

Fluid-tight and thermally insulative tank

Technical field

The invention relates to the field of membrane type fluid-tight and thermally
5 insulative tanks for the storage and/or the transportation of fluids such as a cryogenic fluid.

Membrane type fluid-tight and thermally insulative tanks are employed in particular for the storage of liquefied natural gas (LNG) which is stored, at atmospheric pressure, at approximately -162°C . These tanks may be installed on
10 land or on a floating structure. In the case of a floating structure, the tank may be intended to transport liquefied natural gas or to receive liquefied natural gas serving as fuel for the propulsion of the floating structure.

Technological background

Fluid-tight and thermally insulative tanks for liquefied natural gas are known
15 in the art, integrated into a support structure, such as the double hull of a ship intended to transport liquefied natural gas. Such tanks generally include a multilayer structure featuring in succession, in the direction of thickness, from the exterior toward the interior of the tank, a secondary thermal insulation barrier retained on the support structure, a secondary sealing membrane resting against the secondary
20 thermal insulation barrier, a primary thermal insulation barrier resting against the secondary sealing membrane, and a primary sealing membrane resting against the primary thermal insulation barrier and intended to be in contact with the liquefied natural gas contained in the tank.

The document WO2016/046487 describes a secondary thermal insulation
25 barrier and a primary thermal insulation barrier formed of juxtaposed insulating panels. In this document WO2016/046487 the secondary sealing membrane consists of a plurality of metal plates including corrugations projecting toward the exterior of the tank and therefore enabling the secondary sealing membrane to be deformed by the effect of thermal and mechanical loads generated by the fluid
30 stored in the tank. An internal face of the insulating panels of the secondary thermal insulation barrier features grooves receiving the corrugations of the corrugated

metal plates of the secondary sealing membrane. These corrugations and these grooves form a lattice of channels developing along the walls of the tank.

Summary

An idea on which the invention is based is to propose a sealing membrane
 5 type fluid-tight and thermally insulative tank including corrugations in which convection phenomena are reduced. In particular, one idea on which the invention is based is to provide a fluid-tight and thermally insulative tank limiting the presence of continuous circulation channels in the thermal insulation barriers in order to limit natural convection phenomena in said thermal insulation barriers. A further idea on
 10 which the invention is based is to provide such a tank adapted to allow for fabrication and/or assembly tolerances of the various constituent elements of said tank.

In accordance with one embodiment, the invention provides a fluid-tight and thermally insulative fluid tank, in which a tank wall includes at least one thermal
 15 insulation barrier and one sealing membrane,

the sealing membrane including a series of parallel corrugations having a longitudinal direction and plane portions situated between said corrugations, said corrugations projecting from the plane portions on a side projecting from the sealing membrane, said thermal insulation barrier being disposed on the side projecting
 20 from the sealing membrane,

said thermal insulation barrier including a series of parallel grooves in which are housed the corrugations,

and in which said groove has a width in a widthwise direction perpendicular to the longitudinal direction of the corrugations greater than the width in said widthwise
 25 direction of the corrugation housed in said groove,

the thermal insulation barrier further including a housing intersecting said groove and having a width greater than the width of the groove,

the tank further including a blocking member arranged in the housing, the blocking member having a width greater than the width of the groove, and preferably less
 30 than the width of the housing, the blocking member having a cut-out configured to receive the corrugation,

the blocking member being arranged in the housing in such a manner that the cut-out is housed in the groove and the corrugation is housed in the cut-out and so that the blocking member blocks a portion of the groove situated on the side projecting from the sealing membrane by creating a pressure drop for a flow circulating in the
 5 groove.

Thanks to these features, such a tank offers the possibility of flexibly blocking the grooves receiving the corrugations of the membrane despite a tolerance affecting the position of the corrugations in the grooves. Such a tolerance may in particular result from the fabrication and the mounting of the corrugations in
 10 the grooves. Moreover, thanks to these features, the groove portion between the convex side of the corrugation and the bottom of the groove, formed by the thermal insulation barrier, can be blocked by the blocking member for different positions of the corrugation in the groove. In particular, said groove portion can be blocked despite the uncertainty as to the positioning of the corrugation in the groove linked to
 15 the application and/or assembly tolerances. The width of the blocking member preferably enables blocking of the groove whatever the position of the corrugation in the groove. The width of the blocking member preferably enables positioning of said portion of the blocking member in the groove portion without necessitating modification of the blocking member, in particular without modification of its
 20 resistance to the flow of the gas.

The blocking member therefore enables limitation of the formation of flows in the channels of the thermal insulation barrier, in particular formation of thermosiphons between those channels and any flow channel situated closer to the hull, for example a mastic-filled space between the thermal insulation barrier and the
 25 support structure. In particular, it is possible to limit the formation of these flows for example in grooves having a vertical component in which such flows may be assisted by gravity.

Embodiments of such a tank may have one or more of the following features.

30 In accordance with one embodiment, the housing is developed in a plane perpendicular to the longitudinal direction of the corrugation.

In accordance with one embodiment, the cut-out of the blocking member has a shape complementary to the shape of the corrugation. In other words, the cut-

out has a concave shape and the corrugation has a convex shape with substantially identical radii of curvature.

In accordance with one embodiment, the membrane is a corrugated metal membrane.

5 In accordance with one embodiment, the thickness of the blocking member in the longitudinal direction of the corrugation is equal to the thickness of the housing in said longitudinal direction of the corrugation.

In accordance with one embodiment, a clearance between the housing and the blocking member is adapted to enable movement of the blocking member in the housing in the widthwise direction whilst preventing a peripheral flow between the housing and the blocking member. In accordance with one embodiment, that
10 clearance is plus or minus 0.1 mm.

In accordance with one embodiment, the depth of the blocking member in a direction of thickness of the tank wall is greater than or equal to the depth of the housing in said direction of thickness of the tank wall.
15

In accordance with one embodiment, the longitudinal direction of the corrugation includes a vertical component in the terrestrial frame of reference, that is to say in a direction of gravity.

The blocking member may be made from numerous materials. In accordance with one embodiment, the blocking member includes an assembly of materials. In accordance with one embodiment, the blocking member includes a material having a low coefficient of friction on its faces that face the housing. One such low coefficient of friction material is for example polyethylene, polypropylene, polymethylmethacrylate (PMMA), polyvinyl chloride (PVC) or a synthetic plastic
20 foam. In accordance with one embodiment, the blocking member is made from a foam of correctly chosen density in order to enable deformation thereof, for example of expanded polystyrene with a density to 10 to 30 kg/m³.
25

In accordance with one embodiment, the thermal insulation barrier includes a plurality of juxtaposed insulating elements held against a support wall.

30 In accordance with one embodiment, a plurality of insulating elements each include a respective groove portion, said insulating elements being aligned in such a

manner that the groove portions of said aligned insulating elements conjointly form the groove in which the corrugation is housed.

5 In accordance with one embodiment, at least one insulating element includes a plurality of portions of grooves housing distinct corrugations of the series of corrugations. In accordance with one embodiment, a plurality of blocking members is arranged on said at least one insulating element in such a manner as to block respective groove portions.

In accordance with one embodiment, the housing is formed in an insulating element.

10 Thanks to these features, the blocking member may be arranged in the insulating element at a prefabrication stage, prior to its installation in the tank. Such a tank is therefore simple and rapid to fabricate.

The housing may be formed in the insulating element in numerous ways. In accordance with one embodiment, the housing is produced by machining the insulating element. In accordance with one embodiment, the housing is produced by end milling using a two- size milling tool. In accordance with one embodiment, the housing is produced by rolling milling with a milling saw of diameter adapted to three sizes.

20 In accordance with one embodiment, the housing is formed in an interstice between two adjacent insulating elements.

Thanks to these features, the blocking member necessitates no modification of the insulating elements to be housed in the tank. Thus the insulating elements and therefore the tank are simple to fabricate.

25 In accordance with one embodiment, the blocking member is fixed to one side of an insulating element.

In accordance with one embodiment, an insulative filling is arranged in the interstice between the two adjacent insulating elements, said insulative filling forming a bottom of the housing.

30 Such a tank has good insulation characteristics. Moreover, the housing for the blocking member is therefore simple to produce.

In accordance with one embodiment, the depth of the blocking member in a direction of thickness of the tank wall is greater than, preferably slightly greater than, for example 1 to 3 mm greater than, the depth of the housing in said direction of thickness of the tank wall before installation of the sealing membrane. In other words, the blocking member has a depth such that its upper face extends 1 to 3 mm beyond the upper surface of the insulating element when it is arranged in the housing, on the surface of the insulative filling, before fitting the sealing membrane.

In accordance with one embodiment, the insulative filling is compressible. In accordance with one embodiment, the insulative filling is compressed by the blocking member when the corrugation rests in the cut-out of the blocking member.

In accordance with one embodiment, the blocking member includes a lower portion in contact with a bottom of the housing consisting of a rigid material, preferably having a low coefficient of friction to enable sliding of the blocking member in the housing.

In accordance with one embodiment, the blocking member includes a locally deformable portion, the corrugation bearing on the locally deformable portion.

In accordance with one embodiment, the lower portion of the blocking member in contact with the bottom of the housing consists of a material chosen from the material group consisting of polypropylene, polymethylmethacrylate, polyvinyl chloride, polyethylene, synthetic plastic foam or combinations thereof.

In accordance with one embodiment, the locally deformable portion consists of a material chosen from the material group consisting of fibrous materials, glass wool, melamine foam, flexible polyurethane foam or combinations thereof.

Thanks to these features, the pressure drop in the channel formed by the groove can be controlled. In particular, such a locally deformable portion does not block the groove in a fluid-tight manner and enables passage of the gas in the channel whilst causing a high pressure drop preventing the flow and convection phenomena. Moreover, such a locally deformable portion enables the blocking member better to espouse the profile of the corrugation. Finally, such a locally deformable blocking member enables local deformation to compensate fabrication tolerances of the various elements with which it cooperates.

In accordance with one embodiment, the blocking member includes a strip of compressible material on its upper face, that is to say on the face that faces the sealing membrane. In accordance with one embodiment, this strip is an attached strip. In accordance with one embodiment, such a strip has a thickness of 1 to 2 mm. In accordance with one embodiment, such a strip is for example made of fibrous material, of melamine foam or of another material. In accordance with one embodiment, this strip has dimensions substantially equal to the dimensions of the upper face of the blocking member in order not to create an unwanted bypass flow.

In accordance with one embodiment, the upper face of the blocking member has a profile favoring local deformation, for example a sawtooth profile perpendicular to the longitudinal direction of the corrugation.

In accordance with one embodiment, the corrugation has a first lateral surface inclined relative to a thickness direction of the tank wall, the blocking member having a second surface inclined relative to said thickness direction of the tank in such a manner as to cause the blocking member to slide in the width of the housing when the corrugation is inserted in the groove.

Thanks to these features, the corrugation is positioned in the cut-out of the blocking member automatically upon insertion of the corrugation in the groove. Indeed, the cooperation between the inclined surface of the corrugation and the inclined surface of the cut-out enables simple and rapid imposition of movement of the blocking member in the housing in order to position the cut-out correctly to receive the corrugation. Moreover, these features enable movement of the blocking member without generating high stresses on the corrugation liable to generate deformation of said corrugation.

In accordance with one embodiment, the width of the blocking member is greater than or equal to the width of the corrugation plus twice the width difference between the groove and the corrugation.

The blocking member therefore has a width adapted to block the groove portion between the corrugation and the thermal insulation barrier for any position of the corrugation in the groove. In particular, the width of the blocking member enables blocking of said portion of the groove even if the corrugation is in an extreme lateral position in the groove because of the fabrication and/or assembly tolerances.

In accordance with one embodiment, the blocking member is housed in the housing with one degree of freedom in movement in the widthwise direction.

In accordance with one embodiment, the blocking member is housed in the housing so as not to be prevented from moving in the direction of thickness of the tank wall between the sealing membrane and the thermal insulation barrier.

In accordance with one embodiment, the blocking member includes a member for fixing it in the housing adapted to prevent said blocking member from moving in the direction of thickness of the tank wall and to enable its movement in the widthwise direction in the housing. In accordance with an embodiment that is not shown, the fixing member consists of at least two hooks fixed into at least one insulating block. In accordance with one embodiment, the blocking member includes a blade housed, for example forcibly housed, between one of the insulating elements forming the interstice and the insulative filling in such a manner as to retain the blocking member in the direction of thickness of the tank.

In accordance with one embodiment, the cut-out forms a cam surface along which the corrugation slides when positioning the corrugation in the groove.

In accordance with one embodiment, the longitudinal direction of the corrugation includes a vertical component with respect to the terrestrial frame of reference, that is to say a component in the direction of terrestrial gravity.

In accordance with one embodiment, the tank includes a row of housings, said housings of the row of housings intersecting a respective groove of the series of grooves, said housings having a width greater than the width of the respective grooves, the tank further including a row of blocking members arranged in a respective housing, said blocking members having a width greater than the width of the groove intersected by the respective housing and less than a width of said housing, the blocking members having a cut-out configured to receive the corresponding corrugation, the blocking members being arranged in said housings in such a manner that the cut-out is housed in the corresponding groove and the corrugation is housed in said cut-out and so that the blocking member blocks a portion of said groove situated on the side projecting from the sealing membrane creating a pressure drop for a flow circulating in said groove.

In accordance with one embodiment, the series of parallel corrugations of the sealing membrane is a first series of parallel corrugations of the sealing

membrane and the longitudinal direction of said corrugations of said first series of corrugations is a first direction, the sealing membrane further including a second series of corrugations perpendicular to the first series, a longitudinal direction of the corrugations of the second series of corrugations forming a second direction
 5 perpendicular to the first direction, the blocking members of the row of blocking members being arranged between two adjacent corrugations of the second series of corrugations.

In accordance with one embodiment, the tank includes a plurality of row of blocking members housed in respective housings, said rows of blocking members
 10 being arranged at a regular interval in the longitudinal direction of the corrugations. Thanks to these features their effect is cumulative and creates serial pressure drops in the grooves housing the corresponding corrugations.

Thanks to these features, a pressure drop is created in the tank wall for the whole of said tank wall. In particular, whatever the path of circulation of a flow in the
 15 tank wall, the latter will encounter one of the blocking elements of the row of blocking elements.

In accordance with one embodiment, the tank includes a plurality of rows of blocking members housed in respective housings. In accordance with one embodiment, the rows of blocking members are arranged at a regular interval in the
 20 longitudinal direction of the corrugations in such a manner that their effect is cumulative and creates serial pressure drops in the grooves housing the corresponding corrugations. In accordance with one embodiment, the blocking members of two rows of blocking members are spaced in the longitudinal direction of the corrugations by a distance of 3 m. In accordance with one embodiment, the
 25 blocking members of two rows of blocking members are spaced in the longitudinal direction of the corrugations by a distance of 1 m.

In accordance with one embodiment, at least one blocking member is arranged in the tank wall in order to block a groove portion housing a corrugation of the second series of corrugations.

30 In accordance with one embodiment, the sealing membrane is supported by the thermal insulation barrier, the corrugations projecting toward the support wall.

In accordance with one embodiment, the sealing membrane is a secondary sealing membrane, the thermal insulation barrier is a primary thermal insulation

barrier, the corrugations projecting toward the interior of the tank, and the tank further includes a secondary thermal insulation barrier retained on the support wall and supporting the secondary sealing membrane, the primary thermal insulation barrier being supported by the secondary sealing membrane, the tank further
5 including a primary sealing membrane supported by the primary thermal insulation barrier and intended to be in contact with the fluid in the tank, the grooves being formed on a lower surface of the primary thermal insulation barrier.

In accordance with one embodiment, the sealing membrane is a primary sealing membrane, the thermal insulation barrier is a primary thermal insulation
10 barrier, the corrugations projecting toward the exterior of the tank, and in which the tank further includes a secondary thermal insulation barrier retained on the support wall and supporting a secondary sealing membrane, the primary thermal insulation barrier being supported by the secondary sealing membrane, the primary sealing membrane being supported by the primary thermal insulation barrier and intended to
15 be in contact with the fluid in the tank, the grooves being formed on an upper surface of the primary thermal insulation barrier.

Such a tank may form part of a terrestrial storage installation, for example for storing 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),
20 a floating production storage and offloading (FPSO) unit, etc.

In accordance with one embodiment, a ship for the transportation of a cold liquid product includes a double hull and an aforementioned tank disposed in the double hull.

In accordance with one embodiment, the invention also provides a method
25 of loading or offloading such a ship, in which a cold liquid product is fed through insulated pipes from or to a floating or terrestrial storage installation to or from the tank of the ship.

In accordance with one embodiment, the invention also provides a system for transferring a cold liquid product, the system including the aforementioned ship,
30 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 installation 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.

Brief description of the figures

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 of particular embodiments of the invention given by way of
 5 nonlimiting illustration only with reference to the appended drawings.

- figure 1 is a partial perspective view of a fluid-tight and thermally insulative tank wall thermal insulation barrier;
- 10 • figure 2 is a view from above of an insulating element of the thermal insulation barrier from figure 1;
- 15 • figure 3 is a part-sectional view of a thermal insulation barrier on which rests a corrugated sealing membrane including a corrugation housed in a groove of the thermal insulation barrier showing different possible positions of the corrugation in the groove;
- 20 • figure 4 is a partial perspective view of a thermal insulation barrier on which rests a sealing membrane and including a blocking member in accordance with a first embodiment of the invention;
- 25 • figure 5 is a schematic perspective view of a blocking member that may be used in the thermal insulation barrier from figure 4;
- figure 6 is a schematic plane view from above of a tank wall thermal insulation barrier showing a network of grooves intended to receive sealing membrane corrugations and rows of blocking members arranged in said thermal insulation barrier;
- 30 • figure 7 is a schematic partial perspective view of a thermal insulation barrier on which rests a sealing membrane and including a blocking member in accordance with a second embodiment;

- figure 8 is a schematic perspective view of a thermal insulation barrier on which rests a sealing membrane and including a blocking member in accordance with a third embodiment;
- 5 • figure 9 is a schematic perspective view of a thermal insulation barrier on which rests a sealing membrane and including a blocking member in accordance with a fourth embodiment prior to mounting it in the thermal insulation barrier;
- 10 • figure 10 is a view analogous to figure 9 showing the thermal insulation barrier after mounting the blocking member in the thermal insulation barrier;
- figure 11 is a partial sectional view of a tank wall including blocking members in accordance with a fifth embodiment;
- 15 • figure 12 is a sectional view of a detail of the tank wall from figure 11 at the level of a blocking member of the tank wall;
- 20 • figure 13 is a schematic cutaway representation of a methane tanker ship tank including a fluid-tight and thermally insulative tank and a terminal for loading/offloading that tank;
- 25 • figure 14 is a view from above of a thermal insulation barrier insulating panel of a bottom wall of a fluid-tight and thermally insulative tank schematically showing two rows of blocking members arranged in said insulating panel.

Detailed description of embodiments

By convention, the terms "external" and "internal" are used to define the position of one element relative to one another with reference to the interior and to

30 the exterior of the tank.

A fluid-tight and thermally insulative tank for storing and transporting a cryogenic fluid, for example liquefied natural gas (LNG), includes a plurality of tank walls each having a multilayer structure.

Such a tank wall includes, from the exterior toward the interior of the tank, a
 5 secondary thermal insulation barrier anchored to a support structure by secondary retaining members, a secondary sealing membrane supported by the secondary thermal insulation barrier, a primary thermal insulation barrier anchored to the secondary thermal insulation barrier, and a primary sealing membrane supported by the primary thermal insulation barrier and intended to be in contact with the
 10 cryogenic fluid contained in the tank.

The support structure may in particular be a self-supporting metal plate or, more generally, any type of rigid partition having appropriate mechanical properties, The support structure may in particular be formed by the hull or the double hull of a ship. The support structure includes a plurality of walls defining the general shape of
 15 the tank, usually a polyhedral shape. Some tanks may also include only one thermal insulation barrier and one sealing membrane, for example for storing LPG.

In figure 1 there has been represented a portion of a thermal insulation barrier, for example a secondary thermal insulation barrier, such as a fluid-tight and thermally insulative fluid tank wall.

20 This thermal insulation barrier includes a plurality of juxtaposed insulating panels 1 anchored to the support structure. The insulating panels 1 have a substantially rectangular parallelepiped shape. Figure 2 shows such an insulating panel 1 seen from above.

An insulating panel 1 can be made of various materials or various
 25 combinations of materials, in particular plywood, polymer foam, fiber-reinforced polymer foam. In embodiments, the insulating panel includes one or more metal plates fixed to its internal face to be able to weld on sealing membrane corrugated metal plates.

As shown in figure 1, each of the insulating panels 1 includes an insulating
 30 lining layer 2, for example an insulating polymer foam layer 2, sandwiched between an internal rigid plate 3 and an external rigid plate 4. The internal rigid plate 3 and the external rigid plate 4 are for example sheets of plywood glued onto said insulating polymer foam layer 2. The insulating polymer foam layer 2 may in

particular be a polyurethane-based foam layer. The polymer foam layer 2 is advantageously reinforced by glass fibers contributing to reducing its thermal contraction.

The insulating panels 1 are juxtaposed in parallel rows separated from one another by interstices 5 guaranteeing a functional assembly clearance. The interstices 5 are filled with a heat resistant lining 6 represented in figures 7 to 10. The heat resistant lining 6 is advantageously made from a porous material so as to avoid the formation of free spaces in the thermal insulation barrier without completely prohibiting circulation of gas in the interstices 5 between the insulating panels 1, for example circulation of an inert gas, such as nitrogen. The heat resistant lining 6 is for example made of glass wool, rock wool or open-cell flexible synthetic foam. The interstices 5 have for example a width of the order of 10 to 60 mm, in particular 30 mm.

As shown in figures 1 and 2, the internal plate 3 includes two series of mutually perpendicular grooves 7, 8 so as to form a network of grooves. Each of the series of grooves 7, 8 is parallel to two opposite sides of the insulating panels 1. The grooves 7, 8 are intended to receive corrugations 9 represented for example in figures 3 and 4 projecting toward the exterior of the tank formed on metal plates 10 of the sealing membrane. In the embodiment represented in figure 2 the internal plate 3 includes three grooves 7 extending in the longitudinal direction of the insulating panel 1 and nine grooves 8 extending in the transverse direction of the insulating panel 1.

Moreover, the internal plate 3 is equipped with small metal plates 11, 12 for anchoring the edge of the corrugated metal plates 10 of the sealing membrane onto the insulating panels 1. The small metal plates 11, 12 extend in two perpendicular directions parallel to two opposite sides of the insulating panels 1. The small metal plates 11, 12 are fixed to the internal plate 3 by screws, rivets or staples, for example. The small metal plates 11, 12 are placed in recesses formed in the internal plate 3 so that the internal surface of the small metal plates 11, 12 is flush with the internal face of the internal plate 3. The internal plate 3 has a substantially plane internal surface outside possible singular zones such as the grooves 7, 8 or the recesses for housing the small metal plates 11, 12. The metal plates 11 and 12 as shown are an illustrative example. These metal plates may be arranged with numbers, relative dimensions and positions different from those shown.

The internal plate 3 may equally be equipped with studs 13 projecting toward the interior of the tank and intended for fixing a primary thermal insulation barrier to the insulating panels 1. The studs 13 pass through orifices formed in the small metal plates 11, 12.

5 The sealing membrane comprises a plurality of corrugated metal plates 10 each having a substantially rectangular shape. Each corrugated metal plate 10 includes a first series of parallel corrugations 9 extending in a first direction and a second series of parallel corrugations 9 extending in a second direction. The directions of the two series of corrugations 9 of each corrugated metal plate 10 are
10 perpendicular. These corrugations 9 project toward the exterior of the tank, that is to say in the direction of the support structure. The corrugated metal plate 10 includes between the corrugations 9 a plurality of plane surfaces. The corrugations 9 of the corrugated metal plates 10 are housed in the grooves 7, 8 formed in the internal plate 3 of the insulating panels 1. Alternatively, and in a manner that is not shown,
15 corrugations 9 may also be housed in the interstices between insulating blocks.

The corrugated metal plates 10 are for example made of Invar®: that is to say an alloy of iron and nickel the coefficient of expansion of which is typically between 1.10^{-6} and 2.10^{-6} K^{-1} inclusive or an alloy of iron with a high content of manganese the coefficient of expansion of which is typically of the order of
20 7.10^{-6} K^{-1} . Alternatively, the corrugated metal plates 10 may equally be made of stainless steel or of aluminum.

During the fabrication of the tank the grooves 7, 8 are sized to constitute a zone of adjustment of the arrangement of the corrugations 9 in the tank. In particular, these grooves 7, 8 must be sized to enable variations in the dimensions
25 of the corrugations 9 linked to the fabrication tolerances of said corrugations 9 in the corrugated metal plates 10. Moreover, this sizing must take account of the tolerances on positioning the insulating panels 1 and the corrugated metal plates 10 relative to one another.

Figure 3 shows a central position 35 and extreme positions 34 defining a
30 range of possible positions of a corrugation 9 housed in a groove 7 or 8. The groove 7 or 8 is preferably sized in such a manner as to have a width 14 in a direction perpendicular to a longitudinal direction 15 of the corrugation 9 and parallel to an internal face 16 of the internal plate 3 that is greater than or equal to a width 17 of

the corrugation 9 in said direction, plus a predetermined tolerance value corresponding to twice the tolerance for positioning the corrugation 9 in the groove 7 on either side of the central position 35.

Because of these sizes, a space remains in the grooves 7, 8 between the thermal insulation barrier and the sealing membrane. These grooves 7, 8 could therefore constitute a network of circulation channels. Such channels developing continuously between the sealing membrane and the thermal insulation barrier throughout the tank wall would favor convection movements, in particular over tank walls having a large vertical component such as transverse tank walls. Such a network of continuous channels could generate thermosiphon phenomena favoring transfer of heat by gaseous convection in the thermal insulation barrier.

One aspect of the invention stems from the idea of preventing these convection movements in the walls of the tank. To this end, one aspect of the invention stems from the idea of limiting the length of the channels formed by the grooves 7, 8 of the thermal insulation barrier.

In accordance with the first embodiment, blocking members 18 are inserted in one, some or all of the grooves 7, 8 of the thermal insulation barrier. These blocking members 18 are disposed in the grooves 7, 8 in order to be arranged between the sealing membrane and the thermal insulation barrier.

Figure 4 shows diagrammatically a portion of an insulating panel at the level of a groove 7 in which is housed a corrugation 9 of the sealing membrane and including a blocking member 18 in accordance with the first embodiment.

The insulating panel 1 includes a housing 19 in which the blocking member 18 is housed with one degree of freedom of movement. This housing 19 is developed perpendicularly to the longitudinal direction 15 of the corrugation 9. A width 20 of the housing 19 in the widthwise direction of the groove 7 is greater than the width 14 of the groove 7. In the embodiment shown in figure 4 the groove 7 has inclined lateral walls substantially parallel to the corrugation 9. The width 20 of the housing 19 is greater than the maximum width 14 of the groove 7, that is to say that at the level of the junction between the groove 7 and the internal face 16 of the internal plate 3. This housing 19 crosses the groove 7. In other words, the housing 19 includes a central portion common to the groove 7 and two lateral portions each opening into the groove 7 on either side of the corrugation 9.

This housing 19 in the insulating panel 1 may be produced in numerous ways, for example by machining, milling or otherwise.

Here the blocking member 18 has a plane general shape. A central portion of the blocking member 18 includes a cut-out 21. This cut-out 21 has a shape
 5 complementary to the convex face of the corrugation 9. The cut-out 21 is more particularly of concave shape and has a concavity the radius of curvature of which is preferably identical to the radius of curvature of the corrugation 9. The internal face of the blocking member therefore espouses the shape of the sealing membrane in the groove 7.

10 The blocking member 18 has a thickness in the longitudinal direction 15 of the corrugation 9 substantially equal to that of the housing 19 but without gripping so that the blocking member 18 can easily be moved in the housing 19. The blocking member 18 has for example a thickness between 5 mm and 30 mm inclusive, preferably between 10 mm and 12 mm inclusive. Moreover, the blocking member 18
 15 has a depth in a direction of thickness of the tank wall substantially corresponding to the depth in that direction of the housing 19. In other words, with the exception of the cut-out 21, the blocking member is developed over all of the depth of the groove 7 in the direction of thickness of the tank wall.

The fit between the housing 19 and the blocking member 18 in the
 20 longitudinal direction 15 of the corrugation 9 is sufficient to allow movement of the blocking member 18 in the housing 19 in the widthwise direction of the housing 19 without this enabling a penalizing peripheral flow. This adjustment is preferably adapted to limit or even to block the movement of the blocking member 18 under its own weight. The clearance is for example of the order of plus or minus 0.1 mm.

25 The blocking member 18 can may be made of a material or an assembly of different materials.

In one embodiment the blocking member 18 is made of a single material. Such a material is chosen to enable sliding movement of the blocking member 18 in the housing 19. One such material is for example a plastic material such as a plastic
 30 foam, polyvinyl chloride (PVC), polymethylmethacrylate (PMMA), polyethylene (PE), polypropylene (PP) or again expanded or non-expanded polystyrene (PS).

In one embodiment, the blocking member 18 is produced by an assembly of materials, for example based on a plastic material covered with a layer of porous

material on its face cooperating with the sealing membrane. One such porous material is for example glass wool, melamine foam or felt. Such a porous material layer enables the blocking member 18 to allow an inert gas to circulate whilst generating a pressure drop of the flows.

5 The blocking member 18 may be covered on its various faces that face the walls of the housing 19 with a material having a low coefficient of friction with respect to the material forming the housing 19. This coating may therefore be produced from a plastic material such as plastic foam, polyvinyl chloride (PVC), polymethylmethacrylate (PMMA), polyethylene (PE), polypropylene (PP) or again
10 expanded or non-expanded polystyrene (PS).

 The blocking member 18 may equally be made from a material the mechanical strength and the geometry of which enable local deformation of its surface in contact with the housing 19 and/or the sealing membrane when placing it in position. Such a locally deformable blocking member 18 enables compensation of
15 the fabrication tolerances of the housing 19 and/or of the sealing membrane. For example, the blocking member 18 may be made from expanded polystyrene having a density of 10 to 30 kg/m³.

 A width 22 of the blocking member 18 in the widthwise direction of the housing 19 is between the width 20 of the housing 19 and the width 14 of the groove
20 7 inclusive. The width 22 of the blocking member 18 is preferably greater than or equal to the width 14 of the groove 7 plus twice the tolerance on positioning of the corrugation 9 in the groove 7 on either side of the central position 35 of the corrugation 9 in the groove 7. Moreover, the width 20 of the housing 19 is greater than or equal to the width 22 of the blocking member 18 and thus twice said
25 tolerance for positioning the corrugation 9 in the groove 7.

 The blocking member 18 can therefore be housed in the housing 19 in different positions along the widthwise direction 20 of the housing 19. Moreover, whatever the position of the blocking member 18 in the housing 19, the blocking member 18 is developed over all of the width 14 of the groove 7.

30 These different possible positions of the blocking member 18 enable the cut-out 21 to be positioned in the groove 7 for any position of the corrugation 9 in said groove 7.

In the embodiment shown in figure 4, the cut-out 21 is centered in the widthwise direction of the blocking member 18 and the housing 19 is centered in the groove 7 in the widthwise direction of the groove 7. In other words, the housing 19 is symmetrical relative to the groove 7 and the blocking member is symmetrical relative to the cut-out 21. However, the position of the cut-out 21 in the widthwise direction 22 of the blocking member 18 and/or the position of the housing 19 in the widthwise direction 14 of the groove 7 may be different from those represented in figure 4 whilst enabling positioning of said cut-out 21 suitable for all possible positions of the corrugation 9 in the groove 7. Accordingly, in an example that is not shown, the cut-out may be disposed in an asymmetrical manner relative to the blocking member 18, the housing then having asymmetrical lateral portions relative to the groove 7 so that the cut-out 21 is able to assume all possible positions in the groove 7 in the widthwise direction of the groove 7.

The blocking member 18 is preferably housed in the housing 19 at a prefabrication stage, that is to say before installation of the insulating panel 1 carrying the housing 19 in the support structure.

During installation of the sealing membrane in the tank, the corrugated metal plate 10 is positioned in such a manner as to house the corrugation 9 in the groove 7. The complementary shapes of the cut-out 21 and the corrugation 9 enable the cut-out to fulfill the cam surface function during insertion of the corrugation 9 into the groove 7. The corrugation 9 therefore has at least one external face, two in the embodiment shown, inclined relative to the internal face 16 of the internal plate 3 of the insulating panel 1. Likewise, the cut-out 21 has at least one internal face (two in the embodiment shown) inclined relative to said internal face 16. Thus when the corrugation 9 is inserted into the groove 7 the external face of the corrugation 9 bears on the internal face of the cut-out 21. The cooperation of the external face of the corrugation 9 and the internal face of the cut-out 21 during insertion of the corrugation 9 into the groove 7 can therefore impose a movement of the blocking member 18 in the housing 19 in the widthwise direction of the housing 19. Insertion of the corrugation 9 in the groove 7 therefore enable automatic positioning of the blocking member 18 in order for said corrugation 9 to be housed in the cut-out 21 of the blocking member 18.

Moreover, the complementary shapes of the cut-out 21 and the corrugation 9 enable the blocking member 18 to espouse the shape of the fluid-tight membrane

in the groove 7. The blocking member 18 is therefore developed in the whole of the portion of the groove 7 between the sealing membrane and a bottom of the groove 7 at the level of the housing 19. In other words, the blocking member 18 blocks said portion of the groove 7 at the level of the housing 19. It is not necessary for this
5 blocking to be totally fluid-tight. However, this blocking must create a pressure drop sufficient to prevent flows that could be generated in the groove 7 by convection in the thermosiphon form.

Figure 5 shows a variant embodiment of the blocking member 18 in accordance with the first embodiment shown in figure 4. In this variant the profile of
10 the blocking member 18 intended to be in contact with the sealing membrane features a plurality of ribs 23. In the embodiment shown in figure 5 these ribs 23 are developed on the internal face of the blocking member 18 in the widthwise direction 22 of the blocking member 18. These ribs 23 favor local deformation of the blocking member 18, enabling better cooperation between the internal face of the blocking
15 member 18 and the sealing membrane.

In accordance with another variant that is not shown, a 1 to 2 mm thick strip of compressible material is added to the internal face of the blocking member 18. In a manner analogous to the ribs 23, this strip enables the blocking member 18 best to espouse the profile of the corrugation 9 and of the sealing membrane with which it
20 cooperates. The strip preferably has dimensions substantially equal to those of the internal face of the blocking member 18 in order not to create an unwanted bypass flow.

Figure 6 schematically represents a thermal insulation barrier portion, for example a secondary thermal insulation barrier portion, of a tank wall and shows
25 one example of the arrangement of a plurality of blocking members 18 in said thermal insulation barrier.

Blocking members 18 are placed at a regular interval on a plurality of insulating panels 1 the grooves 7, 8 of which could form flow channels in the tank wall. Here a blocking member 18 is more particularly positioned in all the grooves 7
30 crossing two given adjacent grooves 32 of the series of grooves 8, said blocking members 18 being positioned in said grooves 7 interleaved between said adjacent grooves 32. In other words, a blocking member 18 is positioned in the thermal insulation barrier in all the grooves 7 connecting two given adjacent grooves 32.

Such a row of blocking members 18 therefore leaves to a flow no possibility of a path bypassing a blocking member 18 by momentarily taking one of the perpendicular grooves 8.

5 In the embodiment shown in figure 6 a row of blocking members 18 is therefore disposed so as to be aligned in a plane in the set of parallel grooves 7 intersecting said plane.

Such blocking members 18 are preferably used in all the grooves 7 or 8 having a vertical component in the terrestrial frame of reference, for example the lateral walls, the cofferdams or the chamfered walls of the tank. Likewise, such
10 blocking members 18 are advantageously positioned in the thermal insulation barrier of a bottom wall of the tank, in all the grooves 7 and 8.

These blocking members 18 are preferably placed at a regular interval 33 along the grooves 7, 8 in such a manner that their effect is cumulative and creates series pressure drops in the preferential flow direction. For example, in the case of
15 corrugations 9 having a vertical component, these blocking members 18 may be disposed along said corrugations 9 every 3 m or even every 1 m. In the case of corrugations 9 of the horizontal bottom wall, blocking members 18 are for example arranged every 1 m.

In the context of insulating panels 1 having a vertical component relative to
20 the terrestrial frame of reference, blocking members 18 are preferably disposed close to the lower level at the level of the grooves 7, 8 having a vertical component. The distance separating the blocking member 18 from the heat resistant lining 6 housed between two insulating panels 1 is therefore insufficient for a flow toward the bottom of the tank to form between the blocking member 18 and said heat resistant
25 lining 6, thus limiting the pressure that can be exerted on said heat resistant lining 6.

Figure 14 shows an example of the arrangement of blocking members 18 in the context of an insulating panel 1 integrated into a fluid-tight and thermally insulative tank bottom wall. In this example, blocking members 18 are arranged in all the grooves 7, 8 formed by said insulating panel 1. These blocking members 18 are
30 aligned along two adjacent edges of the insulating panel 1, forming two perpendicular rows of blocking members 18 having substantially the shape of an "L" in the insulating panel 1. If insulating panels 1 as shown in figure 14 are juxtaposed in the bottom of the tanks, the rows of blocking members of said juxtaposed

insulating panels 1 are therefore aligned to form a lattice of blocking members in all the channels formed by the grooves 7, 8 of the various insulating panels 1.

The maximum spacing between two rows of blocking members 18 is chosen so that the pressure drop thereby created at a particular speed and considered tolerable is greater than the hydrostatic load of the flow to be constrained. Such a pressure drop coefficient may easily be determined by trials, establishing a flow in a blocking member mock-up, varying the flow speeds and measuring the pressure difference between upstream and downstream, or numerically. The load may be calculated by considering the integral of the variation of the density ρ of the given fluid in the direction fixed by gravity in the circulation loop concerned and multiplying it by the universal gravitation constant. Thus to a first approximation, on two vertical channels of height H (at respective temperatures T_f and T_c) communicating at their ends there is to a first approximation a pressure difference dP that satisfies the equation:

$$dP = (\rho(T_f) - \rho(T_c)) * g * H$$

Figure 7 represents a second embodiment. Elements identical to or fulfilling the same function as elements described hereinabove with reference to figures 1 to 6 carry the same reference.

This second embodiment differs from the first embodiment in that the housings 19 are not formed in the insulating panels 1 but in the interstices 5 between two adjacent insulating panels 1. Such an embodiment has the advantage of not necessitating machining of the insulating panel 1 to form the housing 19. The bottom of the housing 19 on which the blocking member 18 rests is for example formed by the heat resistant lining 6 housed in the interstices 5.

In this embodiment the corrugated metal plate 10 is positioned on the insulating panel 1 prior to the installation of the blocking member 18 in order to determine the position of the corrugation 9 in the corresponding groove 7, 8. When the position of the corrugation 9 in the groove 7, 8 is determined, the blocking member 18 is fixed in the appropriate position on the corresponding side of the insulating panel 1. The blocking member 18 is for example fixed by stapling, screwing or gluing to the flank of the insulating panel 1. In this embodiment the blocking member 18 has a thickness in the longitudinal direction 15 of the corrugation 9 smaller than the interstice 5.

Figure 8 shows a third embodiment. Elements identical to or fulfilling the same function as elements described hereinabove with reference to figures 1 to 6 carry the same reference.

In an analogous manner to the second embodiment, this third embodiment
 5 differs from the first embodiment in that the housing 19 is formed in the interstice 5 between two insulating panels 1. However, in this embodiment, the heat resistant lining 6 includes a depression 24 forming the bottom of the housing 19. This depression 24 has width characteristics analogous to the characteristics described
 10 hereinabove for the width 20 of the housing 19 in accordance with the first embodiment. Thus, in this third embodiment, the blocking member 18 is positioned on the heat resistant lining 6 in the depression 24 without being fixed to the flank of the insulating panel 1. This blocking member 18 may be positioned prior to positioning the corrugated plates 10 on the thermal insulation barrier.

In a manner analogous to the first embodiment, when the corrugation 9 is
 15 inserted in the groove 7, 8 the cooperation between the internal face of the cut-out 21 and the external face of the corrugation 9 enables sliding of the blocking member 18 in the depression 24 in the widthwise direction 22 of the blocking member 18.

The blocking member 18 advantageously has a thickness in the longitudinal direction 15 of the corrugation 9 substantially equal to that of the
 20 interstice 5, typically of the order of 30 mm or even 40 mm.

In an embodiment that is not shown the heat resistant lining 6 has no depression 24, the blocking member 18 resting on an internal face of said heat resistant lining 6. In this embodiment, when the blocking member 18 is positioned in the interstice 5 at the level of the groove 7, it projects beyond the internal faces of
 25 the insulating panels 1 forming said interstice 5, for example by 1 to 3 mm. When the corrugated metal plate 10 is positioned in such a manner as to insert the corrugation 9 in the groove 7, the corrugation 9 pressing on the blocking member 18 automatically positions the blocking member 18 relative to the groove 7 as explained hereinabove. Moreover, the corrugation 9 pressing on the blocking member 18
 30 compresses the heat resistant lining 6 disposed under the blocking member 18 so that the blocking member 18 is flush with the internal face of the insulating panels 1 forming the interstice 5.

Figures 9 and 10 show a fourth embodiment of the invention. Elements identical to or fulfilling the same function as elements described hereinabove with reference to figures 1 to 6 carry the same reference.

5 This fourth embodiment differs from the third embodiment in that the blocking member further includes a blade 25 projecting from the external face of the blocking member 18. This blade 25 is arranged so as to extend a lateral face of the blocking member 18 in the direction of the support wall.

10 When positioning the blocking member 18 the blade 25 is inserted between the heat resistant lining 6 and one of the insulating panels 1 forming the interstice 5 in which said heat resistant lining 6 is housed. Insertion of the blade 25 between the heat resistant lining 6 and the insulating panel 1 enables the blocking member 18 to be pressed against the flank of the insulating panel 1 whilst retaining said blocking member 18 in position. The blade 25 advantageously has a taper of a few degrees in order on the one hand to facilitate its insertion and on the other hand to contribute
15 to optimum placing of the profile of the blocking member 18 on the surface of the sealing membrane. Such a taper makes it possible to ensure that the position of the blocking member 18 is maintained over the service life of the tank.

In an embodiment that is not shown the fixing member consists of at least two hooks fixed to at least one insulating block in order to block movement in the
20 direction of the thickness of the insulating block or blocks whilst enabling lateral movement of the blocking member 18.

Figures 11 and 12 show a fifth embodiment of the invention suitable for a tank including a secondary thermal insulation barrier and a primary thermal insulation barrier. Elements identical to or fulfilling the same function as elements
25 described hereinabove with reference to figures 1 to 6 carry the same reference.

As shown in figure 11, the tank wall in accordance with this fifth embodiment includes a secondary sealing membrane the corrugations 9 of which project in the direction of the interior of the tank resting on a secondary thermal insulation barrier. The primary thermal insulation barrier includes a plurality of
30 primary insulating panels 26 of substantially rectangular parallelepiped shape. The primary insulating panels 26 include a structure of any kind, for example a sandwich structure consisting of a layer of insulating lining such as a layer 27 of insulating polymer foam 27 sandwiched between an internal rigid plate 28 and an external rigid

plate 29, for example a sheet of plywood. The primary sealing membrane is obtained by assembling a plurality of corrugated metal plates 30.

Thus the grooves 7, 8 for housing the corrugations 9 are produced in the primary insulating panels 26. These grooves 7, 8 are produced in the external rigid
5 plate 29 of said primary insulating panels 26 and where applicable also in the insulating lining of said primary insulating panels 26.

This fifth embodiment therefore differs from the first embodiment in that the housing 19 is produced in the primary insulating panel 26 in order to house the blocking member 18. Such housings 19 and blocking members 18 moreover have
10 characteristics of dimensions and positions in the tank analogous to those of the housings 19 and blocking member 18 described hereinabove with reference to figures 1 to 6 for the first embodiment. Figure 12 shows a detail view in section of the tank wall shown in figure 11 at the level of a blocking member 18 in a housing 19 and intersecting a groove 7 housing a corrugation 9, said groove 7 intersected by
15 the housing 19 being shown in dashed line in this figure 12.

Other details and other embodiments, in particular regarding the secondary and primary thermal insulation barriers, the members anchoring the thermally insulative barrier and the sealing membranes may be found in the document WO2016/046487, the document WO2013004943 or again the document
20 WO2014057221.

The technique described hereinabove for producing a fluid-tight and thermally insulative tank may be used in different types of reservoirs, for example to constitute an LNG or LPG reservoir in a terrestrial installation or in a floating structure such as a methane tanker ship or other ship including a plurality of sealing
25 membranes or only one sealing membrane.

Referring to figure 13, a cutaway of a methane tanker ship 70 shows a fluid-tight 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 fluid-tight barrier intended to be in contact with the LNG contained in the tank, a secondary fluid-tight
30 barrier arranged between the primary fluid-tight barrier and the double hull 72 of the ship, and two insulating barriers respectively arranged between the primary fluid-tight barrier and the secondary fluid-tight barrier and between the secondary fluid-tight barrier and the double hull 72.

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 LNG from or to the tank 71.

Figure 13 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 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.

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.

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 the latter fall within the scope of the invention defined by the claims.

In particular, the housings and blocking members are described in the various embodiments hereinabove in the context of a secondary sealing membrane the corrugations of which are housed in grooves made on an internal face of the secondary insulating panels or on an external face of the primary insulating panels according to whether the corrugations respectively project in the direction of the exterior of the tank or of the interior of the tank. However, such grooves, housings and blocking members may equally be produced and installed at the level of an internal face of the primary insulating panels in the context of a primary sealing

membrane having corrugations projecting toward the exterior of the tank. Likewise, such grooves, housings and blocking members may equally be produced and installed at the level of an internal face of insulating panels in the context of a tank including only one thermal insulation barrier and only one sealing membrane having
5 corrugations projecting toward the exterior of the tank.

Likewise, the description hereinabove is mainly given in the context of grooves 7 housing parallel corrugations 9 in a first direction. However, this description applies by analogy to blocking members 18 and housings 19 enabling blocking of the grooves 8 housing corrugations 9 in a second direction perpendicular
10 to the first direction. Such blocking members 18 can therefore be arranged so as to block grooves 7 and/or grooves 8.

The use of the verb "to include" or "to comprise" and conjugate forms thereof do not exclude the presence of elements or other steps other than those stated in a claim. The use of the indefinite article "a" or "an" for an element or a step
15 does not exclude, unless otherwise mentioned, the presence of a plurality of such elements or steps.

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

CLAIMS

1. A fluid-tight and thermally insulative fluid tank, in which a tank wall includes at least one thermal insulation barrier and one sealing membrane,

the sealing membrane including a series of parallel corrugations (9) having a longitudinal direction (15) and plane portions situated between said corrugations (9),

5 said corrugations (9) projecting from the plane portions on a side projecting from the sealing membrane, said thermal insulation barrier being disposed on the side projecting from the sealing membrane,

said thermal insulation barrier including a series of parallel grooves (7, 8) in which

10 are housed the corrugations (9),

and in which said groove (7, 8) has a width (14) in a widthwise direction perpendicular to the longitudinal direction (15) of the corrugations (9) greater than the width (17) in said widthwise direction of the corrugation (9) housed in said groove (7, 8),

15 the thermal insulation barrier further including a housing (19), a widthwise axis of said housing (19) in the widthwise direction of the groove (7, 8) intersecting said groove (7, 8), said housing (19) having a width (20) greater than the width of the groove (7, 8),

the tank further including a blocking member (18) arranged in the housing (19), the

20 blocking member having a width (22) greater than the width (14) of the groove (7, 8), the blocking member (18) having a cut-out (21) configured to receive the corrugation (9),

the blocking member (18) being arranged in the housing (19) in such a manner that the cut-out (21) is housed in the groove (7, 8) and the corrugation (9) is housed in

25 the cut-out (21) and so that the blocking member (18) blocks a portion of the groove (7, 8) situated on the side projecting from the sealing membrane by creating a pressure drop for a flow circulating in the groove (7, 8).
2. The fluid-tight and thermally insulative tank according to claim 1, in which the thermal insulation barrier includes a plurality of juxtaposed insulating
- 30 elements (1, 26) held against a support wall.

3. The fluid-tight and thermally insulative tank according to claim 2, in which the housing (19) is formed in an insulating element (1, 26).

4. The fluid-tight and thermally insulative tank according to claim 2, in which the housing (19) is formed in an interstice (5) between two adjacent insulating elements (1, 26).

5. The fluid-tight and thermally insulative tank according to claim 4, in which an insulative filling (6) is arranged in the interstice (5) between the two adjacent insulating elements (1, 26), said insulative filling (6) forming a bottom of the housing (19).

6. The fluid-tight and thermally insulative tank according to any one of claims 1 to 5, in which the blocking member (18) includes a lower portion in contact with a bottom of the housing (19) consisting of a rigid material and a locally deformable portion (23), the corrugation (9) bearing on the locally deformable portion (23).

7. The fluid-tight and thermally insulative tank according to claim 6, in which the lower portion of the blocking member (18) in contact with the bottom of the housing consists of a material chosen from the material group consisting of polypropylene, polymethylmethacrylate, polyvinyl chloride, polyethylene, synthetic plastic foam or combinations thereof.

8. The fluid-tight and thermally insulative tank according to claim 6 or 7, in which the locally deformable portion of the blocking member (18) includes a strip of compressible material on the upper face of the blocking member (18).

9. The fluid-tight and thermally insulative tank according to any one of claims 6 to 8, in which the locally deformable portion (23) consists of a material chosen from the material group consisting of fibrous materials, glass wool, melamine foam, flexible polyurethane foam or combinations thereof.

10. The fluid-tight and thermally insulative tank according to any one of claims 1 to 9, in which the corrugation (9) has a first lateral surface inclined relative to a thickness direction of the tank wall, the blocking member (18) having a second surface inclined relative to said thickness direction of the tank in such a manner as to cause the blocking member (18) to slide in the width (20) of the housing (19) when the corrugation (9) is inserted in the groove (7, 8).

11. The fluid-tight and thermally insulative tank according to any one of claims 1 to 10, in which the width (22) of the blocking member (18) is greater than or equal to the width (17) of the corrugation (9) plus twice the width difference between the groove (7, 8) and the corrugation (9).

5 12. The fluid-tight and thermally insulative tank according to any one of claims 1 to 11, in which the longitudinal direction (15) of the corrugation (9) includes a vertical component with reference to the terrestrial frame of reference.

10 13. The fluid-tight and thermally insulative tank according to any one of claims 1 to 12, including a row of housings (19), said housings (19) of the row of housings (19) intersecting a respective groove (7, 8) of the series of grooves (7, 8), said housings (19) having a width (20) greater than the width (14) of the respective grooves (7, 8), the tank further including a row of blocking members (18) arranged in a respective housing (19), said blocking members (18) having a width (22) greater than the width (14) of the groove (7, 8) intersected by the respective housing (19)
15 and less than a width (20) of said housing (19), the blocking members (18) having a cut-out (21) configured to receive the corresponding corrugation (9), the blocking members (18) being arranged in said housings (19) in such a manner that the cut-out (21) is housed in the corresponding groove (7, 8) and the corrugation (9) is housed in said cut-out (21) and so that the blocking member (18) blocks a portion of
20 said groove (7, 8) situated on the side projecting from the sealing membrane creating a pressure drop for a flow circulating in said groove (7, 8).

14. The fluid-tight and thermally insulative tank according to claim 13, in which the series of parallel corrugations (9) of the sealing membrane is a first series of parallel corrugations of the sealing membrane and in which the longitudinal
25 direction of said corrugations (9) of said first series of corrugations is a first direction, the sealing membrane further including a second series of corrugations (9) perpendicular to the first series, a longitudinal direction of the corrugations of the second series of corrugations forming a second direction perpendicular to the first direction, the blocking members (18) of the row of blocking members (18) being
30 arranged between two adjacent corrugations (32) of the second series of corrugations (9).

15. The fluid-tight and thermally insulative tank according to either one of claims 13 or 14, the tank including a plurality of row of blocking members (18)

housed in respective housings (19), said rows of blocking members (18) being arranged at a regular interval (33) in the longitudinal direction (15) of the corrugations (9) of such a manner that their effect is cumulative and creates serial pressure drops in the grooves (7, 8) housing the corresponding corrugations (9).

5 16. The fluid-tight and thermally insulative tank according to any one of claims 1 to 15, in which the sealing membrane is carried by the thermal insulation barrier, the corrugations (9) projecting toward the support wall.

 17. The fluid-tight and thermally insulative tank according to any one of claims 1 to 15, in which the sealing membrane is a secondary sealing membrane,
10 the thermal insulation barrier is a primary thermal insulation barrier, the corrugations (9) projecting toward the interior of the tank, and in which the tank further includes a secondary thermal insulation barrier retained on the support wall and supporting the secondary sealing membrane, the primary thermal insulation barrier being supported by the secondary sealing membrane, the tank further including a primary
15 sealing membrane supported by the primary thermal insulation barrier and intended to be in contact with the fluid in the tank, the grooves (7, 8) being formed on a lower surface of the primary thermal insulation barrier.

 18. The fluid-tight and thermally insulative tank according to any one of claims 1 to 15, in which the sealing membrane is a primary sealing membrane, the
20 thermal insulation barrier is a primary thermal insulation barrier, the corrugations (9) projecting toward the exterior of the tank, and in which the tank further includes a secondary thermal insulation barrier retained on the support wall and supporting a secondary sealing membrane, the primary thermal insulation barrier being supported by the secondary sealing membrane, the primary sealing membrane
25 being supported by the primary thermal insulation barrier and intended to be in contact with the fluid in the tank, the grooves (7, 8) being formed on an upper surface of the primary thermal insulation barrier.

 19. A ship (70) for the transportation of a cold liquid product, the ship including a double hull (72) and a tank (71) as claimed in any one of claims 1 to 18
30 disposed in the double hull.

 20. A system for transferring a cold liquid product, the system including a ship (70) as claimed in claim 19, 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.

21. A method of loading or offloading a ship (70) as claimed in claim
5 19, in which a cold liquid product is fed through insulated pipes (73, 79, 76, 81) from or to a floating or terrestrial storage installation (77) to or from the tank of the ship (71).