

Description

Title of the invention: Self-supporting case suitable for supporting and thermally insulating a sealed membrane

Technical field

- 5 [0001] The invention relates to the field of the sealed and thermally insulating tanks incorporated in a supporting structure for containing a fluid, notably the tanks with a membrane for containing liquefied gases, in particular fuel gases. In particular, the invention relates also to self-supporting cases made of wood suitable for supporting and thermally insulating the membranes of such tanks.
- 10 [0002] Sealed and thermally insulating tanks can be used in different industries for storing fluids. For example, in the field of energy, liquefied natural gas (LNG) is a liquid with high methane content which can be stored at atmospheric pressure at approximately -163°C in onshore storage tanks or in tanks embedded in floating structures. Liquefied petroleum gas (LPG) can be stored at a temperature of between -50°C and 0°C .
- 15 [0003] In the case of a floating structure, the tank can be intended to transport liquefied gas or to receive liquefied gas serving as fuel for the propulsion of the floating structure.

Prior art

- [0004] A self-supporting case made of wood is known, for example from FR-A-2867831, that is suitable for supporting and thermally insulating a sealed membrane intended to
- 20 contain a fluid, the case comprising:
a bottom panel,
lateral webs fixed to the bottom panel and protruding at right angles on one side of the bottom panel to delimit the outline of an internal space of the case,
a cover panel supported and fixed on a top edge of the lateral webs parallel to the
- 25 bottom panel and at a distance from the bottom panel to close the internal space of the case, the cover panel comprising a top plate and a bottom plate that are superposed on and fixed to one another,
at least one groove formed in the cover panel and emerging on a top surface of the cover panel to receive a weld support intended to retain a sealed membrane on the
- 30 cover panel,
at least one supporting partition extending longitudinally vertically in line with the or each groove parallel to the groove, the supporting partition being arranged at right angles to the bottom panel and to the cover panel, the supporting partition extending between said

lateral webs so as to divide the internal space into a plurality of compartments intended to receive a heat-insulating packing, the supporting partition having a top surface in contact with the bottom plate of the cover panel and a bottom surface in contact with the bottom panel,

5 and fasteners engaged at right angles in the bottom plate and the top surface of the supporting partition to fasten the supporting partition to the cover panel.

[0005] In FR-A-2867831, this self-supporting case is used to produce a primary thermally insulating barrier supporting a primary sealed membrane. The primary sealed membrane is welded to a weld support which forms a slip joint with an attachment strip stapled in
10 the groove. For that, the longitudinal groove passes through the two boards of the cover panel and the top part of the underlying supporting partition between two rows of staples.

[0006] It is also known practice, for example from FR-A-2867831 or WO-A-8909909, to use a secondary self-supporting case which comprises a simple cover plate grooved with grooves having a T-shaped section to receive a weld support in the form of a wing folded
15 at right angles. In FR-A-2867831, there is no supporting partition vertically in line with the groove. In WO-A-8909909, the cover plate is fixed to an underlying supporting partition by screws housed at the bottom of the groove.

Summary of the invention

[0007] One aim of the invention is to propose a strong self-supporting case that can be used
20 to produce a primary insulating barrier in a tank, that is likely to be subjected to dynamic pressures and impacts caused by the rocking of the cargo. Another aim of the invention is to allow the use of a weld support in the form of a wing folded at right angles also in a primary sealed membrane, for example in order to simplify or standardize manufacturing procedures and reduce an inventory of parts.

25 [0008] For that, the invention provides an abovementioned self-supporting case, characterized in that the groove has a section comprising, in succession in a thickness-wise direction of the top plate, a wider bottom part and a narrower orifice part, and that the top surface of the supporting partition is wider than the bottom part of the groove, the fasteners being engaged in a zone of the bottom plate that is offset laterally
30 with respect to the bottom part of the groove.

[0009] By virtue of these features, the fasteners engaged in the bottom plate to fasten the supporting partition to the cover panel do not embrittle the cover panel vertically in line with the groove. This arrangement therefore makes it possible to reliably fix the

supporting partition while having a mechanical strength of the cover panel that is increased by comparison to a case of the prior art.

[0010] According to embodiments, such a self-supporting case can comprise one or more of the following arrangements.

5 [0011] Preferably, the groove is formed only in the top plate of the cover panel.

[0012] Preferably, the fasteners fasten the supporting partition to the cover panel independently of the top plate. Thus, the top plate of the cover panel is not embrittled by the presence of the fasteners.

10 [0013] According to one embodiment, the groove has a T-shaped section, in which the bottom part of the groove corresponds to the horizontal bar of the T and the orifice part corresponds to the vertical bar of the T.

[0014] According to one embodiment, the bottom part of the groove has a width of between 20 and 30 mm.

15 [0015] According to one embodiment, a difference between the width of the bottom part of the groove and the width of the top surface of the supporting partition is greater than 10 mm.

[0016] According to one embodiment, a median line of the bottom part of the groove is situated vertically in line with a median plane of the supporting partition.

20 [0017] According to one embodiment, the fasteners are positioned on either side of a median plane of the supporting partition.

[0018] According to one embodiment, the supporting partition is made of wood, of plywood or of composite material.

[0019] According to one embodiment, the supporting partition has a uniform width that is wider than the bottom part of the groove.

25 [0020] According to another embodiment, the internal partition has a top sole plate positioned parallel against the bottom plate and a central portion positioned under the top sole plate, the top sole plate being wider than the bottom part of the groove, the central portion having a width equal to or narrower than the bottom part of the groove.

30 [0021] According to one embodiment, the supporting partition has a multilayer structure in a widthwise direction, the multilayer structure comprising a core made of insulating material and two lateral plates that are more rigid than the insulating material, the fasteners being engaged in the lateral plates. For example, the insulating material is

selected from among polymer foams, notably polyurethane foam, mineral fibers, notably glass wool, cotton wool and expanded polystyrene.

[0022] According to one embodiment, two parallel grooves are formed in the cover panel and a respective internal partition extends vertically in line with each groove.

5 [0023] According to one embodiment, the case has a generally rectangular parallelepipedal form.

[0024] According to one embodiment, the invention also provides a sealed and thermally insulating tank for storing a fluid, said tank comprising a tank wall fixed onto a supporting wall,

10 wherein the tank wall comprises, in the thickness-wise direction from the outside to the inside of said tank, a secondary insulating barrier retained on said supporting wall, a secondary sealed membrane retained on said secondary insulating barrier, a primary insulating barrier retained on said secondary sealed membrane and a primary sealed membrane retained on said primary insulating barrier, characterized in that said primary
15 insulating barrier is essentially composed of abovementioned cases, juxtaposed and filled with a heat-insulating packing, the primary sealed membrane being retained on the cover panels of said cases by weld supports inserted in said grooves.

[0025] According to one embodiment, the fluid is a liquefied gas, such as liquefied natural gas, liquefied petroleum gas or liquefied ethylene.

20 [0026] Such a tank can form part of an onshore storage installation, a storage installation placed on a seabed, for example for storing LNG, or be installed on a floating, coastal or deep-water structure, notably a methane tanker vessel, a floating storage and regassification unit (FSRU), a floating production and storage offshore unit (FPSO) and the like.

25 [0027] According to one embodiment, a vessel for transporting a fluid comprises a double-hull and an abovementioned tank positioned in the double-hull. According to one embodiment the double-hull comprises an inner hull forming the supporting wall of the tank.

30 [0028] According to one embodiment, the invention also provides a method for loading or offloading such a vessel, in which a fluid is conveyed through insulated pipelines from or to a floating or onshore storage installation to or from the tank of the vessel.

[0029] According to one embodiment, the invention also provides a transfer system for a fluid, the system comprising the above-mentioned vessel, insulated pipelines arranged so as to link the tank installed in the hull of the vessel to a floating or onshore storage

installation and a pump for driving a fluid through the insulated pipelines from or to the floating or onshore storage installation to or from the tank of the vessel.

Brief description of the drawings

[0030] The invention will be better understood, and other aims, details, features and advantages thereof will become more clearly apparent from the following description of several particular embodiments of the invention, given in a purely illustrative and nonlimiting manner, with reference to the attached drawings.

[0031] Figure 1 is a cutaway perspective view of a sealed and thermally insulating tank wall in which self-supporting cases can be used.

10 [0032] Figure 2 is a side view of a self-supporting case suitable for a primary insulating barrier of the tank wall of Fig. 1.

[0033] [Fig.3][Fig.4][Fig.5] Figures 3 to 5 are enlarged views of a zone III of Fig. 2 illustrating three embodiments of a supporting partition.

15 [0034] Figure 6 is a cutaway schematic representation of a methane tanker vessel tank and of a terminal for loading/offloading this tank.

Description of the embodiments

[0035] The general structure of a tank wall 1, sealed and thermally insulating, incorporated in and anchored to a supporting wall 2, is illustrated in Fig. 1. The tank wall 1 can form part of a tank of different geometries, for example a polyhedral form. Fig. 1 represents the tank wall 1 seen in perspective from above with a cutaway to show the structure of this wall. Such a structure can be implemented on extensive surfaces of various orientations, for example to cover bottom, ceiling and side walls of a polyhedral tank. The orientation of Fig. 1 is not therefore limiting in this respect. By convention, "above" will denote a position situated closer to the inside of the tank and "below" will denote a position situated closer to the supporting wall 2, whatever the orientation of the tank wall with respect to the Earth's gravitational field.

[0036] The tank wall 1 is composed, in succession in its thickness, of a secondary insulating barrier 3 which is formed by cases juxtaposed on the supporting wall 2 and retained thereon by secondary retaining members; then, a secondary sealed membrane 4 borne by the secondary insulating barrier 3; then by a primary insulating barrier formed by cases 5 juxtaposed and retained on secondary sealed membrane 4 by primary retaining members that are themselves fixed to the secondary retaining members 4 and, finally, a

primary sealed membrane 6 borne by the cases 5. Secondary and primary retaining members are, for example, described in FR-A-2798902.

[0037] The primary sealed membrane 6 can be composed of a continuous sheet of strakes 10 made of steel with high nickel content, for example 37%, known as invar, the expansion coefficient of which is typically between 1.2×10^{-6} and $2 \times 10^{-6} \text{ K}^{-1}$. It is also possible to use alloys of iron and manganese whose expansion coefficient is typically of the order of 7 to $9 \times 10^{-6} \text{ K}^{-1}$. The strakes 10 are tightly welded by their raised lateral edges on parallel weld supports 8 retained in grooves of the cover panels 7 of the cases 5. The secondary sealed membrane 4 can be produced identically, as illustrated in figure 1, or differently. The numeral 9 designates a groove for receiving a weld support of the secondary sealed membrane 4.

[0038] The case 5 that is partially visible in Fig. 1 has an overall parallelepipedal form. Fig. 2 shows a flat side view thereof according to the arrow II of Fig. 1.

[0039] Referring to Fig. 2, a bottom plate 22 and a top plate 21 fixed rigidly to one another, for example by screwing, gluing and/or stapling, together constitute the cover plate. The fixing together of the top 21 and bottom 22 plates is done for example at the periphery of the supporting partitions 26, 126 or 226 and vertically in line with the secondary partitions 25 while securing the top 21 and bottom 22 plates with the secondary partitions 25. The bottom panel 23 and the cover panel 7 have a rectangular outline and are spaced apart from one another by two longitudinal end webs 27 and two lateral end webs 24 together forming the outline of the internal space of the case 5. This internal space is compartmented by two supporting partitions 26 situated vertically in line with the grooves 30 and possibly with the secondary partitions 25 that can be narrower than the supporting partitions 26. The supporting partitions 26 and the secondary partitions 25 extend longitudinally at right angles to the two longitudinal end webs 27 and parallel to the two lateral end webs 24. All these elements are fixed as much as necessary by stapling, screwing and/or gluing. As an example, the secondary partitions 25 have a width of 12 mm and the longitudinal 27 and lateral 24 end webs have a width of between 12 and 24 mm.

[0040] To perform the thermal insulation function of the case 5, the compartments are filled with a heat-insulating packing, for example made of a material chosen from among expanded perlite, aerogel materials in particulate or fibrous form, expanded polystyrene, glass wool, cellulose cotton wool, low-density polymer foams, for example made of polyethylene, polyurethane or the like.

[0041] The dimensions of the case 5 can of course be different from the example represented in figure 2. In its width, the case 5 may have a single supporting partition 26 and a single groove 30 or, on the contrary, more than two supporting partitions 26 and grooves 30.

- 5 [0042] As can be seen better in Fig. 3, the groove 30 has an inverted T-shaped section, comprising a horizontal and wide bottom part 32 and a vertical and narrow orifice part 31, in order to receive a welding wing folded at right angles, according to the known technique. Alternatively, the bottom part 32 could extend on one side of the orifice part, such that the groove has an L-shaped section.
- 10 [0043] The supporting partition 26 is a sheet of plywood which has a width W greater than the width of the bottom part 32. This excess width makes it possible to place rows of staples 35 offset laterally with respect to the bottom part 32, that is to say outside of the zone situated directly vertically in line with the groove 30, to fix the supporting partition 26 to the bottom plate 22. This arrangement makes it possible to preserve the rigidity of
- 15 the cover panel 7 despite the relatively great width of the groove 30, the bottom part 32 of which is for example 24 mm wide. In fact, even though the staples 35 can locally reduce the rigidity of the bottom plate 22 of the cover panel, this weakening does not occur at the same point as the resultant narrowing of the groove 30. Preferably, the excess width of the supporting partition 26 is greater than 10 mm. For example, the width
- 20 W is 36 mm or more and preferably 42 mm.

[0044] In Fig.3, the rigidity of the cover panel 7 is further enhanced by the following measures:

- the groove 30 is formed only in the top plate 21 of the cover panel. Thus, the groove 30 does not affect the rigidity of the bottom plate 22.
- 25 - the fasteners 35 do not affect the rigidity of the top plate 21.
- the supporting partition 26 is centered under the groove 30 and symmetrical with respect to a median plane.
- the fasteners 35 are positioned on either side of the median plane of the supporting partition.

- 30 [0045] Fig. 4 shows another embodiment of the supporting partition 126, which has a multilayer structure in its widthwise direction, with a core 41 made of insulating material and two lateral plates 42 that are more rigid than the insulating material on either side of the core 41. The fasteners 35 are engaged in the lateral plates 42, which are, for example, made of plywood. This construction makes it possible to limit the weight and

the thermal bridge with respect to the supporting partition 26. As an example, the lateral plates 42 have a width of 12 mm.

[0046] Fig. 5 shows another embodiment of the supporting partition 226, which has, in succession in the thickness-wise direction of the case 5, a top sole plate 52 positioned parallel against the bottom plate 22 and a central portion 51 positioned under the top sole plate 52. The top sole plate 52 has a width W greater than the width of the bottom part 32. Conversely, the central portion 51 can be equal to or narrower than the bottom part 32 of the groove 30. The top sole plate 52 and the central portion 51 are, for example, made of plywood. This construction makes it possible to limit the weight and the thermal bridge with respect to the supporting partition 26. As an example, the central portion 51 has a width of between 18 and 30 mm, preferably 24 mm. As an example, the top sole plate 52 has a width greater than 24 mm, for example 42 mm, 50 mm or 60 mm.

[0047] In one embodiment, the top sole plate 52 can have a width equal to the spacing between the supporting partition 226 and a secondary partition adjacent to the supporting partition 226 or less than this spacing. In one embodiment, the supporting partitions 226 and the possible secondary partitions 25 are distributed according to a uniform spacing pitch and the top sole plate 52 can have a width equal to the uniform spacing pitch or smaller than that.

[0048] Figure 2 shows also other features of the self-supporting case 5, that can be used according to the requirements:

- to have an inert gas circulating in the primary insulating barrier, holes 28 are formed in the webs 27 of the case 5.
- a gas-permeable plug 17, made of glass fiber fabric, is glued in front of each hole 28 on the internal surface of the web 27 to avoid leakages of the heat-insulating packing.
- fixing tenons 19 serving as bearing surface for the primary retaining members are fixed against the webs 27 on rims of the bottom panel 23.
- a stiffener comb 16 at right angles to the supporting partitions 26 and secondary partitions 25 extends between the webs 24 at right angles to the bottom panel 23. At its intersection with the supporting partitions 26 and secondary partitions 25, it has notches to form a fitting with the supporting partitions 26 and secondary partitions 25.
- grooves 18 formed in the bottom panel 23 and the supporting partitions 26 make it possible to accommodate the protruding portions of the secondary sealed membrane 4.

[0049] Instead of plywood, composite materials can be used to produce all or part of the self-supporting case. For example, appropriate composite materials are taught in WO-A-2015079135.

[0050] A primary insulating barrier can be constructed entirely with the cases 5 described above, or only in certain parts of the tank. For example, the cases 5 described above can be used in proximity to the edges of the tank while other insulating blocks are used in other portions of the tank walls. Such an arrangement is described for example in WO-A-2019077253.

[0051] Referring to figure 6, a cutaway view of a methane tanker vessel 70 shows a sealed and insulated tank 71 of generally prismatic form mounted in the double-hull 72 of the vessel. The wall of the tank 71 comprises a primary sealed barrier intended to be in contact with the 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 arranged respectively between the primary sealed barrier and the secondary sealed barrier and between the secondary sealed barrier and the double-hull 72. In a simplified variant, the vessel comprises a single hull.

[0052] As is known per se, loading/offloading pipelines 73 arranged on the top deck of the vessel can be connected, by means of appropriate connectors, to a maritime or port terminal to transfer a cargo of liquefied gas from or to the tank 71.

[0053] Figure 6 shows an example of a maritime terminal comprising a loading and offloading station 75, a submarine line 76 and an onshore installation 77. The loading and offloading station 75 is a fixed offshore installation comprising a mobile arm 74 and a riser 78 which supports the mobile arm 74. The mobile arm 74 bears a bundle of insulated flexible pipes 79 that can be connected to the loading/offloading pipelines 73. The orientable mobile arm 74 adapts to all methane tanker templates. A link line that is not represented extends inside the riser 78. The loading and offloading station 75 makes it possible to load and offload the methane tanker 70 from or to the onshore installation 77. The latter comprises liquefied gas storage tanks 80 and link lines 81 linked by the submarine line 76 to the loading or offloading station 75. The submarine line 76 allows liquefied gas to be transferred between the loading or offloading station 75 and the onshore installation 77 over a great distance, for example 5 km, which makes it possible to keep the methane tanker vessel 70 at a great distance from the coast during the loading and offloading operations.

[0054] To generate the pressure necessary to the transfer of the liquefied gas, pumps embedded in the vessel 70 and/or pumps with which the onshore installation 77 is equipped and/or pumps with which the loading and offloading station 75 is equipped are implemented.

[0055] Although the invention has been described in relation to several particular embodiments, it is quite obvious that it is in no way limited thereto and it encompasses all the technical equivalents of the means described, and the combinations thereof provided the latter fall within the framework of the invention.

- 5 [0056] The use of the verb “comprise” or “include” and its conjugate forms does not exclude the presence of elements or steps other than those stated in a claim.

[0057] In the claims, any reference symbol between parentheses should not be interpreted as a limitation of the claim.

Claims

[Claim 1] A self-supporting case (5) suitable for supporting and thermally insulating a sealed membrane (6) intended to contain a fluid, the case (5) comprising:

a bottom panel (23),

5 lateral webs (24, 27) fixed to the bottom panel and protruding at right angles on one side of the bottom panel to delimit the outline of an internal space of the case,

a cover panel (7) supported and fixed on a top edge of the lateral webs parallel to the bottom panel and at a distance from the bottom panel to close the internal space of the case, the cover panel comprising a top plate (21) and a bottom plate (22)

10 superposed on and fixed to one another,

at least one groove (30) formed in the cover panel and emerging on a top surface of the cover panel to receive a weld support (8) intended to retain a sealed membrane (6) on the cover panel,

at least one supporting partition (26, 126, 226) extending longitudinally vertically in line with the groove (30) parallel to the groove, the supporting partition being

15 arranged at right angles to the bottom panel (23) and to the cover panel (7), the supporting partition extending between said lateral webs (27) so as to divide the internal space into a plurality of compartments intended to receive a heat-insulating packing, the supporting partition (26, 126, 226) having a top surface in contact with

20 the bottom plate (22) of the cover panel and a bottom surface in contact with the bottom panel,

and fasteners (35) engaged at right angles in the bottom plate (22) and the top surface of the supporting partition (26, 126, 226) to fasten the supporting partition to the cover panel,

25 characterized in that the groove (30) has a section comprising, in succession in a thickness-wise direction of the top plate, a wider bottom part (32) and a narrower orifice part (31),

and that the top surface of the supporting partition (26, 126, 226) is wider than the bottom part (32) of the groove, the fasteners (35) being engaged in a zone of the

30 bottom plate (22) offset laterally with respect to the bottom part (32) of the groove.

[Claim 2] The case as claimed in claim 1, wherein the groove (30) is formed only in the top plate (21) of the cover panel.

[Claim 3] The case as claimed in claim 1 or 2, wherein the fasteners (35) fasten the supporting partition (26, 126, 226) to the cover panel independently of the top plate (21).

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[Claim 4] The case as claimed in one of claims 1 to 3, wherein the groove (30) has a T-shaped section, in which the bottom part (32) of the groove corresponds to the horizontal bar of the T and the orifice part (31) corresponds to the vertical bar of the T.

5 [Claim 5] The case as claimed in one of claims 1 to 4, wherein the bottom part (32) of the groove has a width of between 20 and 30 mm.

[Claim 6] The case as claimed in one of claims 1 to 5, wherein a difference between the width of the bottom part (32) of the groove and the width (W) of the top surface of the supporting partition is greater than 10 mm.

10 [Claim 7] The case as claimed in one of claims 1 to 6, wherein a median line of the bottom part (32) of the groove is situated vertically in line with a median plane of the supporting partition (26, 126, 226).

[Claim 8] The case as claimed in one of claims 1 to 7, wherein the fasteners (35) are positioned on either side of a median plane of the supporting partition.

15 [Claim 9] The case as claimed in one of claims 1 to 8, wherein the supporting partition (26, 126, 226) is made of wood, of plywood or of composite material.

[Claim 10] The case as claimed in one of claims 1 to 9, wherein the supporting partition (26, 126) has a uniform width that is wider than the bottom part of the groove.

20 [Claim 11] The case as claimed in one of claims 1 to 9, wherein the internal partition (226) has a top sole plate (52) positioned parallel against the bottom plate (22) and a central portion (51) positioned under the top sole plate, the top sole plate (52) being wider than the bottom part (32) of the groove, the central portion (51) having an equal or narrower width than the bottom part (32) of the groove.

25 [Claim 12] The case as claimed in one of claims 1 to 10, wherein the supporting partition (126) has a multilayer structure in a widthwise direction, the multilayer structure comprising a core (41) made of insulating material and two lateral plates (42) that are more rigid than the insulating material, the fasteners (35) being engaged in the lateral plates (42).

30 [Claim 13] The case as claimed in one of claims 1 to 12, comprising two parallel grooves (30) formed in the cover panel and a respective internal partition (26, 126, 226) extending vertically in line with each groove.

[Claim 14] A sealed and thermally insulating tank for storing a fluid, said tank comprising a tank wall (1) fixed onto a supporting wall (2), wherein the tank wall comprises, in

the thickness-wise direction from the outside to the inside of said tank, a secondary insulating barrier (3) retained on said supporting wall (2), a secondary sealed membrane (4) retained on said secondary insulating barrier, a primary insulating barrier retained on said secondary sealed membrane and a primary sealed
5 membrane (6) retained on said primary insulating barrier, characterized in that said primary insulating barrier is essentially composed of cases (5) as claimed in one of claims 1 to 13 juxtaposed and filled with a heat-insulating packing, the primary sealed membrane (6) being retained on the cover panels of said cases by weld supports (8) inserted in said grooves (30).

10 [Claim 15] A vessel (70) for transporting a fluid, the vessel comprising a double-hull (72) and a tank (71) as claimed in claim 14 positioned in the double-hull (72).

[Claim 16] A transfer system for a fluid, the system comprising a vessel (70) as claimed
in claim 15, insulated pipelines (73, 79, 76, 81) arranged so as to link the tank (71) of
the vessel to a floating or onshore storage installation (77) and a pump for driving a
15 fluid through the insulated pipelines from or to the floating or onshore storage
installation to or from the tank of the vessel.

[Claim 17] A method for loading or offloading a vessel (70) as claimed in claim 15,
wherein a fluid is conveyed through insulating pipelines (73, 79, 76, 81) from or to a
floating or onshore storage installation (77) to or from the tank (71) of the vessel.