SUPPORT OF TANKS IN VESSELS

TECHNICAL BACKGROUND

The present invention regards a system for the support of tanks for liquids in vessels. More particularly the invention relates to a system for bearing or support of vertical forces on tanks for liquids in vessels at the base of the tanks and for horizontal forces at few places so that the bearing of forces that arise are transferred in an advantageous manner to the construction of the vessel.

BACKGROUND OF THE INVENTION

It is advantageous that the capacities of a ship is exploited in the most efficient way while safety is maintained. The design and therefore the fastening of tanks are influenced by the liquid that is to be transported. Not the least this is influenced by the environment that the liquid requires. Liquids that are to be transported may be for instance foodstuffs that require cooling in order to maintain quality, while other liquids require an over- or under-pressure. An energy carrier like LNG is a relevant liquid requiring a storage temperature of around -160 °C at atmospheric pressure. For CO_2, a requirement is, for staying fluent, a temperature of -60 °C in addition to a pressure of about 600 kPa. When transporting other liquids, other conditions apply. Together with dimensions and weight of such tanks, this lay the foundation for even minor improvements may result in large economic profit and competitive advantages.

In the art is known to use hardwood to transfer support forces from a tank to hull as pure pressure via hardwood layers or synthetic materials with similar properties. It is essential that the materials in these layers have very good temperature insulating properties and that they can endure the pressure that they are subjected to. Hardwood is a suitable material for this purpose, but there are many synthetic alternatives. The products dehonit ® and Permali from the German company "Deutshe Holzveredlung Schmeing" (www.dehonit.de) are examples of products for such use.

Tanks intended for transport of liquids with boats are often formed as spheres, cylinders or prisms. The patent USRE029424 describes supporting of tanks having a cylinder shaped cross section that rest on a skirt with opposite sides firmly fastened to a hull of a ship, claim 1. The Patent US4013030 describes another form of support, where a number of support units along a horizontal circumference of the tank is put into opposite positioned sleeves, claim 1.

Vessels may also comprise high vertical cylinder shaped tanks. High tanks may be advantageous for transporting liquids because it will then have better opportunity to adapt the amount of liquid that may be transported with a given hull of a vessel. In addition there are of course other technical problems to addressed as a consequence of using such high tanks. An example of such consequences may be conditions regarding the stability of the vessel. Another and important example is the vertical and horizontal support of such high tanks.

The patent application WO2010020431 describes a device for storing a self supporting vertical tank for LNG. It comprises a support arrangement that enables a horizontal relative motion between the tank and the foundation. In this way the tank may contract and expand according to the temperature of the tank without unwanted tension to appear.

This application also describes an arrangement with vertical support faces that are distributed evenly around the tank in two heights. In this way the tank is supported when horizontal forces are applied and pitching is prevented.

A disadvantage with self supporting big and high vertical tanks is that they result in large local load because it is not straightforward to distribute the load. Normally the load is either applied to a ring on the bottom of a ship or to the sidewalls of the hull of the ship. This is described in the WO2010020431.

There are mainly two different versions of cryogenic tank design for transport of LNG that are being used today. One is a self supporting tank while the other is a so called

membrane type. The most common self supporting type is the Moss tank with a design owned by the Norwegian company Moss Maritime and is a spherical tank. One advantage with self supporting tanks like the Moss tank is that they are robust. One disadvantage is that they are not very efficient in that much space is wasted in the hull with spherical tanks.

The French company Gaz Transport & Technigaz (GTT) own some important designs of membrane type tanks. A membrane tank has a layer of corrugated metal that can maintain its proportions in a wide temperature range so that the tank can fill out the space inside a hull and thus rest on the inner bottom and on the walls of the hull. This results in a very efficient utilization of the space in a ship. Disadvantages of membrane tanks today are that they have a history of leakage and they are not as robust as self supporting tanks. Maintenance on membrane tanks therefore has to be done at frequent intervals and this adds to the cost of running such ships.

SUMMARY OF THE INVENTION

On the background of the previously mentioned relations, the present invention solves problems regarding bearing and support of cylinder shaped tanks for use in vessels. Not the least are problems regarding tanks intended to contain cold or very cold liquids solved by the present invention.

Regarding big vertical tanks, the invention relates to tanks having a generally flexible base. In this way such tanks can be seen as a generally self supporting tank but with a base that distributes the load via a number of distributed support elements. These support elements are in turn in contact with the structure in the bottom of the vessel.

Regarding horizontal tanks, the invention relates to self supporting tanks that are vertically supported in sidewalls and transverse bulkheads of a vessel. The tanks also have vertical hull pressure faces that are fastened to the sidewalls and to the inner bottom of the vessel supporting horizontal pressure that appears in vessels. One or more of the pressure faces may support in two horizontal orthogonal directions. The pressure faces have corresponding faces fastened to the tanks. The

support system at each place, comprising mutual pairs of pressure faces is referenced as support point pairs and support point quads respectively.

SUMMARY

The invention regards a system for support of a cargo tank in a vessel,

the cargo tank having a generally flat and generally flexible base;

evenly distributed underneath the base of the tank are support elements, each comprising an insulation layer, transferring pressure generally evenly distributed from the contents of the tank, through the bottom structure of the vessel and on to the water pressure on the outer bottom of the vessel;

the cargo tank comprising at least two pairs of tank pressure faces fastened to the tank shell of said tank and at least one pair of said tank pressure faces is arranged transversally and at least one pair of said tank pressure faces is arranged longitudinally in the vessel;

close next to each of the tank pressure faces is arranged an insulation layer;

close next to each of the insulation layers and on the other side of each of the insulation layers is arranged a corresponding hull pressure face that is fastened to a ship side or to a bulkhead; and

the tank pressure face 38 and the hull pressure face 39 aligned so that the orthogonal line of force is directed generally tangential to the middle of the shell 23 of the tank.

As a result, the insulation layers can transfer pressure without transferring large bending moment from the support loads to the cargo tank structure and, at the same time, thermally insulate between the cargo tank and the vessel.

SHORT DESCRIPTION OF THE DRAWINGS

Fig. 1 depicts a simplified alongside vertical cross section of a vessel in which a vertical cylinder formed tank for liquids is visible.

Fig. 2 depicts one of more vertical support elements for said tank.

Fig. 3 depicts a simplified alongside horizontal cross section seen from above through said vessel in which the section also goes through a vertical tank shaped as a cylinder.

Fig. 4 depicts a support, a support point pair, preventing tangential movement of a tank.

Fig. 5 depicts said support in exploded view.

Fig. 6 is a somewhat simplified drawing similar to Fig. 1, the vertical forces being indicated.

Fig. 7 is a somewhat simplified drawing similar to Fig. 3, the reaction forces from initially longitudinal forces are indicated.

Fig. 8 is a drawing similar to Fig. 7, but in this the reaction forces from initially transversal forces are indicated.

Fig. 9 depicts a longitudinal cross section through a vessel comprising vertically oriented tanks shaped as cylinders.

Fig. 10 is a sketch of a vessel seen from above and gives an overview of possible locations for placing of storage tanks for liquids.

Fig. 11 depicts a longitudinal cross section through a vessel having horizontally located tanks shaped as cylinders.

Fig. 12 is a sketch of a vessel seen from above and gives an overview of possible locations for horizontally oriented storage tanks.

Fig. 13 depicts a longitudinal vertical cross section of a vessel in which a horizontal tank for liquids shaped as a cylinder is visible.

Fig. 14 is a vertical cross section crosswise through said vessel and showing two tanks for liquids and a typical arrangement of these.

Fig. 15 depicts a support, a support point quad, for a tank shaped as a cylinder, for upholding horizontal forces in two orthogonal directions.

Fig. 16 depicts the support in Fig. 15 in perspective and exploded view.

Fig. 17 depicts a cross section crosswise, the applied vertical force and reaction force being shown.

Fig. 18 depicts a longitudinal cross section of the vessel in Fig. 11 presenting vertical applied force and reaction force.

Fig. 19 depicts a cross section crosswise, the vertical applied forces and reaction forces being indicated.

Fig. 20 depicts a cross section alongside the vessel 141, the longitudinally applied torque and longitudinal applied horizontal force and longitudinal reaction force being presented.

Fig. 21 depicts a cross section crosswise, the applied torque, crosswise force and crosswise reaction forces being indicated.

DETAILED DESCRIPTION

A support system for different shapes of load tanks in vessels like carrier ships and storage ships is described. Without this being a limitation, presented embodiments are particularly suited for cooled liquids e.g. Liquid Natural Gas (LNG).

One important advantage with the present invention for vertical high tanks is that vertical pressure comprising large static components is supported separate from horizontal pressure, mainly induced by dynamic movement of the vessel. This will be dealt with later.

Important for tanks for storing LNG is that there is no metallic contact between load tanks and the structure of the vessel. This is of vital importance when the liquid that is to be transported has a temperature which is lower than common steel in ships may endure without loosing some of its properties. The liquid that is to be transported may for instance be LNG having a typical storage temperature of about -160 °C. Another typical liquid that may be transported is CO_2 having a typical storage temperature of -60 °C at a pressure of 600 kPa.

All support forces from tank to the hull of the vessel are generally transferred as pure pressure straight through hardwood layers or synthetic materials having similar properties. It is essential that the material in these layers have advantageous temperature insulating properties and that they withstand the pressure they are to be subjected to. Hardwood is a well suited material for this purpose, but there also synthetic options are available.

The present embodiments of the present invention are based upon the accompanying drawings.

In a first preferred embodiment, the vessel is a ship equipped with number of cylinder shaped tanks being arranged vertically. A support system for cylinder shaped cargo tanks designed for cooled liquid gas in transport ships and storage ships is presented.

Fig. 1 shows a typical alongside cross section of a hold for tanks in a gas carrier. Between two transverse bulkheads 5 for example four such tanks may be arranged. All support forces in this example is foreseen to be in three horizontal planes. The number of planes may be altered when desirable. In Figs. 1 and 2, all vertical forces are supported via a suitable number of transverse webs 14. The number and the size of these webs are depending upon the size of cargo tanks 4, 40 and the structure in the bottom of the ship, possibly a double bottom construction as required today, and the main deck 6. The planes 2 and 3 are arranged to support all horizontal forces including pitching moment.

Fig. 2 presents a typical detail from one of more vertical support elements 13 below the cargo tank 4, 40. The support element 13 comprises a transverse web 14, welded to the inner bottom of the bulkhead 7 aligned with the main webs of the ship and a corresponding web 16, welded to the bottom of the cargo tank. Between these two webs is installed a bottom insulation layer 15 made of hardwood or a material with similar properties. The webs are secured against tilting by means of support elements 13 that are aligned with double bottom stiffening ribs 12 in the bottom of the ship and the cargo tank bottom stiffener rib 17. The support elements just support vertical force and the bottom insulation layer 15 insulates the cargo tank 4, 40 from the structure of the ship.

The base of this vertical tank 4, 40 is generally flat and generally flexible. Underneath this base are a number of generally evenly distributed support elements.

The pressure from the contents of the tank gets evenly distributed to the support elements and further through the bottom structure of the vessel 41 and then to the water pressure on the outer bottom 10 of the vessel. In this way there are not imposed any sizable bending moment from a tank to the structure of the vessel. If the bottom had a rigid construction, this would be difficult to achieve. Common self supporting tanks normally have support frames covering only part of the tank e.g. in a ring underneath and covering the outer part of the base of the tank.

The reference number in the drawings named "support point pair" 8 is a word structure shown in Figs. 4 and 5. A support point pair 8 comprises two main components, the first being a hull support pair 24 and the second being a tank support pair. The hull support pair 24 comprises a number of generally parallel profiles being welded or otherwise anchored to the transverse bulkhead 5 or to the hull of the ship 41, 141. Orthogonally to these profiles are arranged two opposite surfaces of contact. The tank support pair 25 comprises, in a similar fashion, an number of generally parallel profiles being welded or otherwise anchored to the tank shell 23 of the cargo tank 4, 40, 104. Orthogonally to these profiles also are arranged surfaces of contact on two opposite sides. Between the one surface of contact of the hull support pair 24 and the corresponding surface of contact of the tank support pair 25, an insulation layer 26 is arranged with a purpose of spreading the applied forces over the two surfaces of contact. A corresponding insulation layer 26 is arranged between the remaining two surfaces of contact. With this construction, forces and reaction forces are supported in two opposite directions. In this example, the hull support pair 24 is designed with an outer extension having a recess for receiving the inner extension of the tank support pair 25. A variation of this construction is to swap the design of the hull support pair 24 and the tank support pair 25.

The number of support point pairs 8 in the planes 2 and 3 are in the drawings minimized to 2 in each plane, but in some cases 3 or more may be more suitable. In principle, the least number of support points that are necessary to support horizontal movements of a vertical tank is 4, preferably separated about 90 degrees, distributed in two planes. In this first embodiment, the construction is preferably carried out

horizontal support point pairs 8. In Figs. 17 to 21, with details from Figs. 4 and 5, the construction in the presented cross sections orthogonal to the presented forces that are acting. In these is to observe that the support, with positive force, is carried out in such a way that a force in one direction, e.g. from the cargo tank 4, 40, 104 and, upwards in Figs. 4 and 5; towards the hull of the ship going from the tank pressure face 38, through the insulation layer 26; and further on to the hull pressure face 39. Assuming the pressure is directed the other way, from the cargo tank 4, 40, 104 and, downwards in Fig. 4; towards the hull of the ship, the pressure is directed from the lower tank pressure face 38; through the insulation layer 26; and further on to lower hull pressure face 39 further down in the same drawing.

Fig. 3 presents a horizontal cross section through a typical hold and a typical cargo tank 4, 40. Just one cargo tank 4, 40 is shown in the drawing, but the number may vary. Fig. 3 represents cross sections in both planes 2 and 3, these planes possibly being similar. Each plane will have at least 2 support point pairs 8, arranged with a mutual angle that is generally orthogonal, one of the support point pairs being designed to support alongside load and the other transverse load.

Fig. 4 shows a detail of a typical support point pair 8 and Fig. 5 shows the same detail in exploded view. A support point pair 8 comprises a tank support pair 25, comprising a number of parallel faces, each being welded or fastened in some other way to a tank shell 23 of a cargo tank 4, 40, 104, possibly combined with ring stiffeners on the tank, not shown. A compatible frame or hull support pair 24 with recess for the support 25 on the tank 4, 40, 104 is welded to the inside of the ship side 19. The recess in the frame on the ship makes room for an insulation layer 26 made of hardwood on each side. The insulation layer 26 is foreseen to transfer only general pressure, orthogonally related to the faces of the insulation layer 26, so that the insulation layer 26 on the front side of a support point pair 8 receives loads that are directed forwards, while the pressure plate 26 on the back side receives the loads that are directed backwards.

Support point pairs 8 in this preferred embodiment address only horizontal forces while all vertical forces are transferred through the construction below plane 1. The support point pairs 8 are designed to be as long as to accept a construction where a centre in the reaction force from the ship is generally tangential to the middle of the tank shell 23. This results in that no torque is applied into the tank shell 23, but that the force goes tangentially directly into the shell as pressure. This gives a generally even distribution of stress in the tank shell.

Overturning or tipping is counteracted by the support point pairs 8 in plane 3 taking on more force than those in plane 2.

The construction has enough flexibility in the insulation layers 26, 15, to transfer all forces, including forces from deformation, e.g. initiated by temperature variations and the moving of the ship 41, without undesirable stress being inflicted upon cargo tank 4, 40 or ship. The cargo tank may expand or shrink freely in radial directions without inflicting corresponding support point pair 8 any additional force. This is particularly important when expecting as great temperature variations as for e.g. LNG.

Figs. 6, 7 and 8 illustrate schematically how loads are transferred to the hull. The total applied vertical load 29, is transferred in plane 1 by the vertical support elements shown in Fig. 2. Horizontal static and dynamic loads are transferred through the support point pairs 8 in planes 2 and 3.

When the cargo tank 4, 40 gets applied a horizontal transverse load 30 in starboard direction as in Fig. 8 (for example due to the ship heeling over in starboard direction), this load will generally be supported on starboard side of the support point pair 8 arranged on the transverse bulkhead 5. The horizontal transverse reaction load 31 results in a rotating torque 33 to the tank 4, 40 that secondary is supported in the aft in the support point pair 8 arranged at the longitudinal bulkhead 20 on the ship side 19. This secondary reaction load is referenced 32. Part of the transverse loads are naturally be supported by the vertical support elements 13 getting applied an increased load on the starboard side compared to the port.

Similarly, a horizontal alongside load 34 applied to the tank 4, 40 will primarily be supported by the support point pair 8 at the longitudinal bulkhead. The reaction load 35 will in this example result in a torque 37 applied to the tank which is supported by a secondary reaction load 36 in the support point pair 8 arranged at the transverse bulkhead 5.

Support point pair 8 in plane 3 may in such cases take on generally the whole load, and the support point pairs 8 in plane 2 will only contribute in extreme cases in which the whole of the tank is influenced to slide or move horizontally. If the support in plane 1 prevents the tank from sliding of move horizontally, one may leave out arranging the support in plane 2.

Forces directed upwards may appear if damage occurs and water gets into the hold outside a tank 4, 40. If the tank is exposed to water on the outside and the tank is not sufficiently filled, so that it does not float, additional support point pairs 8 may be added to prevent the tank 4, 40 to float inside the hold. This is not shown in the figures relating to this first embodiment, but reference is made to the following embodiments where this is described.

In a second preferred embodiment, the vessel is a ship equipped with a number of cylinder shaped tanks that are placed horizontally. The embodiment is a simple support system for lying cylinder shaped cargo tanks designed for cooled liquids in gas and storage ships. The cooled liquid may for instance be LNG.

Fig. 13 presents a typical longitudinal cross section of a hold in an LNG carrier. Between two transverse bulkheads 5 there may be arranged e.g. two cargo tanks 104. All support forces are in this embodiment handled in three planes. This may naturally be changed on demand.

In this embodiment a construction with support point quads 9 is used in addition to the construction with support point pairs 8 as described earlier.

In Figs. 15 and 16 the construction of a support point quad 9 is presented. It is constructed in a similar way as the support point pair 8, but it has in addition a corresponding arrangement orthogonally to the support point pair 8 so that the combined construction supports loads and reaction loads in four directions, two and two opposite directions generally orthogonally to each other. A person skilled in the art will observe that possible variations to this are feasible. For example a construction with three symmetrical or asymmetrical directions. Another variation may be carried out with a circular version of the tank support and with a corresponding circular arrangement of the hull support. This is not shown on the drawings. Such variations may be a starting point for different embodiments that are not described further here, but may be adapted to different movement patterns of vessels 41, 141 equipped with cargo tanks 4, 104 of different sizes and shapes. As a person skilled in the art will understand, all such embodiments and variations have insulation layers 26 corresponding to their tank pressure faces and hull pressure faces for transferring forces.

Support point pairs 8 may also be arranged on the fore and/or aft end surfaces of cargo tanks. This is not shown in the drawings or described further in the embodiments. The different support point pairs 8 in one vessel may not be design equal, but may be adapted to different requirements.

The construction has to be designed with flexibility and tolerances to handle all loads, including loads resulting from deformations, that may be initiated e.g. by temperature variations and the movement of the vessel, without undesirable strain being enforced on to the cargo tank 4, 40, 104 or ship 41, 141. The cargo tank may in principle expand or shrink freely in its radial or axial direction without adding any additional strain to any of the support point pairs 8 or support point quads 9. This is quite important when having large temperature variations as with e.g. LNG.

Figs. 17-21 illustrate schematically how load is transferred between the tanks and the hull of the ship. The general force of gravity 129 is transferred in plane 102,

shown in Figs. 17 and 18. Horizontal static and dynamic forces, 130, 134, are transferred through support point pairs 8 and through support point quads 9.

When the cargo tank 104 gets applied a horizontal transverse load 130 towards starboard as in Fig. 21, e.g. because the ship is heeling over in starboard direction, with further reference to Fig. 13, this load 130 will primarily be supported by a support point quad 9 and a support point pair 8 on the lower side of tank 104, where the comprised hull support quad 124 and the comprised hull support pair 24 are fastened to the inner bottom of the ship 7.

The horizontal transverse reaction load 131 in turn apply a rotating torque 133 to the tank resulting in a secondary reaction load 132 from the ship supported at the upper part of the support point pair arranged at the port side. Part of the applied horizontal transverse load 130 will be supported by the vertical reaction forces 128 will get a bigger load on the starboard side than on the port side.

While vertical tanks may have a flexible base, horizontal tanks are generally completely self supporting. Both horizontal and vertical applied forces acting on big tanks 4, 40, 104 should be applied as close to the tank shell 23 as possible, preferably by letting the forces act along the middle of the shell, so that bending forces do not act into the tank. This is done in the present invention through the construction in the support point pair 8 and the support point quad 9, allowing the forces act along the centre line 27 of this construction 8, 9 tangential to the centre line of the tank 4, 40, 140. The length of the hull support pair 24, hull support quad 124, tank support pair 25 and the tank support quad 125 may vary to a large extent depending on the shape of the tank. It may even be split in separate halves for long designs, including long horizontal tanks.

Fig. 19 illustrates the upwards directed forces 146 that may appear provided damage arises resulting in water seeping into the hold outside the tank. Provided the tank 104 subject to such forces is not filled sufficiently to preventing it floating, the part of the support pair 8 that is in plane 103 will prevent the tank floating inside the hold.

Support points in the present document is to imply a limited area for support and not a literal point.

REFERENCES:

1, 2, 3, 101, 102, 103	Plane
4, 40, 104	Cargo tank
5	Transverse bulkhead
6	Main deck of ship
7	Inner bottom
8	Support point pair
9	Support point quad
10	Bottom shell
11	Double bottom structure
12	Double bottom longitudinals
13	Support element
14	Transverse web
15	Insulation layer
16	Transverse web
17	Cargo tank bottom stiffener
19	Ship side
20	Longitudinal bulkhead
23	Tank shell
24	Hull support pair
124	Hull support quad
25	Tank support pair
125	Tank support quad
26	Insulation layer
27	Centre line support load
28, 128	Vertical reaction force
29, 129	Total applied vertical load
30, 130	Total applied horizontal transverse load

31, 131	Primary horizontal transverse reaction load
32, 132	Secondary reaction load from ship
33, 133	Torque applied to tank
34, 134	Total applied horizontal longitudinal load
35, 135	Primary horizontal longitudinal reaction load
36, 136	Secondary reaction load
37, 137	Torque applied on tank
38	Tank pressure face
39	Hull pressure face
41, 141	Vessel
46, 146	Vertical lift up
47, 147	Vertical reaction force

Claims

1. System for support of cargo tank (4, 40) in a vessel (41),

the cargo tank having a generally flat and generally flexible base;

evenly distributed underneath the base of the tank are support elements (13); each comprising an insulation layer (15), transferring pressure generally evenly distributed from the contents of the tank, through the bottom structure of the vessel and on to the water pressure on the outer bottom (10) of the vessel (41);

the cargo tank (4, 40) comprising at least two pairs of tank pressure faces (38) fastened to the tank shell (23) of said tank and at least one pair of said tank pressure faces (38) is arranged transversally and at least one pair of said tank pressure faces (38) is arranged longitudinally in the vessel (41);

close next to each of the tank pressure faces is arranged an insulation layer (26); and

close next to each of the insulation layers and on the other side of each of the insulation layers (26) is arranged a corresponding hull pressure face (39) that is fastened to a ship side (19) or to a bulkhead (5);

characterized in that:

the tank pressure face (38) and the hull pressure face (39) aligned so that the orthogonal line of force is directed generally tangential to the middle of the shell (23) of the tank,

so that the insulation layers (15, 26) can transfer pressure without transferring large bending moment from the support loads to the cargo tank structure nor to the bottom of the vessel and, at the same time, thermally insulate between the cargo tank and the vessel.

2. System for support of cargo tank (4, 40) in a vessel (41) as claimed in claim 1, comprising,

between two and six pairs of tank pressure faces (38) fastened to the tank shell (23) of said tank and between one and four pairs of said tank pressure faces (38) are arranged transversally and between one and two pairs of said tank pressure faces (38) are arranged longitudinally in the vessel (41);

close next to each of the tank pressure faces is arranged an insulation layer (26); and

close next to each of the insulation layers and on the other side of each of the insulation layers (26) is arranged a corresponding hull pressure face (39) that is fastened to a ship side (19) or to a bulkhead (5).

3. System for support of cargo tank (4, 40) in a vessel (41) as claimed in claim 1, comprising,

six pairs of tank pressure faces (38) fastened to the tank shell (23) of said tank and four pairs of said tank pressure faces (38) are arranged transversally and two pairs of said tank pressure faces (38) are arranged longitudinally in the vessel (41);

close next to each of the tank pressure faces is arranged an insulation layer (26); and

close next to each of the insulation layers and on the other side of each of the insulation layers (26) is arranged a corresponding hull pressure face (39) that is fastened to a ship side (19) or to a bulkhead (5).