Description

Title: Method for repairing a wall of a tank for transporting and/or storing liquified natural gas

The present invention relates to the field of transport tanks with corrugated membrane for storing and/or transporting a fluid, and particularly the sealed and thermally insulating tanks used for liquified gas.

The invention relates to the field of sealed and thermally insulating tanks for storing and/or transporting liquid at low temperature, such as tanks for transporting liquified petroleum gas (LPG) at, for example, a temperature of between -50°C and 0°C, or for transporting liquified natural gas (LNG) at around -162°C at atmospheric pressure. These tanks can be installed on land or on a floating structure. In the case of a floating structure, the tank may be intended for transporting liquified gas or for receiving liquified gas used as a fuel for the propulsion of the floating structure.

The sealed and thermally insulating tanks used for storing such liquids at low temperature are usually made up of an insulating mass and of a membrane made up of a plurality of corrugations that come into contact with the liquid cargo. Between the insulating mass and the membrane, reinforcers compatible with the shape of the corrugations of said membrane may be nested inside the corrugations of the membrane. The reinforcers then have the function of mechanically supporting the corrugations of the membrane, in the face of a mechanical stress applied to the tank. The reinforcers are assembled for example by connecting pieces to form a secure assembly.

One disadvantage with such a tank wall lies in repairing it and more particularly in repairing a reinforcer which may or may not be inserted in one of the corrugations of the membrane. Specifically, because the elements of the tank wall are superposed and nested in one another, access to each of the elements of said tank wall usually entails dismantling at least part of the tank wall.

It is therefore an object of the invention to overcome this disadvantage by proposing an optimized repair method that does not require excessive dismantling of the tank wall.

One subject of the invention is therefore a repair method for repairing a liquified natural gas transport and/or storage tank wall, the tank wall comprising at least one membrane

and a plurality of reinforcers, the membrane comprises a plurality of corrugations in at least one of which at least one reinforcer is placed, the reinforcer extends in a main direction of elongation and comprises at least an external wall which delimits a cavity of the reinforcer, during which repair method, in at least one step, the reinforcer is cut in a direction secant to its main direction of elongation so as to form at least a first reinforcer portion and a second reinforcer portion that are separable from the tank wall, in another step, the first reinforcer portion and the second reinforcer portion are substituted by at least two replacement portions, and in another step, a sleeve is inserted into the cavity of the at least two replacement portions.

The tank may notably be the tank of a liquified natural gas transport ship and said ship may then comprise several tanks for storing and/or transporting said gas.

The tank wall then comprises at least one insulating mass which provides the tank with the thermal insulation necessary for transporting liquid natural gas and may notably comprise at least one layer of insulation. The membrane comprises the plurality of corrugations distributed over its surface. Such a membrane configuration gives it greater ability to withstand the stresses generated in the tank, notably thermal contraction when the tank is cooled, the hydrostatic pressure due to the load of liquid cargo and the dynamic pressure due to the movements of the cargo, notably as a result of the swell. The corrugations on the membrane therefore allow it to deform in order to withstand these stresses.

More specifically, the plurality of corrugations of the membrane is arranged as first series of corrugations and second series of corrugations which are perpendicular to one another and the intersections of which form nodes. The plurality of reinforcers of the tank wall is then arranged as first series of reinforcers and second series of reinforcers, which extend perpendicularly to one another and respectively in the first series of corrugations and second series of corrugations. Cross-shaped connecting pieces are then arranged between each of the reinforcers of the first series of reinforcers and second series of reinforcers, and more specifically under the nodes of the membrane. It will therefore be appreciated that the cross-shaped connecting pieces arranged under the nodes have the purpose of connecting the reinforcers of the first series of reinforcers and second series of reinforcers to one another and thus extend in the bottom part of the cavities of each of the reinforcers.

The invention seeks to cut a tank wall reinforcer, for example one that has been damaged, in order to form at least two reinforcer portions these being the first reinforcer portion and the second reinforcer portion. The reinforcer portions are then separable, insofar as they are removed from the tank wall. The sleeve slipped into the cavity of the replacement portions allows said replacement portions to be aligned in the main direction of elongation of the reinforcer. The sleeve is more particularly positioned in the upper part of the cavity of the replacement portions and forms a mechanical connection between the two replacement portions. It will therefore be appreciated that the replacement portions used during the method are intended to replace the one same single damaged reinforcer, which is to say an individual reinforcer before it is cut.

The invention finds an advantageous application in that it allows at least one of the reinforcers of the tank wall to be repaired without the need to dismantle this tank wall. Alternatively, the invention finds an advantageous application insofar as it allows at least one of the reinforcers to be repaired while the tank wall is being assembled. The features listed hereinbelow relating to a single reinforcer apply mutatis mutandis to the plurality of reinforcers of which the tank wall is composed.

According to the tank wall repair method, the plurality of reinforcers comprises an adjacent reinforcer adjacent to the reinforcer that is cut, the adjacent reinforcer being aligned along the main direction of elongation, during which method the sleeve is slipped into the adjacent reinforcer prior to the positioning of the replacement portions.

The plurality of reinforcers of the tank wall is organized as a first series of reinforcers and a second series of reinforcers. Thus, what is meant by an adjacent reinforcer is the reinforcer that is positioned next to the reinforcer that has been cut in a same first series of reinforcers or in a same second series of reinforcers. The adjacent reinforcer therefore exhibits the same structural characteristics as the plurality of reinforcers and the sleeve is therefore inserted into the cavity of said adjacent reinforcer. It will also be appreciated that the adjacent reinforcer is distinct from the damaged reinforcer and that, as a result, said adjacent reinforcer is not intended to be replaced by the replacement portions.

According to the tank wall repair method, the sleeve is immobilized in the adjacent reinforcer.

More specifically, the sleeve is temporarily immobilized in the adjacent reinforcer before the subsequent steps of the repair method are performed. This immobilizing of the sleeve in the adjacent reinforcer is advantageous insofar as it keeps the elements together and facilitates the tank wall repair operations. The immobilizing of the sleeve in the adjacent reinforcer can be achieved using a sleeve immobilizing means in the form of a screw or else of a washer, for example made of Teflon.

According to the tank wall repair method, the sleeve is inserted into the cavity of the replacement portions after the positioning of these replacement portions on the tank wall.

According to an alternative of the tank wall repair method, the sleeve is given a translational movement in the main direction of elongation of the reinforcer from the adjacent reinforcer as far as into the cavities of the replacement portions.

According to the tank wall repair method, the sleeve is immobilized in the cavities of the replacement portions.

More specifically, the sleeve is definitively immobilized in the cavities of the replacement portions. Immobilizing the sleeve in the cavities of the replacement portions is achieved by the immobilizing means that may be a screw or a washer, for example made of Teflon. Alternatively, the immobilizing of the sleeve in the cavities of the replacement portions can be performed by crimping the sleeve by deforming one end of one of the replacement portions. Still as an alternative, the immobilizing of the sleeve in the cavities of one of the replacement portions can be performed by forming an end stop on one of the replacement portions by adding an external metallic material, using a welding operation.

According to the tank wall repair method, a cavity of the adjacent reinforcer is closed off to prevent the sleeve from effecting a translational movement therein.

Stated differently, the cavity of the adjacent reinforcer is partially closed off at its end facing the cut reinforcer, it being possible for this operation to be performed prior to the definitive immobilization of the sleeve in the cavities of the replacement portions. For this purpose, a closing-off device that may take the form, for example, of an adhesive, may be applied in such a way that it at least partially closes off the cavity of the reinforcer according to the conditions mentioned hereinabove.

According to the tank wall repair method, prior to the step of cutting the reinforcer, a portion of membrane positioned facing the reinforcer is removed.

Stated differently, the reinforcer that forms the subject of the implementation of the tank wall repair method is bared, this step being necessary for the implementation of the subsequent steps of said method. The removal of the membrane portion may be performed for example by cutting said membrane mechanically or using a laser.

According to the tank wall repair method, a membrane repair patch is secured facing the reinforcer.

Stated differently, the final step in the tank wall repair method is to fit the membrane repair patch facing the least one reinforcer that has formed the subject of the implementation of the repair method. It would therefore be appreciated that the securing of the membrane repair patch is performed after the replacement portions have been installed on the tank wall. Stated differently, the repair patch is positioned as a substitute for the membrane portion that was previously removed during the repair method.

The invention also relates to a repair kit for repairing a liquified natural gas transport and/or storage tank wall, comprising at least two replacement portions intended to replace at least one reinforcer of the tank wall, and at least one sleeve intended to mechanically connect the two replacement portions. The repair kit may also comprise a repair patch able to cover the replacement portions.

The repair kit is involved in implementing the tank wall repair method. It would thus be appreciated that the two replacement portions of the repair kit are intended to replace both or part of just one and the same single damaged reinforcer of the tank wall. Stated differently, the replacement kit according to the invention is used for replacing a single one same tank wall reinforcer.

According to one aspect of this kit, the sleeve is configured to become lodged in an upper part of a cavity of the replacement portions, the upper part of the cavity being triangular in shape.

According to another aspect, the sleeve is of circular cross section.

According to one feature of the invention, the repair kit comprises at least one immobilizing means for immobilizing the sleeve with respect to the replacement portions.

According to one feature of the invention, the repair kit comprises at least one closing-off device configured to close off the cavity of a reinforcer adjacent to one of the replacement portions.

More specifically, the adjacent reinforcer is aligned in the main direction of elongation of the reinforcer that is the subject of the repair method, namely the reinforcer that has been cut. The cut reinforcer therefore comprises the replacement portion.

The invention also relates to a liquified natural gas transport and/or storage tank for a ship, comprising a tank wall and at least a repair kit according to any one of the foregoing features, wherein the replacement portions are secured to the tank wall by the sleeve, the replacement portions being covered by at least one repair patch.

Other features, details and advantages of the invention will become more clearly apparent from, on the one hand, reading the following description and, on the other hand, from a number of exemplary embodiments given by way of nonlimiting indication with reference to the attached schematic drawings in which:

[Fig.1] is a perspective side view of a liquid gas transport ship with four tanks comprising the invention;

[Fig.2] is a close-up view of a tank wall showing an insulating mass, a plurality of reinforcers and part of the membrane;

[Fig.3] is a close-up view of one of the tank wall reinforcers which has been cut into a first reinforcer portion, a second reinforcer portion and a third reinforcer portion;

[Fig.4] is a close-up view of the reinforcer of figure 3, comprising three replacement portions;

[Fig.5] is a perspective view of a sleeve according to the invention;

[Fig.6] is a close-up view of the reinforcer of figure 4 into which the sleeve in figure 5 is inserted;

[Fig.7] is a close-up view of a repair patch placed over the reinforcer of figure 6;

[Fig.8] is a close-up view of the reinforcer of figure 3 in which the first reinforcer portion, the second reinforcer portion and the third reinforcer portion have been removed and which shows an adjacent reinforcer into which the sleeve of figure 5 has been slipped according to a second embodiment of the invention;

[Fig.9] is a close-up view of the adjacent reinforcer of figure 8 into which the sleeve of figure 5 has been inserted and which shows an immobilizing means.

[Fig.10] is a close-up view of the reinforcer of figure 8 incorporating the replacement portions and into which the sleeve previously inserted into the adjacent reinforcer of figure 7 has been moved in a translational movement.

The features, variants and various forms of embodiment of the invention may be combined with one another in various combinations provided that they are not mutually incompatible or mutually exclusive. In particular the invention variants comprising only a selection of features described hereinafter in isolation from the other features described can be conceived of if the selection of features is sufficient to confer a technical advantage or to differentiate the invention from the state of the prior art.

In the following part of the description, the labels longitudinal or transverse refer to the orientation of the membrane according to the invention. A longitudinal direction L corresponds to the axis of the membrane in which the membrane predominantly extends, whereas the transverse orientations correspond to concurrent straight lines, which is to say lines that intersect the longitudinal direction, notably that are perpendicular to the longitudinal direction L of the membrane, so far as the transverse direction T is concerned. One of the directions, illustrated by the arrow referenced V, corresponds to a thickness of the membrane.

The directions mentioned hereinabove can be seen in an orthonormal frame of reference LVT depicted in the figures.

Figure 1 depicts a ship 1, for example a methane tanker, comprising four tanks 2 for the storage of gas in the liquid state, notably liquid natural gas. The tanks 2 are separated from one another by double transverse bulkheads 3 also referred to as cofferdams. Each of the tanks 2 is formed of a tank wall 4 comprising, amongst other things, an insulating mass 5, visible in figure 2, partially forming the thermal insulation of the tank wall 4, and

at least one membrane 6 intended to be in contact with the liquid cargo and anchored to the insulating mass 5.

The membrane 6, which is visible in figure 2, is a sheet of a corrosion-proof material, notably of stainless steel, with a thickness of, for example, between 0.5 mm and 1.5 mm, advantageously 1.2 mm, measured in the vertical direction V of the membrane 6. The membrane may also have a length of between 680 mm and 3060 mm, measured in the longitudinal direction L of the membrane 6. Finally, the membrane 6 may have a width of between of 680 mm and 1030 mm, measured in the transverse direction T of the membrane 6.

The membrane 6 comprises a plurality of corrugations 7 distributed as a plurality of first series of corrugations 8 which are mutually parallel and extend along the longitudinal direction L of the membrane, and a plurality of second series of corrugations 9 which are mutually parallel and extend in the transverse direction T of the membrane 6.

The first series of corrugations 8 and the second series of corrugations 9 extend predominantly in directions that are mutually perpendicular and at their intersection form nodes 10. The nodes 10 emerge vertically from a plane AB in which the membrane 6 is inscribed. What is meant by a corrugation 7 is a deformation of the surface of the membrane 6 in the vertical direction V.

The membrane 6 also comprises planar portions 11 in the shape of a quadrilateral, of which the two sides that extend in the longitudinal direction L of the membrane 6 are delimited by two first series of corrugations 8, and the two sides that extend in the transverse direction T of the membrane 6 are delimited by two second series of corrugations 9. The collection of planar portions 11 therefore defines the non-deformed surface of the membrane 6 extending the plane AB of the membrane 6 and coming into contact with the insulating mass 5 of the tank wall 4 when the membrane is mounted against the insulating mass 5.

Figure 2 also evidences the presence of reinforcers 12, distributed as first reinforcers 13 and second reinforcers 14. In the following part of the detailed description the first reinforcers 13 and the second reinforcers 14 will be grouped together under the heading reinforcer 12, when the features mentioned apply both to the first reinforcers 13 and to the second reinforcers 14. Nevertheless, the invention is not restricted to a plurality of

reinforcers 12 and is applicable wherever it is necessary to implement the repair method on at least one reinforcer 12 of the tank wall 4.

The first reinforcers 13 are aligned to form at least a first series of reinforcers 15 extending in the longitudinal direction L of the membrane 6. The second reinforcers 14 are aligned to form at least a second series of reinforcers 16 extending in the transverse direction T of the membrane 6. The first series of reinforcers 15 and the second series of reinforcers 16 are therefore secant, notably perpendicularly.

The first reinforcers 13 are arranged in the first series of corrugations 8 of the membrane 6. It will be appreciated that the first reinforcers 13 are positioned such as to be nested inside the deformation of the corrugation 7, the shape of the first reinforcers 13 complementing the shape of the corrugations of the first series of corrugations 8 of the membrane 6.

The second reinforcers 14 are positioned in the second series of corrugations 9 of the membrane 6. It will therefore be appreciated that the second reinforcers 14 are positioned in such a way as to be nested inside the deformation of the corrugation 7, the shape of the second reinforcers 14 complementing the shape of the corrugations 7 of the second series of corrugations 9 of the membrane 6.

It will also be appreciated that the intersection between the first series of reinforcers 15 and the second series of reinforcers 16 is positioned beneath a node 10 of the membrane 6.

The reinforcers 12 comprise an external wall 17 which delimits a cavity 18. It will therefore be appreciated from the foregoing that the external wall 17 gives the reinforcers 12 a shape such that they can be arranged in the corrugations 7 of the membrane 6 according to the above features.

Connecting pieces 21 are placed in the first reinforcers 13 and the second reinforcers 14 of the membrane 6 so that they are connected to one another under the series of corrugations 8, 9 of the membrane 6. The connecting pieces 21 are thus placed in line with a node 10 of the membrane 6 and inserted into each of the cavities 18 of the reinforcers 12. The connecting pieces 21 may, for example and nonlimitingly, be cross-shaped 22. It will therefore be appreciated that the collection of reinforcers 12 that make up the first series of reinforcers 15 and the second series of reinforcers 16 form a

secured assembly positioned between the membrane 6 and the insulating mass 5 of the tank wall 4 as described hereinabove.

A method for repairing the tank wall 4 will now be described with reference to figures 3 to 10. More particularly, the repair method allows a simplified repair of the tank wall 4 to be carried out, for example a repair of at least one of the reinforcers 12 of said tank wall 4. In the following part of the description, it will be appreciated that the method can be implemented on at least one of reinforcers 12 of the first series of reinforcers 15 and/or on at least one of the reinforcers 12 of the second series of reinforcers 16. Thus, the longitudinal direction L of the membrane 6, in the case of the first reinforcers 13, and the transverse direction T of the membrane 6, in the case of the second reinforcers 14, are grouped together and defined under the heading main direction of elongation of the reinforcer.

A first step of the method for repairing the tank 2 consists in giving the operator access to the reinforcer 12 that forms the subject of the repair method. To do that, a portion P, visible in figure 2, of the membrane 6 lying facing said reinforcer 12 is removed, for example by cutting it mechanically or using a laser.

It should be considered that, as a non-illustrated alternative, the repair method may be implemented during the assembly of the tank wall, before the membrane is fitted to cover the reinforcers that make up the tank wall, and that the first step of removing the portion of membrane is then not performed.

Once the reinforcer 12 has been bared, a second step of the repair method is to cut the reinforcer 12 in a direction secant to its main direction of elongation to form reinforcer portions 23 and, more specifically, at least a first reinforcer portion 24 and a second reinforcer portion 25. In the example illustrated, a third reinforcer portion 26 is also formed but it will be appreciated that the method can be applied to more or fewer reinforcer portions 23. It will also be appreciated that, during the second step of the method, a one same single reinforcer 12 of the tank wall 4 is cut, such that this one same reinforcer 12 becomes the first reinforcer portion 24, the second reinforcer portion 25 and the third reinforcer portion 26 when the reinforcer 12 has been cut.

This then yields, according to the example illustrated in figure 3, the first reinforcer portion 24, the second reinforcer portion 25 and the third reinforcer portion 26 which are intended to be separated from the tank wall 4. What is meant by separable from the

tank wall 4 is that the reinforcer portions 24, 25, 26 are intended to be permanently removed from the tank wall 4 to be replaced by replacement portions 27.

Alternatively, and this is not illustrated, at least one of the reinforcer portions 24, 25, 26 may be removable, insofar as it may be refitted on the tank wall after at least one of the reinforcer portions 24, 25, 26 has been substituted by at least one replacement portion 27.

According to a first embodiment of the method visible in figure 4, after the first reinforcer portion 24, the second reinforcer portion 25 and the third reinforcer portion 26 have been removed, the replacement portions 27 are fitted in such a way that they take the place of said first reinforcer portion 24, second reinforcer portion 25 and third reinforcer portion 26. It will therefore be appreciated that all three of the replacement portions 27 are aligned in the direction of elongation of the reinforcer 12. It will also be appreciated that the replacement portions 27 are intended to replace one single same reinforcer 12 of the tank wall 4.

Thereafter, in an additional step, a sleeve 28, visible in figure 5, is slipped into at least two cavities 18 of two replacement portions 27. In the example illustrated in figure 6, the sleeve 28 is slipped into the three cavities 18 of the three replacement portions 27.

The sleeve 28 has an elongate shape and a first end 29 and a second end 30, which are opposite ends from one another at each end of the sleeve 28. The inserting of the sleeve 28, as previously mentioned, is performed predominantly through a translational movement, in the main direction of elongation of the reinforcer 12, from the second end 30 toward the first end 29, which is therefore qualified as a first direction of insertion I1. The sleeve 28 therefore has the function of blocking at least movements between the replacement portions 27 in directions perpendicular to the direction of elongation of said reinforcer 12.

Still in this first embodiment, provision may be made for the sleeve 28 to be inserted according to the preceding insertion characteristics, while leaving the second end 30 of said sleeve 28 outside of a volume defined by the cavity 18 of one of the replacement portions 27 situated at one end of the string of replacement portions 27. This then allows the fitting of a means 31 of immobilizing the sleeve 28 at its second end 30. The immobilizing means 31 may for example and nonlimitingly be a Teflon screw or washer. The immobilizing means 31 has the purpose of preventing the movement of the sleeve

28, in this instance definitively, in the translational movement described hereinabove, at least in the first direction of insertion I1 by forming an end stop against the replacement portion 27. Alternatively, the immobilizing means 31 may be a deformation of one of the replacement portions 27 such that it prevents movements of the sleeve 28, or else an addition of a metallic material to one of the replacement portions 27 to form an abutment end stop means and so that the sleeve 28 is left free.

Thereafter, a membrane 6 repair patch 32, visible in figure 7, is fitted to cover the replacement portions 27. It will therefore be appreciated that the repair patch 32 has dimensions in the longitudinal direction L and transverse direction T of the membrane 6 that are substantially identical to the dimensions, in these same directions, of the portion P removed during the first step.

The repair patch 32 may then be welded to the rest of the membrane 6 in order to reestablish the fluid tight sealing thereof.

According to a second embodiment of the invention, after the first reinforcer portion 24, the second reinforcer portion 25 and the third reinforcer portion 26 have been removed from the tank wall, in an additional step, the sleeve 28 is slipped into the cavity 18 of an adjacent reinforcer 33 adjacent to the reinforcer 12 that has been cut, which is to say the one that forms the subject of the repair method. What is meant by adjacent reinforcer 33 is the reinforcer positioned next to the reinforcer 12 that has been cut and aligned in the direction of elongation of the reinforcer 12. The adjacent reinforcer 33 is also distinguishable in that it is not intended to be replaced by the replacement portions 27, these being used exclusively for the one single reinforcer 12 that is the subject of the repair. Stated differently, the cut reinforcer 12 and the adjacent reinforcer 33 are distinct but form part of the one same first series of reinforcers 15 or second series of reinforcers 16 and are directly connected to one another by one of the connecting pieces 21 that connect said series of reinforcers 15, 16.

The sleeve 28 is therefore inserted into the cavity 18 of the adjacent reinforcer 33 by a translational movement in the main direction of elongation of the reinforcer 12, in a second direction of insertion I2 extending from the first end 29 toward the second end 30 such that the first end 29 emerges out from a volume defined by the cavity 18 of the adjacent reinforcer 33, facing the first reinforcer portion 24.

In one embodiment of the invention, visible in figure 9, the means 31 for immobilizing the sleeve 28 may be installed at its first end 29. In this configuration, the immobilizing means 31 temporarily prevents the movement of the sleeve 28 in the translational movement previously described in the second direction of insertion I2. The immobilizing means 31 may therefore, in this instance, be the Teflon screw or washer.

Another step of the method according to this second embodiment involves, as with the first embodiment, substituting the first reinforcer portion 24, the second reinforcer portion 25 and the third reinforcer portion 26 by the replacement portions 27 and in such a way that the three replacement portions 27 are aligned in the main direction of elongation of the reinforcer 12 as visible in figure 10.

As illustrated in figure 10, following this step, the means 31 for immobilizing the sleeve 28 positioned at its first end 29 is removed and said sleeve 28 is made to effect a translational movement in the main direction of elongation of the reinforcer 12, in the first direction of insertion I1, so that it becomes inserted at least into the cavities 18 of two replacement portions 27. According to one example of the invention, the second end 30 may remain outside the cavity 18 of one of the replacement portions 27 situated facing the adjacent reinforcer 33 so that the means 31 of immobilizing the sleeve 28 are available on said second end 30 of the sleeve 28. Thus, the translational movement of the sleeve 28 in the first direction of insertion I1 and in the second direction of insertion I2 is definitively prevented, the immobilizing means 31 forming an end stop against the replacement portion 27 and the adjacent reinforcer 33.

An additional step of this second embodiment of the method may be to close off the cavity 18 of the adjacent reinforcer 33 at its end facing the cut reinforcer 12, by means of a closing-off device 34. Stated differently, the end of the cavity 18 of the adjacent reinforcer 33 that lies facing the second end 30 of the sleeve 28 bearing the immobilizing means 31 is closed off. In that way, the immobilizing means 31 can be removed from the second end 30 of the sleeve 28, the closing-off device 34 preventing the sleeve 28 from effecting a translational movement in the cavity 18 of the adjacent reinforcer 33 in the second direction of insertion I2.

According to one example, the closing-off means 34 may adopt the form of an adhesive tape. According to another example of the invention, the closing-off means 34 may comprise at least a synthetic insert having a shape that complements that of the cavity

18 of the adjacent reinforcer 33. The closing-off means 34 may then be positioned inside the cavity 18 of the adjacent reinforcer 33 or on the outside thereof. Also, this closing-off means 34 may be forcibly assembled around the adjacent reinforcer 33 or in the cavity 18 of said adjacent reinforcer 33, it therefore being possible for the closing-off means 34 to be crinkled in order to ensure the mechanical integrity of said closing-off means 34 on or in the adjacent reinforcer 33.

Alternatively, the closing-off device 34 may be fitted prior to the definitive immobilization of the sleeve 28 in the cavities 18 of the replacement portions 27 by the immobilizing means 31.

Finally, and in common with the first embodiment of the invention, the membrane 6 repair patch 32, visible in figure 7, is applied to cover the replacement portions 27. The repair patch 32 therefore has structural characteristics identical to those in the first embodiment of the invention.

The present invention must not, however, be restricted to the means and configurations described and illustrated here and also extends to any equivalent means and configuration and any technically performing combination of such means.

CLAIMS

1. A repair method for repairing a liquified natural gas transport and/or storage tank wall (4), the tank wall (4) comprising at least one membrane (6) and a plurality of reinforcers (12), the membrane (6) comprises a plurality of corrugations (7) in at least one of which at least one reinforcer (12) is placed, the reinforcer (12) extends in a main direction of elongation and comprises at least an external wall (17) which delimits a cavity (18) of the reinforcer (12), during which repair method, in at least one step, the reinforcer (12) is cut in a direction secant to its main direction of elongation so as to form at least a first reinforcer portion (24) and a second reinforcer portion (25) that are separable from the tank wall (4), in another step, the first reinforcer portion (24) and the second reinforcer portion (25) are substituted by at least two replacement portions (27), and in another step, a sleeve (28) is inserted into the cavity (18) of the at least two replacement portions (27).

2. The repair method as claimed in claim 1, wherein the plurality of reinforcers (12) comprises an adjacent reinforcer (33) adjacent to the reinforcer (12) that is cut, the adjacent reinforcer (33) being aligned along the main direction of elongation, during which method the sleeve (28) is slipped into the adjacent reinforcer (33) prior to the positioning of the replacement portion (27).

3. The repair method as claimed in claim 2, during the course of which the sleeve (28) is immobilized in the adjacent reinforcer (33).

4. The repair method as claimed in claim 1 or 3, during the course of which the sleeve (28) is inserted into the cavity (18) of the replacement portions (27) after the positioning of these replacement portions (27) on the tank wall (4).

5. The repair method as claimed in the preceding claim, during the course of which the sleeve (28) is given a translational movement in the main direction of elongation of the reinforcer (12) from the adjacent reinforcer (33) as far as into the cavities (18) of the replacement portions (27).

6. The repair method as claimed in the preceding claim, during the course of which the sleeve (28) is immobilized in the cavities (18) of the replacement portions (27).

7. The repair method as claimed in claims 2 and 6, during the course of which a cavity (18) of the adjacent reinforcer (33) is closed off to prevent the sleeve (28) from effecting a translational movement therein.

8. The repair method as claimed in any one of the preceding claims, during the course of which, prior to the step of cutting the reinforcer (12), a portion (P) of membrane (6) positioned facing the reinforcer (12) is removed.

9. The repair method as claimed in claim 7, during the course of which a membrane (6) repair patch (32) is secured facing the reinforcer (12).

10. A repair kit for repairing a liquified natural gas transport and/or storage tank wall (4), comprising at least two replacement portions (27) intended to replace at least one reinforcer (12) of the tank wall (4), at least one sleeve (28) intended to mechanically connect the two replacement portions (27) and at least one closing-off device (34) configured to close off a cavity (18) of a reinforcer (33) adjacent to one of the replacement portions (27).

11. The repair kit as claimed in claim 10, comprising at least one immobilizing means (31) for immobilizing the sleeve (28) with respect to the replacement portions (27).

12. A liquified natural gas transport and/or storage tank for a ship, comprising a tank wall (4) and at least a repair kit as claimed in any one of claims 10 or 11, wherein the replacement portions (27) are secured to the tank wall (4) by the sleeve (28), the replacement portions (27) being covered by at least one repair patch (32).