

CLAIMS

1. A sealed and thermally insulating tank intended for the storage of a fluid, said tank comprising a tank wall fixed to a flat bearing wall, the tank wall comprising a sealing membrane and a thermally insulating barrier disposed between
 - 5 the bearing wall and the sealing membrane,
 - the sealing membrane essentially consisting of a plurality of corrugated metal sheets tightly welded to one another which form a first series of equidistant parallel rectilinear corrugations extending in a first direction of the plane of the bearing wall and a second series of equidistant parallel rectilinear corrugations extending in a
 - 10 second direction of the plane of the bearing wall, the second direction being at right angles to the first direction, the distance between two adjacent corrugations of the first series and the distance between two adjacent corrugations of the second series being equal to a predetermined corrugation interval i_0 , the corrugated metal sheets having rectangular forms whose sides are parallel to, respectively, the first
 - 15 direction and the second direction of the plane of the bearing wall and whose dimensions are substantially equal to integer multiples of the corrugation interval, each edge of a corrugated metal sheet being situated between two adjacent corrugations parallel to said edge,
 - the thermally insulating barrier essentially consisting of a plurality of juxtaposed
 - 20 insulating panels each having an inner face which forms a support surface for the sealing membrane, the insulating panels having rectangular parallelepipedal forms whose sides are parallel to, respectively, the first direction and the second direction of the plane of the bearing wall and whose dimensions in projection in the plane of the bearing wall are substantially equal to integer multiples of the corrugation
 - 25 interval,
 - metal anchor plates being fixed onto the inner faces of the insulating panels and the corrugated metal sheets having edges welded to said anchor plates to retain the sealing membrane against said support surface,
 - the sealed tank being equipped with a through-element passing through the tank
 - 30 wall,
 - in which the thermally insulating barrier around the through-element comprises a plurality of insulating panels which form a ring of square form around the through-element, said ring having outer sides measuring substantially $9i_0$ which are parallel to, respectively, the first direction and the second direction of the plane of the

bearing wall, said ring delimiting, at its center, a square window whose sides measure substantially $3i_o$ and which are also parallel to, respectively, the first direction and the second direction of the plane of the bearing wall, such that the through-element passes through the thermally insulating barrier in said square window,

5 a first plurality of anchor plates being disposed on the inner face of said ring along the four outer sides of said ring, the distance between each anchor plate of the first plurality and the outer side that it runs along being equal to the corrugation interval, link parts linked tightly to the through-element being disposed in the square window

10 around the through-element on the inner face of the insulating panels which form the ring,

and in which the corrugated metal sheets of the sealing membrane around the through-element comprise:

two notched rectangular metal plates $3i_o$ wide in the first direction and $7i_o$ long in the second direction, which are symmetrical to one another in relation to an axis of symmetry parallel to the second direction passing through the center of the square window, called second axis of symmetry, each notched rectangular metal plate having three outer edges disposed in line with the first plurality of anchor plates and welded onto the first plurality of anchor plates and an inner edge having a notch

20 formed to avoid cutting said square window, said notch having a width equal to $1i_o$ in the first direction and a length equal to $3i_o$ in the second direction so that the notched portion of the inner edge runs along the square window,

and two metal retrofit plates disposed between the non-notched portions of the inner edges of the two notched rectangular metal plates, the two metal retrofit plates

25 being symmetrical to one another in relation to an axis of symmetry parallel to the first direction passing through the center of the square window, called first axis of symmetry, each metal retrofit plate being $1i_o$ wide in the first direction and $2i_o$ long in the second direction and having a corrugation aligned on said second axis of symmetry,

30 the two longitudinal edges of each metal retrofit plate being tightly welded to the inner edges of the two notched rectangular metal plates, and the outer lateral edge of each metal retrofit plate being welded to the anchor plates of the first plurality, the notched portion of the inner edge of each notched rectangular metal plate and

the inner lateral edge of each metal retrofit plate being tightly welded to said link parts.

2. The tank as claimed in claim 1, in which the inner face of said ring also bears a row of anchor plates parallel to the second direction which extends on
5 either side of the square window and which is offset to one side of the second axis of symmetry by a distance less than $1/10$, and in which a first of the longitudinal edges of each metal retrofit plate, in addition to being welded to the inner edge of a first of the notched rectangular metal plates, is welded to the row of anchor plates to be retained on the inner face of said ring, whereas the second longitudinal edge of
10 each metal retrofit plate is welded to the inner edge of the second notched rectangular metal plate without being retained on the inner face of said ring.

3. The tank as claimed in claim 2, in which a thermal protection coating is disposed on the inner face of said ring in a position symmetrical to the row of anchor plates in relation to the second axis of symmetry, to avoid degrading the
15 inner face by performing the welding between each metal retrofit plate and the second notched rectangular metal plate.

4. The tank as claimed in one of claims 1 to 3, in which the through-element comprises a main body disposed substantially at the center of the square window and extending in the direction of thickness of the tank wall and a tray
20 parallel to the bearing wall linked to the periphery of the main body and extending around the main body at the same level as the inner face of the ring, the link parts comprising closure plates disposed in the window between the tray and the corrugated metal sheets, each closure plate having a first edge welded onto the tray around the main body and a second edge welded onto a second plurality of anchor
25 plates around the square window, the second plurality of anchor plates being disposed on the inner face of said ring along the four inner sides of said ring, so as to run along the edges of the square window, and in which the notched portion of the inner edge of each notched rectangular metal plate and the inner lateral edge of each metal retrofit plate are tightly welded onto the closure plates.

30 5. The tank as claimed in claim 4, in which the tray of the through-element has a square form, the tray has a setback along the outer edges of its four sides, the insulating panels having setbacks along the four inner edges of the square ring, bridging elements being disposed straddling the insulating panels and

the tray, the bridging elements being placed on the bottom of the setbacks of the tray on one side and of the insulating panels on the other side, the thickness of the bridging elements being substantially equal to the depth of said setbacks so as to offer a flat support surface for the closure plates.

5 6. The tank as claimed in claim 4 or 5, further comprising a plurality of metal end parts welded to the closure plates and disposed at the intersections between the second edge of each closure plate and each of the corrugations of the first and second series which terminate on the notched portion of the inner edge of each notched rectangular metal plate and on the inner lateral edge of each metal
10 retrofit plate all around the square window, so as to close the terminations of said corrugations.

 7. The tank as claimed in one of claims 4 to 6, in which the main body of the through-element is a support foot for a piece of equipment intended to be placed in the tank, the support foot having a first end portion bearing against the
15 bearing wall and a second end portion protruding into the tank to support the piece of equipment at a distance from the tank wall.

 8. The tank as claimed in one of claims 1 to 6, in which the corrugated metal sheets of the sealing membrane further comprise a rectangular metal plate 2io wide in the first direction and 7io long in the second direction, which
20 is juxtaposed with the first or second notched rectangular metal plate moving away from the through-element in the first direction and disposed in the alignment of the first or second notched rectangular metal plate in the first direction.

 9. The tank as claimed in one of claims 1 to 7, in which the ring of square form of the thermally insulating barrier consists of two long insulating panels
25 having a width of 3io in the first direction and a length of 9io in the second direction and two short insulating panels having a width of 3io in the first direction and a length of 3io in the second direction, the long insulating panels being disposed in the alignment of one another in the first direction spaced apart by a distance of 3io in the first direction to delimit the square window in the first direction, the short
30 insulating panels being disposed between the two long insulating panels in the alignment of one another in the second direction and spaced apart by a distance of 3io in the second direction to delimit the square window in the second direction.

10. The tank as claimed in any one of claims 1 to 9, in which the corrugations of the metal sheets protrude toward the outside of the tank toward the bearing wall, the inner face of the secondary insulating panels having right-angled grooves receiving the corrugations of the metal sheets.

5 11. The tank as claimed in one of claims 1 to 10, in which said thermally insulating barrier is a secondary thermally insulating barrier retained against the bearing wall, and said sealing membrane is a secondary sealing membrane borne by the secondary thermally insulating barrier, the tank wall further comprising a primary thermally insulating barrier resting against the secondary
 10 sealing membrane and a primary sealing membrane borne by the primary thermally insulating barrier and intended to be in contact with the fluid contained in the tank, and in which the insulating panels forming the square ring bear two series of three anchoring members disposed on the mounting plates of the first plurality along the
 15 two edges of the square ring parallel to the first direction, the two series of three anchoring members being spaced apart by $7i_o$ and symmetrical to one another in relation to the first axis of symmetry, the three anchoring members of each series being disposed at, respectively, $1i_o$, $4i_o$ and $7i_o$ along an edge of the square ring parallel to the second direction such that the series of three anchoring members is dissymmetrical in relation to the second axis of symmetry,
 20 the primary thermally insulating barrier around the through-element comprising two primary insulating panels of rectangular parallelepipedal form having a width of $3i_o$ in the first direction and a length of $7i_o$ in the second direction, a first of said primary insulating panels having its four corners coinciding with the first and the second anchoring members of each series and being anchored to said first and second
 25 anchoring members of each series, a second of said primary insulating panels having its four corners coinciding with the second and the third anchoring members of each series and being anchored to said second and third anchoring members of each series, each of the two primary insulating panels having a respective cutout in its edge turned to the side of the through-element, the cutout of the first primary
 30 insulating panel having a width less than or equal to $1i_o$ in the first direction, the cutout of the second primary insulating panel having a width less than or equal to $2i_o$ in the first direction, each of the two cutouts having a length less than or equal to $3i_o$ in the second direction being symmetrical in relation to the first axis of symmetry.

12. The tank as claimed in claim 11 taken in combination with claim 4, in which the mounting plates of the first plurality also bear a series of anchoring members disposed along the outer longitudinal edge, opposite said cutout, of the first primary insulating panel, the outer longitudinal edge of the first primary
 5 insulating panel being anchored to the series of anchoring members, and in which at least one anchoring member is fixed onto the tray of the through-element on the side of the second primary insulating panel, inside the cutout of the inner longitudinal edge of the second primary insulating panel, the second primary insulating panel being anchored to said at least one anchoring member.

10 13. The tank as claimed in claim 12, in which the primary insulating panels have a sandwich structure consisting of a layer of insulating polymer foam sandwiched between two rigid plates, the second primary insulating panel comprising an oblong well passing through the inner rigid plate and the layer of insulating polymer foam of the second primary insulating panel to reveal an internal
 15 surface zone of the outer rigid plate, an anchoring part being on the one side fixed to the anchoring member of the tray of the through-element and on the other side bearing on the inner surface zone of the inner rigid plate to anchor the second primary insulating panel.

14. The tank as claimed in one of claims 11 to 13, in which the
 20 corrugated metal sheets of the primary sealed membrane around the through-element comprise two primary notched rectangular plates having a width of $3i_0$ in the first direction and a length of $9i_0$ in the second direction and symmetrical to one another in relation to the second axis of symmetry, each of the two primary notched rectangular plates being symmetrical in relation to the first axis of symmetry, each of
 25 the two primary notched rectangular plates having an inner longitudinal edge having a notch to circumvent the through-element, said notch having a width less than $1.5i_0$ in the first direction and a length less than $3i_0$ in the second direction so that the notched portion of the inner longitudinal edge interrupts two corrugations of the first series and one corrugation of the second series of each of the two primary notched
 30 rectangular plates,
 the notched portion of the inner longitudinal edge of each primary notched rectangular plate being tightly welded to link parts tightly linked to the through-element around the through-element on the inner face of the primary insulating panels.

15. The tank as claimed in claim 14, in which a third primary insulating panel of rectangular parallelepipedal form having a width of $3i_o$ in the first direction and a length of $7i_o$ in the second direction is juxtaposed with the second primary insulating panel opposite the first primary insulating panel,
- 5 and in which the inner face of the first, second and third primary insulating panels bears metal anchor plates to anchor the primary notched rectangular plates, the metal anchor plates comprising:
- first metal anchor plates disposed on the second primary insulating panel along the second axis of symmetry to anchor the non-notched portions of the inner
- 10 longitudinal edge of the two primary notched rectangular plates,
- second metal anchor plates disposed on the first primary insulating panel along a line parallel to the second axis of symmetry at a distance of $3i_o$ from the first metal anchor plates to anchor the outer longitudinal edge of a first of the two primary notched rectangular plates,
- 15 third metal anchor plates disposed on the third primary insulating panel along a line parallel to the second axis of symmetry at a distance of $3i_o$ from the first metal anchor plates to anchor the outer longitudinal edge of the second primary notched rectangular plate,
- and fourth metal anchor plates disposed on the first and second primary insulating
- 20 panels in the form of a square frame concentric with the square window accommodating the through-element to anchor the notched portions of the inner longitudinal edge of the two primary notched rectangular plates.

16. The tank as claimed in claim 15, in which the corrugated metal sheets of the primary sealed membrane further comprise a narrow rectangular plate
- 25 having a width of $1i_o$ in the first direction and a length of $9i_o$ in the second direction juxtaposed with the second primary notched rectangular plate opposite the first primary notched rectangular plate, fifth metal anchor plates being disposed on the third primary insulating panel along a line parallel to the second axis of symmetry at a distance of $1i_o$ from the third metal anchor plates to anchor the outer longitudinal
- 30 edge of the narrow rectangular plate.

17. A ship for transporting a fluid, the ship comprising a double hull and a tank as claimed in any one of claims 1 to 16 disposed in the double hull.

18. A method for loading or unloading a ship as claimed in claim 17, in which a fluid is routed through insulated pipelines from or to a floating or onshore storage installation to or from the tank of the ship.

19. A transfer system for a fluid, the system comprising a ship as
5 claimed in claim 17, insulated pipelines arranged so as to link the tank installed in the hull of the ship 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 ship.