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(54) SYSTEM FOR LOADING AND OFF-LOADING A LNG CARRIER VESSEL

(57) The invention relates to a LNG carrier vessel comprising a transfer system with a moveable arm having a fluid opening at its distal end and an off-shore mooring system with a manifold, wherein the manifold and fluid opening can be brought into fluid communication to load or off-load the LNG carrier vessel.

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Description

FIELD OF THE INVENTION

[0001] The present invention is directed to a LNG carrier vessel, a mooring system and an assembly comprising such a LNG carrier vessel and mooring system.

BACKGROUND TO THE INVENTION

[0002] LNG carrier vessels are used to transport liquefied natural gas (LNG) to the market.

[0003] LNG is a cryogenic fluid, mainly comprising methane (e.g. more than 80 mol% or even 90 mol%) typically having a temperature, depending on the pressure, well below minus 100°C. Often, when stored at atmospheric pressure or close to atmospheric pressure (below 1.5 bar), LNG has a temperature of about minus 162°C. LNG is produced at a LNG plant by treating and cooling down natural gas.

[0004] LNG may be loaded from an on-shore or off-shore LNG plant to the LNG carrier vessel at a first location and unloaded from the LNG carrier vessel to an on-shore or off-shore regasification terminal at a second location. Transporting LNG between the LNG carrier vessel and on-shore facility requires suitable infrastructure, such as a jetty and at many terminals also a breakwater to allow the LNG carrier vessel to approach the berth. Generally, the (long) jetty and breakwater are a considerable part of the costs.

[0005] A transfer system may be provided on the LNG plant/regasification terminal to establish a fluid connection between the LNG plant/regasification terminal and the LNG carrier vessel. The transfer system may comprise a mechanical loading arm or a flexible hose, or an hybrid transfer system combining mechanical components with one or more flexible hoses. The transfer system is arranged to connect to a manifold on the LNG carrier to load or unload the LNG carrier vessel.

[0006] Lower cost transfer systems are desired, in particular for small-scale regasification terminals, i.e. regasification terminals with a capacity less than 1.0 MtPA, as conventional regasification terminals may not be economically feasible for small scale developments. To be able to serve customers with lower LNG need, lower cost solutions for small-scale regasification terminals are required.

SUMMARY OF THE INVENTION

[0007] It is an object to provide an alternative, preferably more cost-efficient, system transferring LNG from/to a LNG carrier vessel.

[0008] In particular it is an object to provide a system for unloading LNG to an on-shore regasification terminal at lower costs.

[0009] In one aspect, there is provided a LNG carrier vessel, comprising one or more LNG storage tanks and a transfer system,

the transfer system comprises a moveable arm, the moveable arm having a proximal end (permanently) connected to or based on the LNG carrier vessel and a distal end which is moveable between an onboard position and an outboard position,

wherein the transfer system further comprises a fluid opening positioned at the distal end of the moveable arm, which fluid opening is in fluid communication with the one or more LNG storage tanks.

[0010] The moveable arm may comprise

- one or more rigid arm sections comprising cryogenic piping or having flexible ducts connected thereto, or
- one or more rigid arm sections comprising cryogenic piping or having flexible ducts connected thereto and in addition one flexible arm section, being a distal arm section, e.g. formed by a flexible duct.

[0011] According to an other embodiment, the moveable arm only comprises rigid arm sections, the distal rigid arm section being a hose manipulator to manipulate a flexible end section of a duct establishing at least part of the fluid communication between the fluid opening at the distal end of the moveable arm and the one or more LNG storage tanks.

[0012] The rigid arm sections are preferably interconnected by (hydraulic) controllable joints arranged to convey LNG. Once a fluid connection has been established between the fluid opening positioned at the distal end of the moveable arm and a remote manifold, the controllable joints may be put in follow-modus or free wheel modus to allow for relative movement of the LNG carrier vessel and the loading or off-loading facility the manifold is positioned on.- In case of hydraulically controllable joints, this may be achieved by releasing/letting down the pressure in (part of) the hydraulic circuit.

[0013] The LNG carrier vessel comprises a hull, the hull having an outer perimeter when seen in top view. The LNG storage tanks are positioned inside the outer perimeter when seen in top view. The term outboard position with respect to the position of the distal end of the moveable arm is used to indicate a position outside the outer perimeter of the hull of the LNG carrier vessel and the term onboard position with respect to the position of the distal end of the moveable arm is used to indicate a position inside the outer perimeter of hull of the LNG carrier vessel.

[0014] Such a transfer system on the LNG carrier vessel allows to connect to loading and off-loading facilities relatively easy, without requiring presence of such a transfer system on the loading and off-loading facilities. This means that such facilities can be built at lower costs.

[0015] According to an embodiment the moveable arm is arranged to move the distal end to an outboard position which is more than 15 meters, preferably more than 25 meters away from the outer perimeter of the hull when seen in side view.

[0016] This allows the transfer system to connect to loading or off-loading equipment positioned at a safe distance from the LNG carrier vessel.

[0017] According to an embodiment the moveable arm comprises a coupler positioned at the distal end, the coupler being arranged to couple the fluid opening to a manifold to establish a fluid path between the LNG storage tanks and the manifold.

[0018] This has the advantage that the LNG carrier vessel can connect to loading or off-loading facilities comprising such a manifold. The loading or off-loading facility doesn't require a transfer system, coupler and associated hardware and can thus be relatively simple and cost-efficient.

[0019] The coupler is arranged to provide a fluid-tight, decouplable coupling between the fluid opening and the manifold. The coupler may comprise controllable clamps that can move from an open position to a closed position in which the clamps can lock to the manifold.

[0020] The coupler is preferably a quick release coupler that allows for a quick release in case of an emergency.

[0021] According to an embodiment the moveable arm comprises a shock absorbing jacket positioned at or close to the distal end of the moveable arm.

[0022] Such a shock absorbing jacket may be provided to interact with a catching arrangement provided on the loading or off-loading equipment, such as an off-shore structure comprising a manifold to be coupled to the fluid opening, to facilitate establishment of a connection between the moveable arm and such equipment.

[0023] The shock absorbing jacket is preferably positioned adjacent to the coupler and may further comprise a protection screen or protection sleeve encompassing the coupler. This protects the coupler from unwanted collisions when manoeuvring the moveable arm, for instance collisions with the catching arrangement.

[0024] According to an embodiment the LNG carrier vessel comprises a messenger line, the messenger line being connectable to a messenger line connection point not comprised by the LNG carrier vessel, the messenger line being arranged to guide the distal end and/or the fluid opening to a predetermined position relative to the messenger line connection point.

[0025] The messenger line connection point is preferably located on the off-shore single point mooring system described below. This allows to first establish a connection between the LNG carrier vessel and the off-shore single point mooring system via the messenger line and possibly the mooring hawsers, and then move the moveable arm to establish the fluid connection. This procedure limits the risk of damaging any of the equipment.

[0026] According to an embodiment the transfer system is arranged to connect the fluid opening positioned at the distal end of the moveable arm to a manifold positioned on an off-shore structure, thereby establishing a fluid connection between the manifold and the one or more LNG storage tanks on the LNG carrier vessel. The manifold positioned on the off-shore structure is in fluid communication with an on-shore or off-shore regasification terminal or with an on-shore or off-shore LNG plant as will be explained in more detail below.

[0027] The mooring of the LNG carrier vessel may be arranged through the connection of one or more mooring hawsers connected to the tower. Alternatively, or in addition, the LNG carrier vessel may be arranged to use dynamic positioning to control the position the LNG carrier vessel with respect to the off-shore structure to allow the transfer system to connect to the manifold at the off-shore structure and keep the LNG carrier vessel within a defined position range with respect to the off-shore structure.

[0028] Transfer of cryogenic fluid takes place while the LNG carrier vessel is moored to off-shore structure.

[0029] According to an embodiment the moveable arm comprises one or more passive joints to allow for relative movement of the distal end of the arm with respect to the proximal end.

[0030] This allows for a stable connection despite movements of the LNG carrier induced by metocean conditions, such as wind, current, waves and tides. The one or more flexible sections or passive joints may allow the LNG carrier to weathervane.

[0031] The flexible section or passive joints are preferably located close to the distal end of the moveable arm.

[0032] The moveable arm may preferably be an articulated arm, i.e. comprising two or more rigid arm sections connected by controllable joints. The passive joints are preferably comprised by a distal arm section. The passive joints may for instance be positioned close to the coupler and optionally the shock absorbing jacket.

[0033] So, in an embodiment in which the moveable arm comprises a plurality of rigid arm sections, one of the rigid arm sections, preferably the distal rigid arm section comprising the distal end may comprise a number of passive joints.

[0034] The term controllable joints is used to indicate that the joints may be controlled by an operator, for instance using a hydraulic system. The term flexible section or passive joint is used to indicate that movements thereof are not controlled and are not controllable by an operator but only induced by movements of the LNG carrier vessel. So, a controllable joint put in follow modus or free wheel modus is not considered a passive joint.

[0035] The passive joints may for instance comprise a first, second and third bearing and swivel arrangement, each enabling rotation about a first, second and third rotational axis, the first, second and third rotational axis being perpendicular with respect to each other. For instance, the first, second and third bearing and swivel arrangement may be a pitch, roll and yaw bearing and swivel arrangement respectively. The pitch and roll bearing and swivel arrangements allow the LNG carrier vessel to surge/sway/roll/pitch relative to the loading and off-loading facilities, which may be fixedly positioned. The yaw bearing and swivel arrangement allows the LNG carrier vessel to weathervane about the loading and off-loading facilities. Some of the movements may also be absorbed by the controllable joints connecting the different arm sections in follow or free wheel modus.

[0036] According to an embodiment the moveable arm comprises one or more passive joints allowing the LNG carrier vessel to weathervane over a predetermined angle, the predetermined angle being equal to or smaller than 180° or 90°.

[0037] This may be advantageous in situations in which the metocean conditions do not require 360° weathervaning. By restricting the weathervaning to a predetermined angle, the mooring equipment provided on the single point mooring system to connect to mooring hawsers can be relatively simple and thereby cost-efficient. For instance, the mooring equipment does not need to comprise a turn table to allow for 360° weathervaning.

[0038] According to an embodiment the LNG carrier vessel comprises an elongated hull having a bow and a stern, wherein the transfer system is located at or near the bow or the stern.

[0039] The elongated hull has a length L which is measured from the extreme forward end of the bow to the extreme aft end of the stern. The term near the bow or the stern is used to indicate that the transfer system is located with 0.1*L from the extreme forward end or extreme aft end of the stern.

[0040] According to an embodiment, the transfer system is moveable connected to the LNG carrier vessel, wherein the transfer system is moveable between a position at or near the bow or the stern and a midship position.

[0041] The term midship position is used to indicate a position which is located more than 0.2L, 0.3L or even more than 0.4L away from the extreme forward end of the bow and the extreme aft end of the stern (again L being the length of the hull measured from the extreme forward end of the bow to the extreme aft end of the stern). This will allow the LNG carrier vessel to load or unload from and to facilities that require a midship transfer system.

[0042] The LNG carrier vessel may for instance comprise a rail assembly on which the transfer system is positioned, the rail assembly running from the position at or near the bow or the stern to the midship position. The moveable arm may be positioned on a base comprising wheels that allow the base to move over the rails or directly over the deck of the LNG carrier vessel.

[0043] According to an embodiment, the transfer system comprises a duct suitable to convey cryogenic fluids, the duct establishing at least part of the fluid communication between the fluid opening at the distal end of the moveable arm and the one or more LNG storage tanks.

[0044] The duct may run through the one or more LNG storage tanks, through the moveable arm to the distal end. The duct may be a flexible duct. The duct may also be a rigid duct with a flexible end section, the flexible end section being manipulated by a distal rigid arm section (e.g. hose manipulator). The duct may also be a rigid duct with a flexible end section, the flexible end section being a free hanging.

[0045] The term cryogenic is used here to refer to temperatures below minus 100°C, preferably below minus 150°C and even more preferably below minus 160°C.

[0046] The transfer system may also be referred to as a cryogenic transfer system, i.e. suitable for transferring cryogenic fluids, such as LNG.

[0047] According to an embodiment the duct is at least partially made of a composite material.

[0048] For instance, the flexible end section described above may be at least partially made of a composite material.

[0049] The composite material forms a fluid tight and fluid conveying part of the duct, in use, being in direct contact with the LNG being transferred.

[0050] The composite material may be a material as disclosed in WO2008068303. The composite material preferably has (a) a tensile Young's modulus of less than 50 Gpa at ambient conditions; and (b) a tensile strain at break of at least 5% at ambient conditions. The term composite material and the different embodiments thereof are explained in more detail below.

[0051] The duct may be manufactured in accordance with any of the techniques disclosed in WO2016102624 and/or WO2016102618.

[0052] According to an alternative embodiment the duct is a metallic pipe in pipe solution.

[0053] Off-shore mooring system comprising a tower which is positioned on the seabed and a manifold positioned on the tower at a level above sea level, wherein the off-shore mooring system comprises at least one cryogenic fluid duct which establishes a fluid path between the manifold and a regasification terminal or a LNG plant.

[0054] The off-shore mooring system may be a single point mooring system.

[0055] The tower is permanently fixed to the seabed, for instance by one or more piles.

[0056] The regasification terminal may be an on-shore or an off-shore regasification terminal. The LNG plant may be an on-shore or an off-shore LNG plant.

[0057] The tower comprises a manifold. The manifold is arranged to connect to a (cryogenic) transfer system to receive a cryogenic fluid such as LNG. The manifold may be provided with structured elements compatible with the coupler to which the coupler may lock. For instance, the manifold may comprise a ring-shaped flange behind which a clamps of the coupler can lock.

[0058] According to an embodiment the manifold does not comprise a coupler. The manifold may not comprise any parts that need to be controlled actively needed to make the coupling with the coupler provided on the moveable arm.

[0059] The cryogenic fluid duct may at least partially be made of a composite material as described above.

[0060] The cryogenic fluid duct may run downwards from the manifold through the tower to the seabed. In between the tower and the shore, the cryogenic fluid duct may be positioned underneath the seabed at a depth of at 1 meter to run to shore.

[0061] Alternatively, the cryogenic fluid duct may run downwards from the manifold through the tower to the sea level. In between the tower and the shore, the cryogenic fluid duct may be a floating cryogenic fluid duct.

[0062] According to an embodiment, the off-shore mooring system comprises a turn table comprising mooring equipment to receive and connect a mooring hawser.

[0063] The turn table is preferably a 360° turn table allowing the LNG carrier vessel to weather vane.

[0064] According to an embodiment the tower comprises a catching arrangement.

[0065] The catching arrangement is arranged to catch the distal end of the moveable arm provided on the LNG carrier vessel and guide it towards the manifold to correct for inaccuracies in the relative positioning of the distal end of the moveable arm with respect to the manifold. Inaccuracies may be caused by waves etc.

[0066] The catching arrangement may be shaped as funnel, comprising a wider opening and a smaller opening, the funnel having its body axis aligned with the body axis of the manifold, and having its wider opening facing upwards or vertically outwards (with respect to the off-shore point mooring system) and its smaller opening facing downwards or vertically inwards (with respect to the off-shore mooring system).

[0067] The catching arrangement has the function to centralize the distal end of the moveable arm with respect to the manifold. The smaller opening of the funnel preferably has a diameter that matches the width of that part of the moveable arm that is positioned in the smaller opening just before and during connection.

[0068] System comprising a LNG carrier vessel as descried above and an off-shore mooring system as described above, wherein the distal end of the moveable arm is releasably connected to the manifold on the off-shore mooring system.

[0069] According to a further aspect, there is provided a mooring system as described above, comprising a tower which is positioned on shore, e.g. a quay. So, instead of an off-shore mooring system, there is provided an on-shore mooring system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0070] The drawing figures depict one or more implementations in accord with the present teachings, by way of example only, not by way of limitation. In the figures, like reference numerals refer to the same or similar elements.

Figure 1 schematically depict an embodiment of a system comprising a LNG carrier vessel and an off-shore single point mooring system,

Fig. 2 schematically depicts a more detailed view of the distal end of the moveable arm and the manifold on the off-shore single point mooring system according to an embodiment,

Fig. 3a-b schematically depicts a more detailed view of the distal end of the moveable arm and the manifold on the off-shore single point mooring system according to an alternative embodiment,

Figures 4 schematically depicts an alternative embodiment of a system comprising a LNG carrier vessel and an off-shore single point mooring system and

Fig. 5 schematically depicts a top view of a system with restricted weather vaning.

DETAILED DESCRIPTION OF THE INVENTION

[0071] There is provided a more cost-efficient system for transferring LNG to and from a LNG carrier vessel, comprising of a LNG carrier vessel and an (off-shore) single point mooring system.

[0072] There is provided a LNG carrier vessel with an onboard transfer system for cryogenic product transfer to an importing or exporting terminal (off-shore or on-shore). The (off)loading system is installed onboard the LNG carrier vessel. The equipment at the offshore terminal is limited to a manifold on a single point mooring system. The single point mooring system comprises a bottom fixed structure (i.e. tower) with a manifold. The connection between the LNG carrier vessel and the single point mooring system may allow for a full weathervaning of the LNG carrier vessel or for restricted weathervaning, i.e. approximately 90° weathervaning of the LNG carrier relative to the single point mooring system.

[0073] With such a system the need for a jetty and breakwater is omitted. The provided solution is cost-efficient as it doesn't require a transfer system to be present on each single point mooring system. This results in reduced CAPEX and OPEX and increased safety.

[0074] According to the solution provided, only a single transfer system is required in situations wherein the LNG carrier vessel sails between a plurality of (off-)shore single point mooring systems (e.g. a single loading point and a plurality of off-loading points). The costs for cryogenic transfer systems are reduced to only one system instead of a plurality of cryogenic transfer systems at every (off-)shore single point mooring system. Inspection, maintenance and repair can be performed in dedicated areas, e.g. shipyards, instead of remote areas where the (off-)shore single point mooring systems may be located, also resulting in reduced safety risks.

[0075] With the new system, the risks of vessel collisions with such (off-)shore single point mooring systems are reduced as there is no expensive transfer system on the (off-)shore single point mooring systems that could be damaged by a collision. Also, in case of a collision during loading/offloading, the volume of LNG that could be released to the environment is significantly reduced as there is no transfer system on the (off-)shore single point mooring system that contains LNG.

[0076] The transfer system is located onboard the LNG carrier vessel and connectable to the (off-)shore single point mooring system by means of a quick release coupling.

[0077] The amount of LNG contained by the (off-)shore single point mooring system is relatively small as it is limited to the piping inside the (off-) shore single point mooring system. The off-shore single point mooring system comprises a tower which provides additional protection to the LNG piping in case of collision with a vessel. If a leak would occur then the volume of LNG that could be released to the environment is limited by the presence of emergency shut-down valves.

[0078] Safety and efficiency is further improved as the loading/off-loading procedures and operations can be optimized, standardized and automated for the LNG carrier vessel and will not be subject to different transfer systems at different loading/offloading locations.

[0079] Fig. 1 schematically depicts a LNG carrier vessel 1, comprising one or more LNG storage tanks 2 and a transfer system 3.

[0080] The LNG carrier vessel comprises an elongated hull 10. The elongated hull has a length L which is measured from the extreme forward end of the bow to the extreme aft end of the stern as shown in Fig. 1. The transfer system 3 may be positioned at or near the bow or the stern. Alternatively, the transfer system 3 may be positioned at a midship position (not shown). According to a further embodiment, the transfer system 3 is moveable between a position at or near the bow or the stern and a midship position.

[0081] The transfer system 3 comprises a moveable arm 4, the moveable arm having a proximal end 5 (permanently) connected to the LNG carrier vessel and a distal end 6 which is moveable between an onboard position and an outboard position. The transfer system 3 comprises a fluid opening 7 (not indicated in Fig. 1) positioned at the distal end 6 of the moveable arm 4, which fluid opening 7 is in fluid communication with the one or more LNG storage tanks 2. The fluid connection between the fluid opening 7 and the one or more LNG storage tanks 2 is not fully shown.

[0082] The moveable arm is arranged to move the distal end 6 to an outboard position which is more than a distance D away from the outer perimeter of the hull when seen in side view, as indicated in Fig. 1.

[0083] As shown in more detail in Fig. 2, the moveable arm 4 comprises a coupler 8 positioned at the distal end 6, the coupler 8 being arranged to provide a fluid connection between the fluid opening 7 and a manifold 102 of an (off-)shore single point mooring system 100 as will be described in more detail below.

[0084] The coupler 8 may comprise controllable clamps 81 that can move from an open position to a closed position in which the clamps 81 can lock to the manifold 102.

[0085] According to an embodiment as schematically depicted in Fig. 3 the moveable arm 4 comprises a shock absorbing jacket 11 positioned at or close to the distal end 6 of the moveable arm 4.

[0086] Optionally, the moveable arm comprises a protection screen or protection sleeve 12 encompassing the coupler 8.

[0087] Optionally, the moveable arm comprises one or more flexible sections or passive joints 21, 22, 23 to allow for relative movement of the distal end 6 of the moveable arm 4 with respect to the proximal end 5. The first bearing and swivel arrangement 21 may be a yaw bearing and swivel arrangement, second bearing and swivel arrangement 22 may be a roll bearing and swivel arrangement and the third bearing and swivel arrangement 23 may be a pitch bearing and swivel arrangement.

[0088] Fig. 1 further shows an off-shore single point mooring system 100 comprising a tower 101 which is positioned on the seabed SB and a manifold 102 positioned on the tower 101 at a level above sea level SL, wherein the off-shore single point mooring system 100 comprises at least one cryogenic fluid duct 103 which establishes a fluid path between the manifold 102 and an on-shore regasification terminal or an on-shore LNG plant 200. For instance, the at least one cryogenic fluid duct 103 establishes a fluid path between the manifold 102 and LNG-storage tanks comprised by the on-shore regasification terminal or the on-shore LNG plant 200.

[0089] It is noted that the on-shore regasification terminal or on-shore LNG plant may alternatively be positioned off-shore, for instance on a FSRU-vessel or FLNG vessel.

[0090] The tower 101 is permanently fixed to the seabed, for instance by one or more piles 104.

[0091] The tower 101 comprises a manifold 102, which may be provided with structured elements compatible with the coupler 6 to which the coupler 6 may lock. For instance, the manifold 102 may comprise a ring-shaped flange 105 behind which clamps of the coupler can lock.

[0092] The cryogenic fluid duct 103 runs downwards from the manifold 102 through the tower 101 to the seabed SB. In between the tower 101 and the shore, the cryogenic fluid duct 103 is positioned underneath the seabed SB.

[0093] As further shown in Fig. 1, the tower comprises a catching arrangement 5. The catching arrangement 5 is funnel-shaped, comprising a wider opening 51 and a smaller opening 52, the funnel 5 having its body axis BA5 aligned with the body axis BA102 of the manifold 102, and having its wider opening 51 facing upwards and its smaller opening 52 facing downwards.

[0094] Fig. 1 further shows a mooring line or mooring hawser 9 mooring the LNG carrier vessel 1 to the off-shore single point mooring system 100.

[0095] In use, the distal end 6 of the moveable arm 4 is aligned with the manifold 102 and moved towards the manifold. The catching arrangement 5 catches the distal end and guide the distal end 6, i.e. the fluid opening 7 towards the manifold. The coupler 6 is then actuated to move from its open to its closed position.

[0096] According to an alternative shown in Fig.4, the body axis BA102 of the manifold 102 may be substantially vertical. The fluid opening 7 comprised by the moveable arm may have a body axis (not shown) that is either substantially vertical to allow connection with the manifold 102. The moveable arm 4 may be build such that the body axis of the fluid opening 7 is substantially vertical or may be arranged to orientate the body axis of the fluid opening 7 between horizontal and a vertical orientation.

[0097] According to the embodiment shown in Fig.'s 4a and 4b, the catching arrangement 5 comprised by the off-shore single point mooring system may be funnel-shaped, comprising a wider opening 51 and a smaller opening 52, the funnel 5 having its body axis BA5 substantially vertical, and having its wider opening 51 facing outwards (with respect to the off-shore single point mooring system) and its smaller opening 52 facing inwards (with respect to the off-shore single point mooring system).

[0098] Fig. 5 shows a top view of a system in which the LNG carrier vessel 1 is allowed to weathervane over a predetermined angle α, the predetermined angle being 90°.

[0099] As mentioned, the duct establishing at least part of the fluid communication path between the fluid opening at the distal end of the moveable arm and the one or more LNG storage tanks may at least partially be made of or comprise a composite material. Also, the cryogenic fluid duct which establishes a fluid path between the manifold on the off-shore single point mooring system and the on-shore regasification terminal or an on-shore LNG plant may at least partially be made of or comprise a composite material.

[0100] The composite material may comprise a matrix and reinforcement composed of the same thermoplastic polymer, for example polypropylene or polyethylene. The reinforcement can be in the form of, for example, fibres, tows, sheets, or woven fabric. The reinforcement generally has a higher tensile strength and melting temperature than the matrix, which is obtained by specialised processing, often mechanical in nature. The composite is formed by fusing the reinforcement layer(s) with the matrix. The fusing process is a controlled thermo-mechanical procedure which generally utilizes the lower melting temperature of the matrix. This results in a fully bonded material. Such a fully bonded material has superior properties due to the mechanical properties of the reinforcement. The physical properties of the mono-material composite can be controlled by the processing of the reinforcement, the thermos-mechanical fusion process, the reinforcement/matrix ration, and the orientation of reinforcement.

[0101] The present disclosure is not limited to the embodiments as described above and the appended claims. Many modifications are conceivable and features of respective embodiments may be combined.

[0102] The following examples of certain aspects of some embodiments are given to facilitate a better understanding of the present invention. In no way should these examples be read to limit, or define, the scope of the invention.

Claims

1. LNG carrier vessel, comprising one or more LNG storage tanks and a transfer system, the transfer system comprises a moveable arm, the moveable arm having a proximal end (permanently) connected to or based on the LNG carrier vessel and a distal end which is moveable between an onboard position and an outboard position, wherein the transfer system further comprises a fluid opening positioned at the distal end of the moveable arm, which fluid opening is in fluid communication with the one or more LNG storage tanks.

2. LNG carrier vessel according to claim 2, wherein the moveable arm is arranged to move the distal end to an outboard position which is more than 15 meters, preferably more than 25 meters away from the outer perimeter of the hull when seen in side view.

3. LNG carrier vessel according to any one of the preceding claims, wherein the moveable arm comprises a coupler positioned at the distal end, the coupler being arranged to couple the fluid opening to a manifold to establish a fluid path between the LNG storage tanks and the manifold.

4. LNG carrier vessel according to any one of the preceding claims, wherein the moveable arm comprises a shock absorbing jacket positioned at or close to the distal end of the moveable arm.

5. LNG carrier vessel according to any one of the preceding claims, wherein the LNG carrier vessel comprises a messenger line, the messenger line being connectable to a messenger line connection point not comprised by the LNG carrier vessel, the messenger line being arranged to guide the distal end and/or the fluid opening to a predetermined position relative to the messenger line connection point.

6. LNG carrier vessel according to any one of the preceding claims, wherein the transfer system is arranged to connect the fluid opening positioned at the distal end of the moveable arm to a manifold positioned on an off-shore structure, thereby establishing a fluid connection between the manifold and the one or more LNG storage tanks on the LNG carrier vessel.

7. LNG carrier vessel according to any one of the preceding claims, wherein the moveable arm comprises

one or more passive joints to allow for relative movement of the distal end of the arm with respect to the proximal end.

8. LNG carrier vessel according to any one of the preceding claims, wherein the moveable arm comprises one or more passive joints allowing the LNG carrier vessel to weathervane over a predetermined angle, the predetermined angle being equal to or smaller than 180° or 90°.

9. LNG carrier vessel according to any one of the preceding claims, wherein the LNG carrier vessel comprises an elongated hull having a bow and a stern, wherein the transfer system is located at or near the bow or the stern.

10. LNG carrier vessel according to any one of the preceding claims, wherein the transfer system is moveable connected to the LNG carrier vessel, wherein the transfer system is moveable between a position at or near the bow or the stern and a midship position.

11. LNG carrier vessel according to any one of the preceding claims, wherein the transfer system comprises a duct suitable to convey cryogenic fluids, the duct establishing at least part of the fluid communication between the fluid opening at the distal end of the moveable arm and the one or more LNG storage tanks.

12. LNG carrier vessel according to claim 11, wherein the duct is at least partially made of a composite material.

13. Off-shore mooring system comprising a tower which is positioned on the seabed and a manifold positioned on the tower at a level above sea level, wherein the off-shore mooring system comprises at least one cryogenic fluid duct which establishes a fluid path between the manifold and a regasification terminal or a LNG plant.

14. Off-shore mooring system according to claim 13, wherein the cryogenic fluid duct is at least partially partially positioned underneath the seabed.

15. Off-shore mooring system according to any one of the claims claim 13 and 14, wherein the tower comprises a catching arrangement.

16. System comprising a LNG carrier vessel according to any one of the claims 1 - 12 and an off-shore mooring system according to any one of the claims 13 - 14, wherein the distal end of the moveable arm is releasably connected to the manifold on the off-shore mooring system.

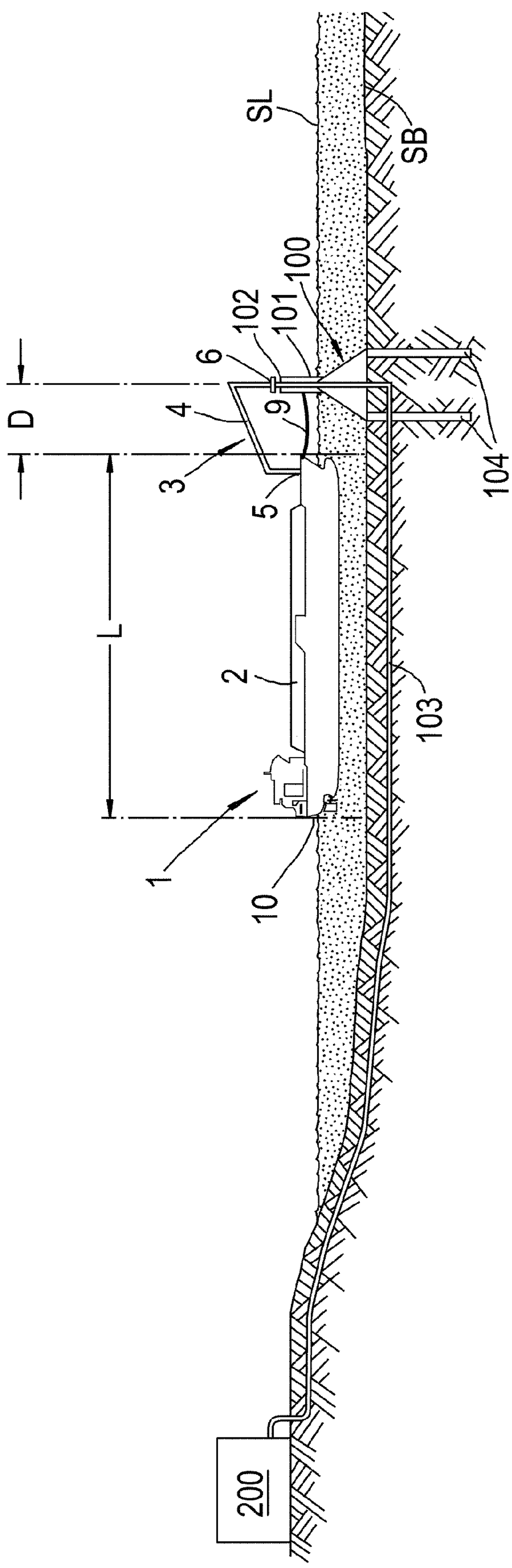


Fig.1

Fig.2

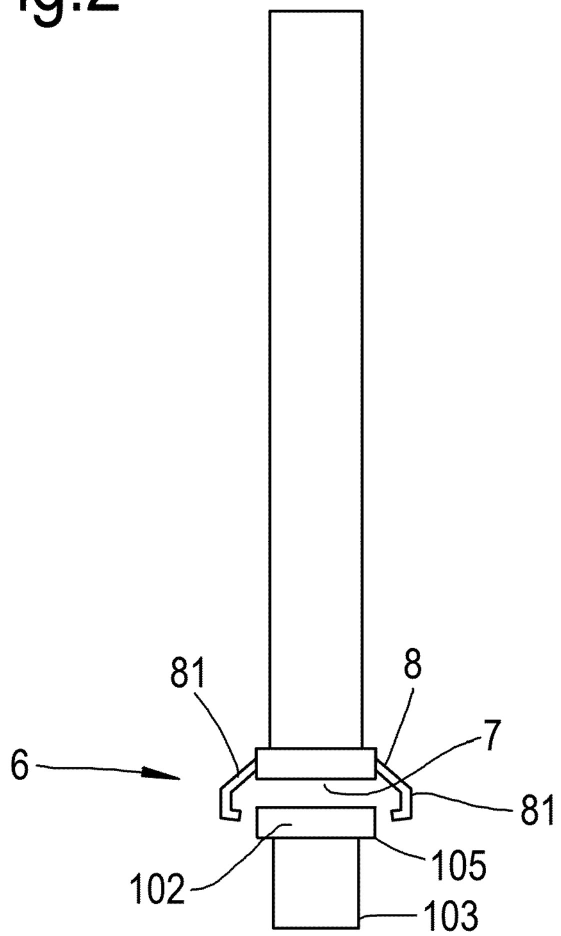


Fig.3a

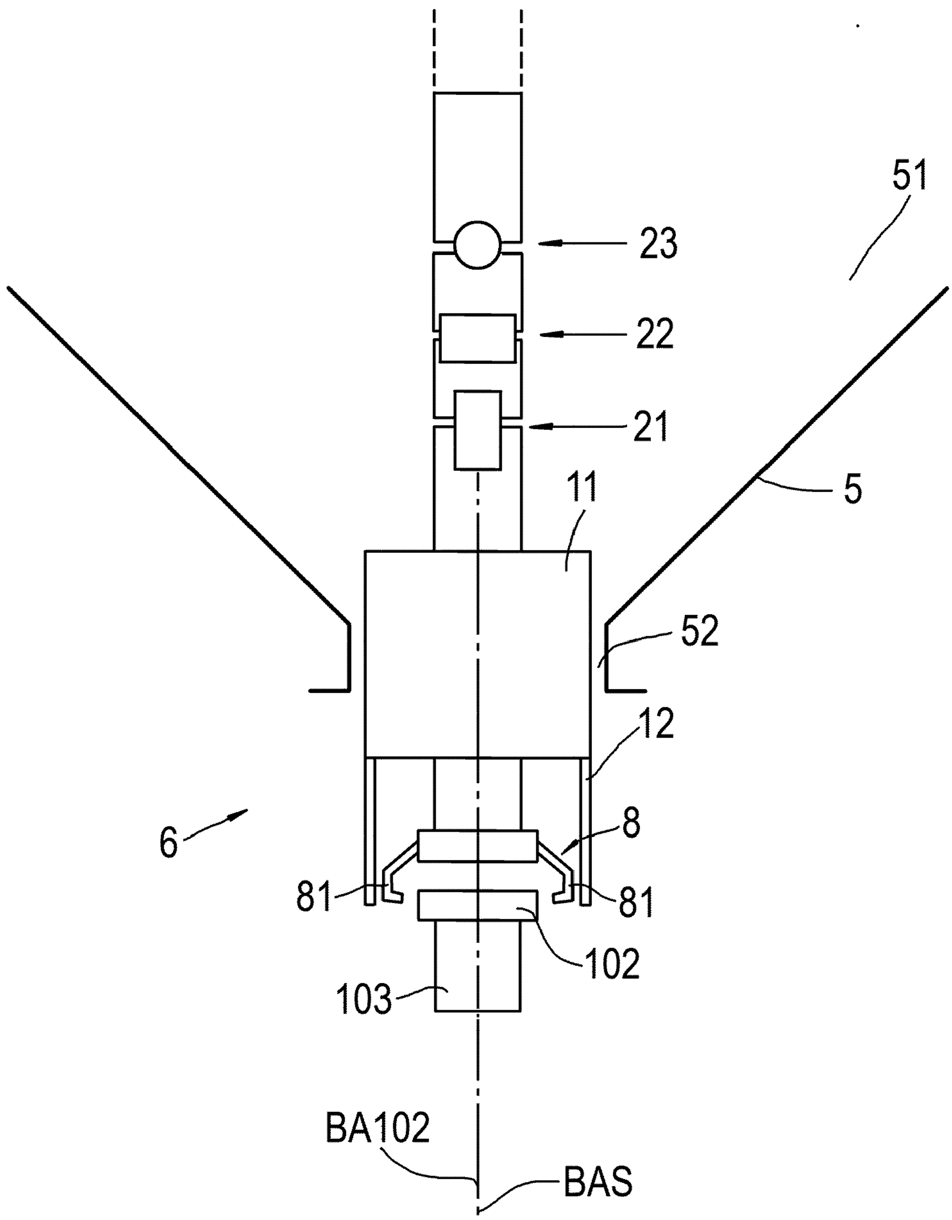
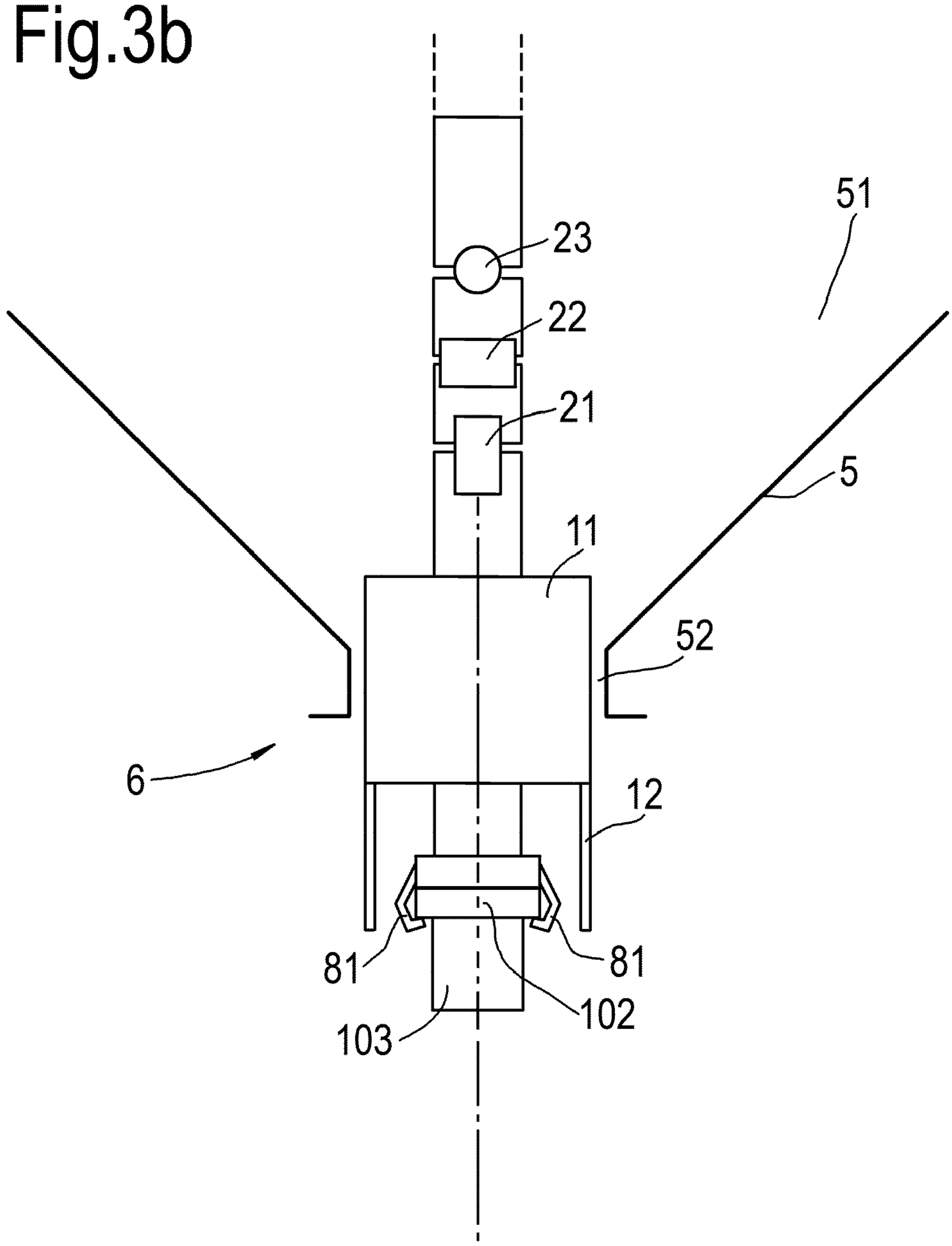


Fig.3b



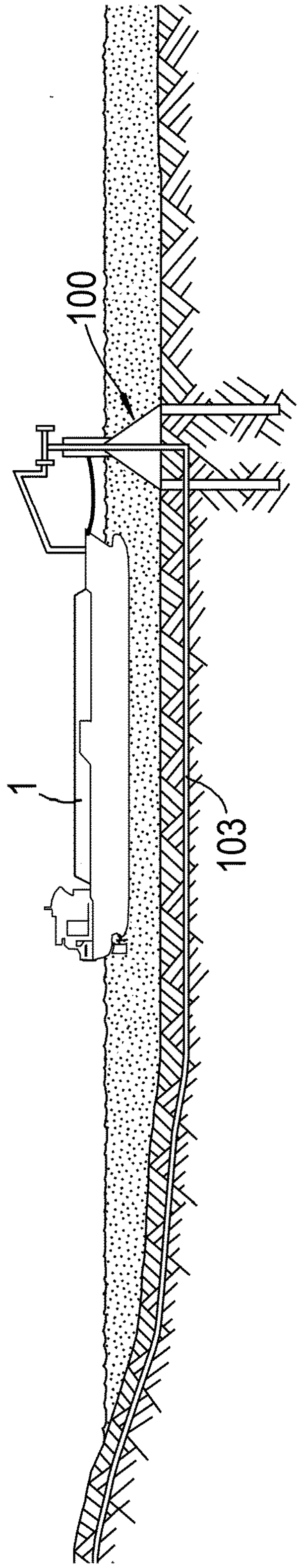


Fig.4

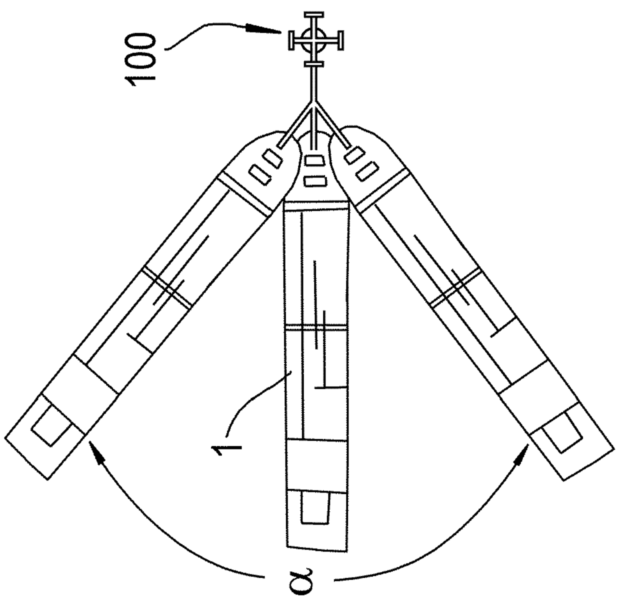


Fig.5

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Application Number
EP 17 19 6486

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1

Place of search	Date of completion of the search	Examiner
The Hague	14 March 2018	Mauriès, Laurent

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