank of the ship.

Brief description of the drawings

[33] The invention will be better understood and other aims, details, features and advantages thereof will become more clearly apparent in the course of the following description with reference to the appended drawings of particular embodiments of the invention provided by way of non-limiting illustration only.

[34] [Fig.1] Figure 1 is a schematic view from above of a tank wall according to a first embodiment.

[35] [Fig.2] Figure 2 is a perspective view to a larger scale of a mechanical coupler of the tank wall from figure 1 in a retaining position.

[36] [Fig.3] Figure 3 is a view analogous to figure 2 showing a mechanical coupler in a release position.

[37] [Fig.4] Figure 4 is a perspective view of a tank wall in accordance with a second embodiment, the sealed membrane being omitted.

[38] [Fig.5] Figure 5 is a cutaway perspective view of a tank wall in accordance with a third embodiment.

[39] [Fig.6] Figure 6 is a schematic cutaway representation of a methane tanker ship tank and a terminal for loading/offloading that tank.

Description of embodiments

[40] Figure 1 represents a wall of a thermally insulating tank 1 as seen from above to show the structure of that wall. A structure of this kind may be implemented on extensive surfaces having diverse orientations, for example to cover the bottom, ceiling and side walls of a polyhedral tank. The orientation in figure 1 is not limiting in this regard.

[41] The tank 1 is attached to a supporting wall 2. By convention, “above” will refer to a position situated closer to the interior of the tank and “below” to a position situated closer to the supporting wall 2, whatever the orientation of the tank wall relative to the terrestrial gravity field.

[42] The tank wall includes at least one insulating barrier and one sealed membrane 10 (which is represented as if partially transparent in figure 1 for explanatory purposes) retained on top of the insulating barrier. The insulating barrier consists of a plurality of parallelepipedal insulating panels 3 that are disposed side by side in the form a plurality of parallel rows A, B so as substantially to cover the internal surface of the supporting wall 2. To make possible the flatness of the sealed member 10 beads 29 of mastic (represented in figure 4) are placed between the supporting wall 2 and the lower surface of the insulating panel 3. These beads 29 of mastic are for example stuck to the lower surface of the insulating panel 3. In accordance with one embodiment the beads of mastic may be corrugated beads as described in FR-A-2931535. Shims that are not represented may equally be provided on the supporting wall 2 to support the corners of the insulating panels 3.

[43] The insulating panels 3 includes for example a block 42 of high-density polymer, in particular polyurethane, foam with or without glass fibers and sandwiched between two plane plates made of plywood for example, namely a bottom plate 41 and a cover plate 44. For example, the block of foam has a density of the order of 130 kg/m^3. Other structures are equally possible.

[44] The rows A and B of insulating panels 3 extend in a first direction and are separated by interstices 4 that also extend in the first direction. In the row B the insulating panels 3 are separated in a substantially regular manner by interstices 5 that extend in a second direction. The insulating panels 3 have two edges parallel to the first direction and along which the first retaining members 21 are disposed. The insulating panels 3 have two edges parallel to the second direction and along which the second retaining members 22 are disposed.

[45] In accordance with one embodiment the beads 29 of mastic do not adhere to the supporting wall 2. To this end a film that is not represented, for example of kraft paper or plastic, is disposed between the beads 29 and the supporting wall 2. Here the retaining members 21 and 22 are arranged four by four per insulating panel 3 and serve to retain the insulating panels 3 on the supporting wall 2. They may be produced in various ways.

[46] In accordance with another embodiment the beads 29 of mastic also adhere to the supporting wall 2 to retain the insulating panels 3 by adhesion. In this case the retaining members 21 and 22 serve to retain the insulating panels 3 on the supporting wall 2 in a manner that is redundant with the aforementioned adhesion but above all during the polymerization of the mastic during the production of the tank.

[47] The sealed membrane 10 includes a continuous layer of metal strakes 11, 12 with raised edges, the length of which extends in the first direction and the width of which extends in the second direction. The raised edges of the strakes 11, 12 are welded to weld supports that are not represented fixed into grooves 13 formed on the cover plates 44 of the insulating panels 3. For example, the strakes 21 are made of Invar®: that is to say an alloy of iron and nickel the coefficient of expansion of which is typically between 1.2×10^{-6} and 2×10^{-6} K^{-1}. It is also possible to use alloys of iron and manganese the coefficient of expansion of which is typically of the order of 7 to 9×10^{-6} K^{-1}.

[48] The insulating barrier may be constructed on surfaces of any size by periodically repeating the rows of insulating panels A, B and the metal strakes 11 and 12 in the second direction. In the first direction the rows of insulating panels A, B and the metal strakes 11 and 12 may extend over any required length. As the dimension of the periodic pattern of the rows A, B is equal to twice the width of a strake 11, 12 and the longitudinal

edges of the strakes 11, 12 are offset by one half-width in the second direction relative to the edges of the rows A, B, it follows that a row A is covered by a strake 11 that rests entirely on it and two strakes 12 that straddle the row A and the two adjacent rows. Only the adjacent row B is represented here.

[49] Alternatively, the offset of the strakes 11, 12 could be different from a half-width but, so that the grooves 13 may be produced, this offset cannot be zero.

[50] Placing the retaining members 21 and 22 in the middle of the four edges of the insulating panels 3, which here have a square section, obtains the advantage of a substantially equal number of retaining members in line with each of the strakes 11 and 12.

[51] Moreover, compared to an anchorage provided at the four corners of the insulating panel 3, anchoring by the retaining members 21 and 22 arranged in the middle of the edges of the insulating panel 3 has the advantage of limiting the length of panel liable to bend because of the effect of loading ballast and/or a thermal gradient. Here this length is limited to the distance between a retaining member 21 or 22 and a corner, i.e. the half-length of the side. To the contrary, the distance between two retaining members is the entire length of the side if the retaining members are arranged at the corners of the insulating panel 3.

[52] If the dimension of the insulating panel 3 in the second direction (the direction of width of the strakes 11, 12) is greater, for example increased by a strake width, there will be a second strake 11 resting entirely on the row. In this case there may be a plurality of retaining members 22 spaced from one another along the edge of the insulating panel 3 in order for there always to be a retaining member 22 positioned in line with each of the strakes 11 resting entirely on the row.

[53] There is described below with reference to figures 2 and 3 an embodiment of the retaining members 21 and 22 in the form of a mechanical coupler.

[54] This mechanical coupler includes a stud 31 that extends perpendicularly to the supporting wall 2 and the lower end of which is accommodated in a bush 30 possibly forming a ball joint and itself welded to the supporting wall 2. The stud 31 could also be welded directly to the supporting wall 2.

[55] On the stud 31 are engaged successively a retaining part 32 able to pivot, spring washers 34 and a nut 33 taking the form of a split nut to prevent it being loosened by vibrations. In figure 3 the retaining part 32 is oriented parallel to the interstices 4 or 5 in which the coupler is disposed and therefore does not cooperate with the insulating

panels 3. In the retaining position illustrated in figure 2 the retaining part 32 has been pivoted approximately 90° about the stud 31, which constitutes a shaft engaged through the central part 36 so that the end lug 35 of the retaining part 32 enters a housing 43 in the insulating panel 3 to immobilize the latter in the direction of thickness. If the retaining part 32 is symmetrical as represented here, the second end lug 35 of the retaining part 32 is able to produce the same effect for a second insulating panel 3 (not represented) situated on the other side of the interstice.

[56] Here the housing 43 is a groove machined into the block 42 of foam that uncovers an upper surface of the bottom panel 41. The end lug 35 therefore has a flat shape parallel to the bottom panel 41 and can inter-engage with the latter over a sufficient area to prevent degrading it by punch-through.

[57] There has been represented with reference to figure 4 a second embodiment of the insulating barrier. Here the housings that receive the end lug 35 of the retaining part 32 are produced in the form of wells 143 passing through the entire thickness of the block 42 of foam and the cover plate 44. Thus here the locking of the insulating panel 3 is effected, not by pivoting the retaining part 32 but by placing it from above onto the stud 31. The well 143 then enables the nut 33 to be placed on and tightened on the stud 31.

[58] Figure 4 also shows a series of beads 29 of mastic disposed on the supporting wall 2 at the location of an insulating panel 3. This representation is explanatory and does not necessarily correspond to the manner in which the beads 29 of mastic are placed in the tank.

[59] The technique described hereinabove for producing a tank wall having a single sealed membrane can also be used in different types of reservoirs, for example to construct a double-membrane tank for liquefied natural gas (LNG) in a terrestrial installation or in a floating structure such as a methane tanker ship or other structure. In this context the sealed membrane 10 illustrated in the preceding figures may be considered a secondary sealed membrane and a primary sealing barrier and a primary sealed membrane, not represented, must be added to this secondary sealed membrane. In this way this technique can also be applied to tanks having a stacked plurality of thermally insulating barriers and sealed membranes.

[60] To this end figure 4 and figure 1 also show primary retaining members 46 that may optionally be provided on the cover panels 44 so as to be able to fix the primary insulating barrier. To be more precise figure 4 shows a first line I parallel to the first direction and situated in line with the retaining members 22 and a second line II parallel to the second direction and situated in line with the retaining members 21. As illustrated

here, the primary retaining members 46 are preferably situated on upper panels 44 at the intersection of the lines I and II. It will be clear that a series of parallel lines I may be traced out in the same manner on a plurality of successive rows. It will be clear that a series of parallel lines II may be traced out in the same manner on a plurality of successive insulating panels of a row.

[61] Alternatively, the primary retaining members may be positioned elsewhere on the insulating panels 3, for example on the lines I or on the lines II.

[62] A third embodiment of the plane tank wall, more particularly suitable for a double-membrane tank, will now be described with reference to figure 5.

[63] A cutaway view of the multilayer structure of a thermally insulating sealed tank wall 101 has been represented in figure 5. Elements analogous or identical to the preceding embodiments bear the same reference number and will not be described again.

[64] A primary insulating barrier 53 consisting of primary insulating panels 54 has been added to the secondary membrane formed by strakes 11, 12 and weld supports 55. A primary sealed membrane 51 has been added to the primary insulating barrier 53. Other details of the primary insulating barrier 53 and/or of the primary sealed membrane 51 may be found for example in the publication WO-A-2019234360.

[65] Referring to figure 6, a cutaway view of a methane tanker ship 70 shows a sealed and insulated tank 71 of prismatic general shape mounted in the double hull 72 of the ship. The wall of the tank 71 includes a primary sealed barrier intended to be in contact with the liquefied gas contained in the tank, a secondary sealed barrier arranged between the primary sealed barrier and the double hull 72 of the ship, 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 simplified variant the ship includes a single hull.

[66] In a manner known in itself loading/offloading pipes 73 disposed on the top deck of the ship may be connected by means of appropriate connectors to a maritime or harbor terminal to transfer a cargo of liquefied gas from or to the tank 71.

[67] Figure 6 shows an example of a maritime terminal including a loading and offloading station 75, an underwater pipe 76 and a terrestrial installation 77. The loading and offloading station 75 is a fixed off-shore installation including a mobile arm 74 and a tower 78 that supports the mobile arm 74. The mobile arm 74 carries a bundle of insulated flexible tubes 79 that can be connected to the loading/offloading pipes 73. The orientable mobile arm 74 adapts to all methane tanker loading gauges. A connecting

pipe that is not shown extends inside the tower 78. The loading and offloading station 75 enables loading and offloading of the methane tanker 70 from or to the terrestrial installation 77. The latter includes liquefied gas storage tanks 80 and connecting pipes 81 connected via the underwater pipe 76 to the loading or offloading station 75. The underwater pipe 76 enables transfer of the liquefied gas between the loading or offloading station 75 and the terrestrial installation 77 over a great distance, for example 5 km, which enables the methane tanker ship 70 to remain at a great distance from the coast during loading and offloading operations.

[68] Pumps onboard the ship 70 and/or pumps equipping the terrestrial installation 77 and/or pumps equipping the loading and offloading station 75 are used to generate the pressure necessary to transfer the liquefied gas.

[69] Although the invention has been described in connection with a plurality of particular embodiments, it is obvious that it is in no way limited to them and that it encompasses all technical equivalents and combinations of the means described if they fall within the scope of the invention.

[70] The use of the verb "to include" or "to comprise" and conjugate forms thereof does not exclude the presence of elements or steps other than those stated in a claim. Unless stated otherwise use of the indefinite article “a” or “an” for an element or a step does not exclude the presence of a plurality of such elements or steps.

[71] In the claims, any reference sign between parentheses should not be interpreted as a limitation of the claim.

Claims

[Claim 1] A thermally insulating sealed tank built into a load-bearing structure, said tank including a tank wall (1, 101) fixed to a supporting wall (2) of the load-bearing structure,
in which the tank wall includes a thermally insulating barrier fixed to the supporting wall and a sealed membrane carried by said thermally insulating barrier,
in which the thermally insulating barrier includes a plurality of rows (A, B, C) parallel to a first direction, a row including a plurality of juxtaposed parallelepipedal insulating panels (3), the rows being juxtaposed in a second direction perpendicular to the first direction in a repeated pattern,

in which the sealed membrane includes a plurality of metal strakes (11, 12) parallel to the first direction, a strake (11, 12) including a plane central portion resting on an upper surface of the insulating panels and two raised edges projecting toward the interior of the tank relative to the central portion, the strakes being juxtaposed in the second direction in a repeated pattern and welded together in sealed manner at the level of the raised edges,
in which the dimension of the repeated pattern of the rows is an integer multiple greater than or equal to two of the dimension of the repeated pattern of the strakes in the second direction, the strakes that rest on a row being arranged in such a manner that at least one said strake (11) rests entirely on said row and at least two strakes (12) straddle the row and two adjacent rows situated on either side of said row, the raised edges of said strakes being offset in the second direction relative to the edges of said row,
and in which the supporting wall carries first and second retaining members (21, 22) cooperating with first and second edges of the insulating panels (3) of said row to retain the insulating panels of said row on the supporting wall, the first retaining members (21) being disposed at the level of the first edges, the first edges being parallel to the first direction, the first retaining members (21) being disposed in line with the strakes (12) straddling the row and the adjacent rows, the second retaining members (22) being disposed at the level of the second edges, the second edges being parallel to the second direction, and the second retaining members (22) being disposed at a distance from the

corners of the insulating panels of the row and in line with said or each strake (11) that rests entirely on said row.

[Claim 2] The tank as claimed in claim 1, in which the first retaining members (21) are disposed at a distance from the corners of the insulating panels (3) of the row.

[Claim 3] The tank as claimed in claim 1 or 2, in which the raised edges of said strakes (11, 12) are offset in the second direction by a distance equal to half the dimension of the repeated pattern of the strakes relative to the edges of the row, the second retaining members (22) being distant from the corners of the insulating panels by a distance equal to the dimension of the repeated pattern of the strakes or to an integer multiple of that dimension.

[Claim 4] The tank as claimed in any one claims 1 to 3, in which the dimension of the repeated pattern of the rows (A, B, C) is twice the dimension of the repeated pattern of the strakes (11, 12) in the second direction, the second retaining members (22) being arranged in the middle of the second edges.

[Claim 5] The tank as claimed in any one of claims 1 to 3, in which the dimension of the repeated pattern of the rows is greater than twice the dimension of the repeated pattern of the strakes in the second direction and in which second retaining members spaced from one another by a distance equal to the dimension of the repeated pattern of the strakes are arranged along a second edge.

[Claim 6] The tank as claimed in any one of claims 1 to 5, in which the parallelepipedal insulating panels (3) of the row are juxtaposed in accordance with a repeated pattern in the first direction, in which the dimension of the repeated pattern in the first direction is twice the dimension of the repeated pattern of the strakes (11, 12) in the second direction, and in which the first retaining members (21) are arranged in the middle of the first edges.

[Claim 7] The tank as claimed in any one of claims 1 to 6, in which the parallelepipedal insulating panels (3) have a square shape.

[Claim 8] The tank as claimed in any one of claims 1 to 7, in which the second retaining member (22) includes a stud (30, 31) fixed perpendicularly to the supporting wall (2) in an interstice (5) between two parallelepipedal insulating

panels (3) of the row and an elongate attachment part (32) having a central part (36) mounted to pivot on the stud and two end parts (35) extending transversely to the stud on either side of the latter, the attachment part (32) being pivotable between a release position in which the attachment part is oriented parallel to the second direction and a retaining position in which the attachment part is oriented parallel to or obliquely to the first direction, said two parallelepipedal insulating panels (3) having lateral housings (43, 143) to receive the end parts (35) of the attachment part in the retaining position so that the attachment part (32) in the retaining position immobilizes the two parallelepipedal insulating panels in the direction of thickness of the tank wall.

[Claim 9] The tank as claimed in any one of claims 1 to 8, in which the first retaining member (21) includes a stud (30, 31) fixed perpendicularly to the supporting wall (2) in an interstice (4) between two rows (A, B) and an elongate attachment part (32) having a central part (36) mounted to pivot on the stud and two end parts (35) extending transversely to the stud on either side of the latter, the attachment part being pivotable between a release position in which the attachment part (32) is oriented parallel to the first direction and a retaining position in which the attachment part is oriented parallel to or obliquely to the second direction, two parallelepipedal insulating panels (3) situated on either side of the interstice (4) having lateral housings (43, 143) to receive the end parts (35) of the attachment part in the retaining position so that the attachment part (32) in the retaining position immobilizes the two parallelepipedal insulating panels in the direction of thickness of the tank wall.

[Claim 10] The tank as claimed in either one of claims 8 or 9, in which the end parts (35) of the attachment part in the retaining position cooperate with an upper surface of a bottom plate (41) of the parallelepipedal insulating panels (3).

[Claim 11] The tank as claimed in any one of claims 8 to 10, in which the stud (30, 31) also carries a nut (33) screwed onto an end portion of the stud opposite the supporting wall and spring washers (34) arranged between the nut (33) and the central part (36) of the attachment part.

[Claim 12] The tank as claimed in any one of claims 1 to 11, in which anchor flanges (51) anchored to the insulating panels and parallel to the first direction are arranged between the juxtaposed strakes (11, 12) to retain the sealed membrane on the insulating barrier.

[Claim 13] The tank as claimed in any one of claims 1 to 12, in which the thermally insulating barrier is a secondary insulating barrier and the sealed membrane is a secondary sealed membrane, the tank wall further including a primary sealed membrane (51) intended to be in contact with a product contained in the tank and a primary insulating barrier (53) arranged between the primary sealed membrane and the secondary sealed membrane (10).

[Claim 14] The tank as claimed in claim 13, in which the first and second retaining members (21, 22) are first and second secondary retaining members, the tank further including primary retaining members placed on the insulating panels (3) of said row at places situated on a first line (A) parallel to the first direction and situated in line with said one second secondary retaining member (22) and a second line (B) parallel to the second direction and situated in line with said one first secondary retaining member (21).

[Claim 15] A ship (70) for the transport of a fluid, the ship including a double hull (72) and tank (71) as claimed in any one of claims 1 to 14 built into the double hull (72).

[Claim 16] A transfer system for a fluid, the system including a ship (70) as claimed in claim 15, insulated pipes (73, 79, 76, 81) arranged in such a manner as to connect the tank (71) of the ship to a floating or terrestrial storage insulation (77) and a pump for driving a fluid through the insulated pipes from or to the floating or terrestrial storage insulation to or from the tank of the ship.

[Claim 17] A method for loading or offloading a ship (70) as claimed in claim 15, in which a fluid is routed through insulated pipes (73, 79, 76, 81) from or to a floating or terrestrial storage installation (77) to or from the tank (71) of the ship.