

Claims

[Claim 1] A storage installation for a liquefied gas comprising a supporting structure and a sealed and thermally insulating tank arranged in the supporting structure, the tank comprising at least a first tank wall (1) fixed to a first supporting wall (3) of the supporting structure and a second tank wall (101) fixed to a second supporting wall (103) of the supporting structure, each tank wall (1, 101) comprising at least one sealing membrane (4, 104) and at least one thermally insulating barrier (2, 102), the thermally insulating barrier (2, 102) being placed between the sealing membrane (4, 104) and the supporting structure, the first supporting wall (3) forming a corner with the second supporting wall (103) along an edge (100), the sealing membrane (4) of the first tank wall (1) including a plurality of metal plates (87),

in which the sealing membrane (4) includes a plurality of strakes parallel to a longitudinal direction perpendicular or oblique to said edge (100), each strake including a plane central portion resting on an upper surface of the thermally insulating barrier (2) and two raised edges projecting toward the interior of the tank relative to the central portion, the strakes being juxtaposed in accordance with a repeated pattern and welded together in sealed manner at the level of the raised edges,

in which the thermally insulating barrier (2) of the first tank wall (1) comprises an insulating fixing beam (11) anchored to the first supporting wall (3) and having a length extending parallel to the edge (100),

in which the tank comprises a corner insulation block (25) situated in line with the thermally insulating barrier (2) of the first tank wall (1) and the thermally insulating barrier (102) of the second tank wall (101) at the level of the edge (100), the corner insulation block (25) being configured to ensure the continuity of the thermally insulating barrier (2) of the first tank wall (1) and of the thermally insulating barrier (102) of the second tank wall (101) at the level of the edge (100) of the supporting structure, the insulating fixing beam (11) being juxtaposed to the corner insulation block (25),

in which the insulating fixing beam (11) includes an upper face (13) maintained at a distance from the first supporting wall (3) by a plurality of shear webs (14), the shear webs (14) being situated between the upper face (13) and the first supporting wall (3) and oriented perpendicularly to the edge (100), the insulating fixing beam (11) including an insulating packing arranged between the shear webs (14), and the insulating fixing beam (11) also including a metal covering element (15) comprising a plane portion (16) forming the upper face (13), an end edge of the sealing membrane (4) of the first tank wall (1) being welded to the plane portion (16) of the metal covering element (15),

and in which the supporting structure comprises an abutment device (19) projecting from the first supporting wall (3) in the direction of the interior of the tank, the abutment device (19) having a length extending parallel to the edge (100), the abutment device (19) being placed along an edge of the insulating fixing beam (11) opposite the edge (100) and being configured to form an abutment limiting the movement of the insulating fixing beam (11) in a direction away from the second tank wall (101).

[Claim 2] The storage installation as claimed in claim 1, in which the metal covering element (15) comprises a plane metal plate (63) including a supporting portion (65) projecting from the shear webs (14) in the direction of the sealing membrane (4, 104) and in a direction away from the edge (100) so that an end of the supporting portion (65) rests on an insulating panel (7) of the thermally insulating barrier (2, 102) adjacent to the insulating fixing beam (11, 111).

[Claim 3] The storage installation as claimed in claim 2, in which the plane metal plate (63) has a dimension in the direction of the edge (100) equal to the separation between two adjacent shear webs (14) and is arranged so as to extend between the two adjacent shear webs (14).

[Claim 4] The storage installation as claimed in any one of claims 1 to 3, in which the shear webs (14) are made of composite material including a polymer resin and fibers (99).

[Claim 5] The storage installation as claimed in claim 4, in which the fibers (99) are oriented at an angle of $\pm 45^\circ$ relative to a direction of thickness of the tank wall.

[Claim 6] The storage installation as claimed in any one of claims 1 to 5, in which the insulating fixing beam (11, 111) comprises a fixing angle-iron (67) including a first angle-iron flange (68) and a second angle-iron flange (69) connected to the first angle-iron flange (68), the second angle-iron flange (69) being fixed to one of the shear webs (14) and the first angle-iron flange (68) being welded to the metal covering element (15).

[Claim 7] The storage installation as claimed in any one of claims 1 to 5, in which the insulating fixing beam (11, 111) comprises a fixing angle-iron (67) including a first angle-iron flange (68) and a second angle-iron flange (69) connected to the first angle-iron flange (68), the second angle-iron flange (69) being fixed to one of the shear webs (14) and the first angle-iron flange (68) comprising at least one fixing orifice (64) coinciding with a fixing orifice (64) of the metal covering element (15) so as to fix the first angle-iron flange (68) to the plane metal plate (63) by means of a fixing device

(47) traversing the fixing orifice (64) in the metal covering element (15) and the fixing orifice (64) in the first angle-iron flange (68).

[Claim 8] The storage installation as claimed in claim 6 or claim 7, in which the second angle-iron flange (69) includes a beveled portion (82) at an end remote from the first angle-iron flange (68).

[Claim 9] The storage installation as claimed in any one of claims 1 to 8, in which the insulating fixing beam (11, 111) includes a cleat (83) fixed to a face of the shear web (14) perpendicular to the edge (100) and extending parallel to the metal covering element (15), the cleat (83) including a principal portion (84), an upper extension (85) and a lower extension (86) on respective opposite sides of the principal portion (84), the principal portion (84), the upper extension (85) and the lower extension (86) being fixed to the shear web (14),

and in which the cleat (83) is fixed to the supporting structure with the aid of anchoring studs (92) distributed over a length of the cleat (83), the anchoring studs (92) coming to exert a clamping force against an upper face of the principal portion (84) of the cleat (83).

[Claim 10] The storage installation as claimed in claim 9, in which the upper extension (85) is beveled so as to have a thickness that decreases in the direction away from the principal portion (84).

[Claim 11] The storage installation as claimed in any one of claims 1 to 10, in which the abutment device (19) includes an abutment bar (30), the abutment bar (30) extending in a continuous manner parallel to the edge (100) along the edge opposite the edge (100) of the insulating fixing beam (11).

[Claim 12] The storage installation as claimed in any one of claims 1 to 10, in which the abutment device (19) includes a plurality of abutment lugs (32), the abutment lugs (32) being regularly spaced along the edge opposite the edge (100) of the insulating fixing beam (11).

[Claim 13] The storage installation as claimed in any one of claims 1 to 12, in which the insulating fixing beam (11) include(s) an internal anti-buckling portion (22) extending the shear webs (14) in a direction away from the edge (100) and extending over a portion of the dimension separating the first supporting wall (3) from the metal covering element (15), the internal anti-buckling portion (22) being fixed by at least one fixing means (19, 47) to the first tank wall (3), and in which the abutment device (19) includes

a hook-forming device configured to fix the internal anti-buckling portion (22) to the first supporting wall (3).

[Claim 14] The storage installation as claimed in any one of claims 1 to 13, in which the insulating fixing beam (11) includes an external anti-buckling portion (21) extending the shear webs (14) in the direction of the edge (100) and extending over a portion of the dimension separating the first supporting wall (3) from the metal covering element (15), the external anti-buckling portion (21) being fixed by a fixing means (47) to the first supporting wall (3).

[Claim 15] The storage installation as claimed in claim 13 or 14, in which the fixing means (47) comprises a stud fixing the external anti-buckling portion (21) or the internal anti-buckling portion (22) to the supporting structure so that a first end of the stud is anchored to the supporting structure and a second end of the stud opposite the first end is equipped with a nut coming to bear on the external anti-buckling portion (21) or the internal anti-buckling portion (22).

[Claim 16] The storage installation as claimed in any one of claims 1 to 15, in which the supporting structure comprises an additional abutment device (20) projecting from the first supporting wall (3) in the direction of the interior of the tank, the additional abutment device (20) having a length extending parallel to the edge (100), the additional abutment device (20) being placed along an edge of the insulating fixing beam (11) adjacent to the edge (100) and being configured to form an abutment limiting the movement of the insulating fixing beam (11) in a direction opposite to the direction of the abutment device (19).

[Claim 17] The storage installation as claimed in claim 16, in which the additional abutment device (20) includes an additional abutment bar (31), the additional abutment bar (31) extending in a continuous manner parallel to the edge (100) along the edge opposite the edge (100) of the insulating fixing beam (11).

[Claim 18] The storage installation as claimed in claim 16, in which the additional abutment device (20) includes a plurality of additional abutment lugs (33), the additional abutment lugs (33) being regularly spaced along the edge opposite the edge (100) of the insulating fixing beam (11).

[Claim 19] The storage installation as claimed in any one of claims 16 to 18 in combination with claim 14, in which the additional abutment device (20) includes a hook-forming device configured to fix the external anti-buckling portion (21) to the first supporting wall (3), the hook-forming device constituting said fixing means (47).

[Claim 20] The storage installation as claimed in claim 13 or claim 14, in which the external anti-buckling portion (21) and/or the internal anti-buckling portion (22) is/are formed by portions (43) extending the shear webs (14).

[Claim 21] The storage installation as claimed in claim 13 and 14 in combination, in which the external anti-buckling portion (21) comprises a first lateral bar (44) extending parallel to the edge (100), the first lateral bar (44) including a wall pressed against a lateral surface of the shear webs (14), and the internal anti-buckling portion (22) comprises a second lateral bar (45) extending parallel to the edge (100), the second lateral bar (45) including a wall pressed against another lateral surface of the shear webs (14), the first lateral bar (44) and the second lateral bar (45) bracketing the shear webs (14).

[Claim 22] The storage installation as claimed in any one of claims 1 to 21, in which the metal covering element (15) of the insulating fixing beam (11) comprises a first lateral flange (17) extending perpendicularly to the shear webs (14) and in the direction of the first supporting wall (3), the first lateral flange (17) sandwiching the shear webs (14) with the abutment device (19) in order to absorb shear forces exerted by the sealing membrane (4, 104).

[Claim 23] The storage installation as claimed in claim 22, in which the metal covering element (15) of the insulating fixing beam (11) comprises a second lateral flange (18) extending perpendicularly to the shear webs (14) and in the direction of the first supporting wall (3) so that the first lateral flange (17) and the second lateral flange (18) bracket the shear webs (14), the first lateral flange (17) being situated closer to the edge (100) than the second lateral flange (18).

[Claim 24] The storage installation as claimed in any one of claims 1 to 23, in which the tank comprises a corrugated seal (23) comprising a first flat and a second flat forming a corner with the first flat, the first flat being welded in sealed manner to the sealing membrane (4) of the first tank wall (1) and the second flat being welded in sealed manner to the sealing member (104) of the second tank wall (101), the corrugated seal (23) being configured to connect in sealed manner the sealing membrane (4) of the first tank wall (1) and the sealing membrane (104) of the second tank wall (101).

[Claim 25] The storage installation as claimed in claim 24, in which the sealing membrane (4, 104) includes a metal anchoring strip (88) welded to the metal covering element (15), one of the metal plates (87) being welded in sealed manner to a portion of the metal anchoring strip (88) and the metal seal (23) being welded in sealed manner to another portion of the metal anchoring strip (88).

[Claim 26] The storage installation as claimed in claim 25, in which the secondary insulating panel (7) adjacent to the insulating fixing beam (11, 111) includes an upper plate (90) provided with a recess (91) extending in the direction of the edge (100) and situated at the end closest to the edge (100) of the upper plate (90), one end of the metal covering element (15) being placed in the recess (91) in order to obtain a plane support surface for the sealing membrane (4, 104).

[Claim 27] The storage installation as claimed in claim 24, in which the corner insulation block (25) comprises a first face (26) situated against the first supporting wall (3), a second face (27) situated against the second supporting wall (103), a third face (28) configured to offer a bearing surface to the first flat of the corrugated seal (23) and a fourth face (29) configured to offer a bearing surface to the second flat of the corrugated seal (23).

[Claim 28] The storage installation as claimed in any one of claims 1 to 27, in which the insulating fixing beam (11) comprises an upper plate (40) situated under the metal covering element (15) and extending along the insulating fixing beam (11) and in which each shear web (14) comprises on an upper edge two upper tenons (36) separated from one another in such a manner as to form an upper notch (37), the upper plate (40) comprising a plurality of grooves (42) extending parallel to the shear webs (14) and having a shape complementary to the upper tenons (36) in such a manner that the upper tenons (36) are accommodated in the grooves (42) in the upper plate (40) in order to form a mortise and tenon assembly between the shear webs (14) and the upper plate (40).

[Claim 29] The storage installation as claimed in any one of claims 1 to 28, in which the insulating fixing beam (11) comprises a lower plate (41) situated on the first supporting wall (3) and extending along the insulating fixing beam (11) and in which each shear web (14) comprises on a lower edge two lower tenons (38) separated from one another in such a manner as to form a lower notch (39), the lower plate (41) comprising a plurality of grooves (42) extending parallel to the shear webs (14) and having a shape complementary to the lower tenons (38) in such a manner that the lower tenons (38) are accommodated in the grooves (42) in the lower plate (41) in such a manner as to form a mortise and tenon assembly between the shear webs (14) and the lower plate (41).

[Claim 30] The storage installation as claimed in any one of claims 1 to 29, in which the thermally insulating barrier (2) of the first tank wall (1) or the thermally insulating barrier (102) of the second tank wall (101) comprises a plurality of insulating panels (7, 107)

including a lower wall situated close to the first supporting wall (3) or the second supporting wall (103), respectively, an upper wall and a structural insulating packing maintaining the upper wall at a distance from the lower wall, the insulating packing being composed of fiber-reinforced polymer foam.

[Claim 31] The storage installation as claimed in any one of claims 1 to 30, in which the thermally insulating barrier is a secondary thermally insulating barrier (2, 102) and the sealing membrane is a secondary sealing membrane (4, 104) and in which the first tank wall (1) and the second tank wall (101) further include, in a direction of thickness from the exterior to the interior of the tank, a primary thermally insulating barrier (5, 105) carried by the secondary sealing membrane (4, 104) and a primary sealing membrane (6, 106) carried by the primary thermally insulating barrier (5, 105).

[Claim 32] The storage installation as claimed in claim 31, in which the primary sealing membrane (6, 106) includes a plurality of corrugated metal plates, the corrugated metal plates being juxtaposed in accordance with a repeated pattern and welded together in sealed manner.

[Claim 33] The storage installation as claimed in any one of claims 1 to 32, in which the first tank wall (1) comprises bands of mastic (49) disposed between the insulating fixing beam (11) and the first supporting wall (3).

[Claim 34] The storage installation as claimed in any one of claims 1 to 33, in which the shear webs (14) comprise a central portion (51) oriented perpendicularly to the edge (100) and two peripheral portions (52) extending perpendicularly to the central portion (51), the peripheral portions (52) being parallel to one another and bracketing the central portion (51).

[Claim 35] The storage installation as claimed in claim 34, in which the peripheral portions (52) include a lower sole plate (252) and an upper sole plate (252) extending parallel to the first walls (3), the lower sole plates (252) of all the shear webs (14) forming a continuous or discontinuous bottom wall, the upper sole plates (252) forming a continuous or discontinuous covering wall.

[Claim 36] The storage installation as claimed in claim 34, in which the peripheral portions (52) include a front sole plate (152) and a rear sole plate (152) extending perpendicularly to the first supporting wall (3), the front sole plates (152) of all the shear webs (14) forming a continuous or discontinuous front wall facing away from the edge (100), the rear sole plates (152) of all the shear webs (14) forming a continuous or discontinuous rear wall facing toward the edge (100).

[Claim 37] The storage installation as claimed in any one of claims 1 to 36, in which the insulating fixing beam (11) comprises a bottom element (53) including a plane portion (54) resting on the first supporting wall (3) and two lateral walls (55) bracketing the shear webs (14) and extending parallel to the shear webs (14) in the direction of the metal covering element (15), the lateral flanges (55) being fixed by an anchoring means to a central portion (51) of end shear webs (56), the end shear webs (56) being two shear webs (14) formed at the ends of the insulating fixing beam (11) in the direction of the edge (100).

[Claim 38] The storage installation as claimed in claim 37, in which the bottom element (53) comprises at least one bearing element (57) fixed to one of the lateral flanges (55), the bearing element (57) projecting from one of the end shear webs (56), the anchoring means comprising a hook-forming device situated on the bearing element (57) and configured to fix the insulating fixing beam (11) to the first supporting wall (3).

[Claim 39] The storage installation as claimed in claim 37 or claim 38, in which the bottom element (53) is made of metal or of composite material.

[Claim 40] The storage installation as claimed in claims 23 and 37 in combination, in which the metal covering element (15) comprises two internal flanges (58) extending at the ends of the plane portions (16) of the metal covering element (15) and parallel to the first lateral flange (17) and to the second lateral flange (18), the internal flanges (58) being situated between the front and rear sole plates (152) of the shear webs (14), the first lateral flange (17) and the second lateral flange (18) bracketing the front and rear sole plates (152) of the shear webs (14), the first lateral flange (17) being fixed by a fixing means (60) to one of the internal flanges (58) and the second lateral flange (18) being fixed by a fixing means (60) to the other of the internal flanges (58).

[Claim 41] The storage installation as claimed in any one of claims 1 to 40, in which the insulating fixing beam is a first insulating fixing beam (11), the abutment device is a first abutment device (19), and the sealing member (104) of the second tank wall (103) includes a plurality of metal plates or a plurality of strakes parallel to a longitudinal direction perpendicular or oblique to said edge (100), each strake including a plane central portion resting on an upper surface of the thermally insulating barrier (102) and two raised edges projecting toward the interior of the tank relative to the central portion, the strakes being juxtaposed in accordance with a repeated pattern and welded together in sealed manner at the level of the raised edges, and the thermally insulating barrier (102) of the second tank wall (101) comprises a second insulating fixing beam (111) including an upper face (13) maintained at a distance from the second supporting

wall (103) by a plurality of shear webs (14), the shear webs (14) being situated between the upper face (13) and the second supporting wall (103) and oriented perpendicularly to the edge (100), the second insulating beam (111) including an insulating packing arranged between the shear webs (14), and the second insulating fixing beams (111) also including a metal covering element (15) comprising a plane portion (16) forming the upper face (13), an end edge of the sealing membrane (104) of the second tank wall (101) being welded to the plane portions (16) of the metal covering element (15), and in which the supporting structure comprises a second abutment device (119) projecting from the second supporting wall (103) in the direction of the interior of the tank, the second abutment device (119) having a length extending parallel to the edge (100), the second abutment device (119) being placed along an edge of the second insulating beam (11) opposite the edge (100) and being configured to form an abutment limiting the movement of the second insulating fixing beam (111) in a direction away from the first tank wall (1).

[Claim 42] A ship (70) for the transport of a cold liquid product, the ship including a double hull (72) and a storage installation (71) as claimed in any one of claims 1 to 41, a portion of the double hull forming the supporting structure of the storage installation.

[Claim 43] A transfer system for a cold liquid product, the system including a ship (70) as claimed in claim 42, insulated pipes (73, 79, 76, 81) arranged in such a manner as to connect the tank (71) installed in the hull of the ship to a floating or terrestrial storage installation (77), and a pump for driving a flow of cold liquid product through the insulated pipes from or to the floating or terrestrial storage installation to or from the tank of the ship.

[Claim 44] A method of loading or offloading a ship (70) as claimed in claim 42, in which a cold liquid product 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.