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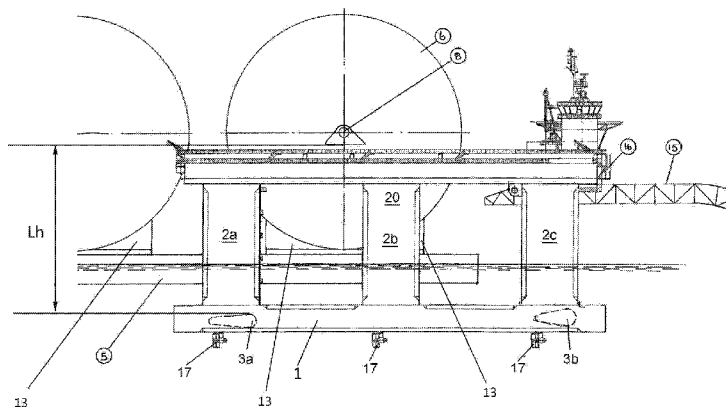


Fig. 3

(57) Abstract: The present invention relates to a semi - submersible vessel for laying coiled tubing uncoiled from a reel (6) on the vessel down to a seabed. The vessel comprises a pool, forming a U - shaped loading zone (17) with an opening (18) in at least one of the vessel's ends. The U - shaped loading zone (17) is adapted for insertion of a vessel with at least one reel (6) for uptake of coiled tubing, as the loading zone (17) has a loading zone width L_w , a loading zone height L_h and a loading zone length L_l . The reel has a reel width D_w and a reel diameter D_d . The loading zone width L_w is larger than the reel width D_w , and the loading zone length L_l is larger than half the reel diameter D_d . A first deck portion (4a) extends along a first side of the loading zone (17) and a second deck portion (4b) extends along a second side of the loading zone (17). The first deck portion (4a) is substantially parallel with the second deck portion (4b). A reel shaft support unit (7) is provided on each of the first and second generally parallel deck portions (4a, 4b). At least a first transverse strut (3b) extends between the pontoons. The deck portions (4a, 4b) extend in a distance above the pontoons (1). A transverse deck portion (4c) extends between the first and second substantially parallel deck portions (4a, 4b). Supporting columns (2a, 2c) extend between the deck portions (4a, 4b) and the pontoons. A laying arm is provided (15) for payout of the coiled tubing, machinery (10) is arranged for operation of the reel. The machinery comprises at least a motor and a gear for engagement

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Semi - submersible pipe laying vessel and method

The present invention is concerned with a semi - submersible vessel for the laying of coiled tubing uncoiled from a reel on the vessel down to a seabed. In particular, the invention relates to a vessel that may be ballasted for laying pipelines having large diameters, by using coiled tubing technology, a system for offshore pipe laying and a method for the loading and unloading of reels.

INTRODUCTION

The present invention is concerned with vessels, equipment and techniques for laying pipes, using coiled tubing technology for pipes with large diameters ($> 16''$, where " denotes inches, which is a common term used on pipe sizes, indicating the diameter of the pipe). A method is also disclosed here.

Pipes are currently laid on the seabed with different types of laying vessels and techniques. Particularly in deep waters this is expensive because of the high daily rates for laying vessels and the time consumption in laying pipes. Laying speeds typically vary from 3 to 6 km per day. By developing a laying vessel being capable of laying the pipes faster, there will be huge savings in both time and money. Coiled tubing technology has been in use for pipes with diameters up to $16''$. This technique implies that the tubing has to be welded together onshore, and coiled onto a reel, which then is lifted on board the pipe laying vessel. The tubing is then laid by uncoiling the tubing from the reel. For large pipe sizes ($> 16''$), it is common to weld the tubing together on board of the laying vessel while they are being laid, either by techniques such as S - lay or J - lay. The latter technique is required at larger depths. This means that the laying speed will depend on the welding speed. In order to increase the speed, attempts have been made on welding several lengths together in advance, but the lengths of prefabricated pipes will depend on the height of laying tower on the vessel, particularly in the J - lay technique, where the tower is almost vertical. Imperfections in the welding will also affect the speed of laying in a negative manner, although the use of automatic welding techniques has managed to reduce the error rate to around 2 %. The length of the individual pipes is usually 12 meters. For S - lay, depending on the length of the vessel, it has been possible to weld 3 to 5 pipe lengths together. Operating costs will also be lower in the coiled tubing

technology, due to fewer welders and sheet metal workers, as well as requiring less welding equipment on board the vessel, as most of the welding work is performed onshore.

The reason for not being common with diameters larger than 16" in laying of pipes by coiling is that, when the tubing is coiled around the reel, the reel must be of such a size that the tubing will not be subject to such large stresses that the tubing will be ovalized, and hence may collapse. Very often the tubing will be wrapped in by a concrete coating in order for the tubing to be of sufficient weight to remain on the seabed. For large deflections, which will take place by bending around small reels, the concrete will break since the tubing then will be subject to too large tensile stresses and possibly compressive stresses.

The present invention provides solutions, so that the large reels may be used, thus reducing the mechanical stresses applied on the piping and the concrete coating as a result of the coiling. It will then be possible to use coiling technology for pipes with large diameters.

In one embodiment, the invention comprises a semi - submersible laying vessel with two pontoons (buoyancy elements submerged), which are connected to four or more (six shown in Figs. 1, 3 and 4) columns, one or more crossbars (two crossbars are shown in Figs. 1, 3, and 4) secured at the underside of the pontoons, and with one deck secured at the top of the columns. The deck is open at one (aft) end, so that one may install and accommodate the reel. Living quarters are installed at the front end of the deck. The pipe laying vessel is equipped with dynamic positioning that allows it to keep its position when the tubing is being laid. In addition to this, the laying vessel is equipped with plumbing equipment which will be further described in detail.

Additionally, the invention comprises a specially designed barge / vessel for uptake of two reels. The purpose - built barge / vessel, hereinafter simply barge, may have its own propelling machinery. By use of such a barge, this may be shipped to a land base, where welding of the tubing, and possibly the concrete coating, may be added. All weldings, assemblies, and possibly the concrete coating, will be completed and

quality assured onshore, before the tubing is coiled on board onto the reel. After the reel (or both reels) has been filled up with tubing, the barge is shipped to the laying vessel for installation at the field or in calm waters near the field assembly of the reel. The pipe laying vessel is then being prepared for installation of the reel. The barge is docked into the open end of the laying vessel and the reel is mounted. After the tubing has been installed, the laying vessel may again move to calm waters and the barge will be ready with a new reel. The empty reel will only be taken out after the barge has been docked in. Then the barge will be turned around and the full reel will again be loaded over. The laying vessel will then continue with the installation, while the barge will go to the land base and load off the empty reel, and load a new full reel on board. The barge may then continue to the field for a new loading / unloading of the laying vessel.

The present invention relates to a vessel for laying coiled tubing, uncoiled from a reel, onto the seabed. The vessel includes equipment for ballasting, and a pool forming a U - shaped loading zone having an opening in at least one end of the vessel, adapted for the introduction of a vessel with a reel for payout of the coiled tubing. The loading zone contains a loading zone width L_w , loading zone height L_h and loading zone length L_l , for uptake of the reel, as the reel has a reel width D_w and a reel diameter D_d , as the loading zone width L_w is larger than the reel width D_w and the barge width B_w . Loading zone length L_l is normally larger than the reel diameter D_d . However, it is conceivable with embodiments where the reel is protruding somewhat outside of the vessel, and if so, the reel diameter D_d could be somewhat larger than the loading zone length L_l . In any case, the loading zone length cannot be less than half the reel diameter D_d . The pipe laying vessel comprises a first deck portion along a first side of the loading zone and a second deck portion along a second side of the loading zone. The first deck portion is substantially parallel with the second deck portion. A reel shaft support unit is placed on each of the two substantially parallel deck portions.

The present invention may in one embodiment comprise a semi - submersible pipe laying vessel for uptake of large reels. The pipe laying vessel has a loading zone or a pool having a width L_w , height L_h and length L_l , and ballasting equipment for lifting, lowering and adjusting the vessel angle for uptake of a reel with a reel width D_w and

a reel diameter D_d and coiled tubing payout. The loading zone width L_w is larger than the reel width D_w and the barge width B_w . The loading zone length L_l is larger than the reel diameter D_d . The pipe laying vessel further comprises at least one propulsion unit, two substantially parallel pontoons at a minimum distance L_w from each other, and at least a first transverse strut extending between the pontoons. A deck structure comprises two substantially parallel deck portions extending at a distance above each of the pontoons and at a smallest distance L_w apart from each other. A transverse deck portion is extending between the two substantially parallel deck portions, forming a U - shaped deck with an open portion. This portion forms the loading zone or the pool mentioned above. A reel shaft support unit is placed on each of the two substantially parallel deck portions. At least two supporting columns extend between each of the pontoons and the parallel extended deck portion. Each of the supporting columns has a height, so as to form the smallest distance L_h between each of the reel shaft support units, and so that at least one first transverse strut will be extended between the pontoons and at a minimum distance C_w between each supporting column. The pipe laying vessel further comprises a laying arm with the equipment required for payout of the coiled tubing.

The pipe laying vessel further comprises machinery for operating the reel, comprising at least a motor and a gear for engagement with a pinion (or another type of drive for rotation of the reel) on the reel.

The pipe laying vessel may further include a second transverse strut extending between the pontoons, since said first strut is positioned at a front end of the pontoons and the second strut is positioned at an aft end of the pontoons.

The pipe laying vessel may further comprise a third supporting column between the first and the second supporting columns at each of the pontoons, extending between each of the pontoons and the respective deck portion.

The pipe laying vessel may further comprise an arrangement for attaching the laying arm, secured onto a transverse beam extending below the transverse deck portion and in front of the front end of the deck.

The arrangement for attaching the laying arm may be secured in front of the other two supporting columns at the front end of the deck, and the arrangement for attaching the laying arm may be adapted in order to adjust an angle for the laying arm in a vertical plane, between a vertical or near vertical angle and a horizontal or near horizontal angle, depending on the water depth (if one chooses S - or J - laying technique). During transport, the laying arm is not in use, and will be approximately horizontal.

The laying arm may further comprise means for straightening of the coiled tubing before it is laid.

The first and second transverse struts that extend between the pontoons may be secured at the lower end of the pontoons.

The pipe laying vessel may further include dynamic positioning equipment for automatic control of the vessel.

Furthermore, the invention comprises a system for offshore pipe laying, comprising a vessel as described, and a barge with a barge width B_w being smaller than the smallest distance C_w between each of the first supporting columns on the vessel, since said barge will be adapted to be inserted into the vessel loading zone, and releasable securing elements for the reel at sea for securing at least one reel on the barge.

Fender protection may be placed between the barge and the vessel when the barge is introduced into the loading zone of the vessel.

Fender protection may be secured onto the barge.

Furthermore, the invention comprises a system as defined above and where the barge is adapted for securing two reels, as there are two releasable securing elements for the reel at sea, for securing each reel onto the barge. The invention may also comprise additional adapted barges / vessels.

The releasable securing elements for the reel at sea may comprise mechanical actuators for releasing or securing the reels onto the barge.

The invention further comprises a method for loading and unloading of a cable between a vessel for laying of coiled tubing uncoiled from a reel on the seabed, and a barge having at least one reel of coiled tubing and a reel shaft having a substantially horizontal longitudinal axis substantially perpendicular to the longitudinal axis of the barge. The vessel includes equipment for ballasting, and a pool which forms a U - shaped loading zone having an opening in at least one of the vessel's ends, adapted for the introduction of a vessel with a reel and a payout of coiled tubing. The loading zone has a loading zone width L_w , a loading zone height L_h and a loading zone length L_l , for uptake of the reel, and said reel has a reel width D_w and a reel diameter D_d . The loading zone width L_w is larger than the reel width D_w and the barge width B_w . The loading zone length L_l is larger than half of the reel diameter D_d , but normally the loading zone length L_l will be larger than the entire reel diameter D_d , so that no parts of the reel will protrude outside of the vessel. The reel mass may be significant, hence the vessel hull would normally extend to somewhat outside of the reel diameter D_d due to stability considerations. The pipe laying vessel further comprises a first deck portion along a first side of the loading zone, and a second deck portion along a second side of the loading zone. The first deck portion is substantially parallel with the second deck portion. A reel shaft support unit is positioned on each of the two substantially parallel deck portions. The method comprises guiding of the vessel to a lower position with ballasting equipment, guiding of the barge with the at least one reel having the coiled tubing into the loading zone of the vessel, aligning the reel shaft support unit with the reel shaft, lifting the vessel by the ballasting equipment to the reel shaft support unit when the reel shaft releases the releasable securing elements for the reel being on the barge at sea, in order to release the reel from the barge (this can be done earlier when the security at sea is needed for transport to the field / the pipe laying vessel) and further raise the vessel to lift the reel from the barge, guide the barge out from the loading zone of the vessel, and lay the coiled tubing onto the seabed.

The coiled tubing may be laid on the seabed with the laying arm for payout of the coiled tubing.

The method may further comprise replacing a first reel on the vessel (after the reel has been emptied of tubing) to the second reel on the barge. The barge comprises a first portion for the uptake of a first reel. The reel has a reel shaft having a longitudinal axis. The reel is placed on the barge so that the reel axis is substantially horizontally and stands basically perpendicular to a longitudinal axis of the barge. The second portion for the uptake of the second reel is adapted for a similar location as the first reel.

The method further comprises the steps of:

guiding the barge into the loading zone, as the barge has a first reel mounted at the said first portion for uptake of the first reel and the second portion for the uptake of a reel is available for the uptake of a reel, and wherein the second portion for the uptake of a reel being free is guided under a reel being secured to the vessel, as the vessel is in a raised position, lower the vessel to the reel on the vessel may be fastened in the barge, secure the reel in the barge with releasable reel securing at sea, and release the reel from a reel shaft support unit on each of the two mainly parallel deck portions of the vessel, lowering the vessel to the barge with two reels being cleared of the vessel, and guide the barge out from the loading zone, turning the barge around and guide the second portion for uptake of a second reel into the loading zone, as the second reel is secured on the second portion, and repeat the operation for transferring the reel from the barge to the vessel.

Furthermore, the invention comprises the use of a vessel or a method as described above, for replacing coiled tubing with a diameter of more than 16".

Brief description of the attached figures:

FIG. 1 is a side view of a laying vessel according to the invention;

FIG. 2 is a front view of the laying vessel shown in FIG. 1;

FIG. 3 is a side view corresponding to FIG. 1, also showing a barge for loading or unloading the reel, and where the laying vessel is partially submerged;

FIG. 4 is a side view similar to FIG. 1, also showing a barge for loading or unloading the reel, and where the laying vessel is in an upper position;

FIG. 5 is a top view of the laying vessel shown in the preceding figures;

FIG. 6 is a top view of a barge to be used together with a laying vessel according to the invention;

FIG. 7 shows a barge as shown in Fig. 6 in a laying vessel as shown in the other figures 1 - 5;

Detailed description of an embodiment of the invention with reference to the enclosed figures:

In the following description it is referred to raised and lowered, upper, lower, and so on, for the semi - submersible vessel. However, the barge may also be raised and lowered slightly, and all loading and unloading of the reels onto the vessel will comprise both the barge and the vessel, being deballasted for the raising and ballasted for the lowering. The invention is not limited to only the vessel being raised and lowered by ballasting. Further descriptions, such as top, bottom, up, down, etc., are related to directions relative to the vessel when this is floating horizontally, in order to ease the description of the invention. One may conceive situations where these references will not be correct, without changing the solution being described.

From Fig. 1 a laying vessel is shown according to the invention, which is constructed as a semi - submersible platform with two pontoons 1 being connected to six columns 2a, 2b, 2c and two transverse struts 3a, 3b. These transverse struts 3a, 3b are so designed that the resistance at the forward motion is minimal, while it will be larger when moving astern, and is shown with a "teardrop" cross section to provide favorable hydrodynamic conditions. The two transverse struts 3a, 3b, are shown in phantom at the bottom end of pontoons 1. The three supporting columns 2a, 2b and 2c are arranged parallel to each other, and are equally spaced apart. On top of the supporting columns 2a, 2b, 2c, there is a deck construction 4, wherein a central part

of the deck is cut out from the aft end, so it is possible to enter with a barge having a reel 6 in between the columns 2a, 2b, 2c, and the deck 4. The two transverse struts 3a, 3b are secured at the bottom of the pontoons 1, so that the barge 5 may float across during docking, during the loading itself and for maneuvering out from the pool afterwards.

The pipe laying vessel is further equipped with two structural members 7 of on which the shaft 8 of the reel 6 will rest, when the reel 6 is being installed on board the laying vessel. At the outer edge 9 of the reel, a propulsion machinery 10 will be installed, which pulls the reel around in connection with the laying of tubing. The propulsion machinery 10 consists of several motors, which via teeth are connected along the outer edge 9 of the reel.

The pipe laying vessel is also equipped with a laying arm 15, being secured onto a transverse beam under the deck in front of the reel 6, and by means of an arrangement 16, for adjusting the angle of the laying arm, is located in front of the front supporting columns 2c. The laying arm 15 should be adjustable in the vertical plane, so that it can be almost vertically to more horizontally; depending on the water depth (and thus the laying technique) that the tubing will be laid into. The laying arm 15 is shown in a position for the placement of the coiled tubing. The arrangement 16, for adjusting the angle of the laying arm, is secured in front of the second supporting columns 2c at the front end of each pontoon, and the arrangement for securing the laying arm is adapted in order to adjust an angle of laying arm 15 in a vertical plane, between a vertical or near vertical angle and a horizontal or near horizontal angle with the arrangement 16.

The laying arm 15 may be provided with the equipment to straighten out the tubing before it is being laid, equipment for securing other tubing with small diameters (which are from other smaller reels secured to the vessel at deck) along with the main pipe, equipment for cutting and securing the wire from the winches, in case it is required to exit the pipe line without the whole pipe being uncoiled from the reel, and for retrieval of the tubing from the seabed, hook up and continue the operation at a later time, and equipment for keeping up the tension of the tubing if it is cut. Some of this equipment may also be placed on the laying vessel itself.

The laying vessel is further equipped with dynamic positioning, which makes it possible to program the route for laying the tubing on your computer, and to request that the pipe laying vessel follows that route with the speed and tension being required for the tubing. Bridge and residential quarters 22 are also shown.

FIG. 2 is a front view of a vessel as shown in the remaining figures, in which the second supporting column 2c at the front end of each pontoon is shown with a minimum mutual distance of C_w , which has to be larger than the width of the barge. The front transverse strut 3b is shown positioned in level with the bottom of the pontoons. Further, a second supporting column 2c is shown at the front end of each of the pontoons. The supporting columns keep the deck at a distance from the pontoons. The arrangement 16, for attaching the laying arm 15, is shown secured to a transverse beam, extending under the transverse deck portion. The arrangement 16, for attaching and adjusting the laying arm 15, is secured to a transverse beam extending below the transverse deck portion. Bridge and living quarters 22 are supported on the transverse deck.

FIG. 3 is a side view of a vessel 20 according to the invention and, as shown in FIG. 7, where the barge is positioned in the loading zone, and corresponds to Fig. 4 (one end of the barge is missing, cf. Fig. 7). The vessel is shown in a partially submerged position, and a reel 6 is shown secured to the barge 5. A reel shaft 8 with a clamping arrangement is shown positioned at a distance above the deck of the vessel. The vessel further comprises the first supporting column 2b at a central portion of each of the pontoons, the second supporting column 2c at a front end of each of the pontoons and the third supporting column 2a at the aft end of each of the pontoons. The supporting columns will extend between each of the pontoons 1 and the respective deck portion.

The supporting columns, extending in parallel between the pontoon 1 and the sidewall portion has a height so as to form the smallest distance L_h between each reel shaft support unit 7 and the two transverse struts 3a, 3b extending between the pontoons 1.

Three thrusters 17 for propulsion and positioning are shown secured at the bottom of each of the pontoons. These are connected to a dynamic positioning system. Further, the securing elements 13 are shown, for securing the reels 6 on the barge 5 at sea. Securing elements 13 for the reel at sea will keep the reels 6 at place in the barge 5, for example when the barge is at the open sea. Securing elements 13 for the reel at sea must be releasable or otherwise must allow for a reel being transferred to the reel shipping vessel, normally with spooled coiled tubing having a large diameter, and to permit the transfer of an empty reel with coiled tubing from the vessel and to the barge.

FIG. 4 is similar to Fig. 3 but shows the vessel in a raised position and the reel 6 being released from the barge and secured to the vessel. The vessel is therefore in a raised position. The laying arm 15 is shown in a raised or near horizontal position.

FIG. 5 is a top view of a vessel as stated in the remaining figures, in which a reel, with a reel width D_w and reel diameter D_d , is secured to the vessel. The loading zone of the vessel has a loading zone width L_w and a loading zone length L_l . The loading zone width L_w is larger than the reel width D_w and the barge width B_w . The loading zone length L_l is larger than the reel diameter D_d . The reel is secured to a reel shaft support unit 7 at each of the two parallel deck portions 4a, 4b. Figure 5 shows a pinion 11 along the periphery of the reel which is in engagement with the machinery 10 for operating the reel. In this context, the peripheral may also comprise solutions where an edge is arranged slightly off the pinion to protect the pinion. The pinion may have external teeth. The pinion may have internal teeth. Without pinion being located along or near the periphery of the reel, it has proven difficult to provide sufficient torque for the reel to be able to rotate and control the reel when the reel has significant dimensions, and when the tubing being coiled on the reel has those dimensions that the invention is intended for (tubing diameter $> 16''$). In this context, the peripherals may mean the interval where the pinion diameter is 80 - 100% of the reel diameter. In this context, the peripherals may mean the interval in which the pinion diameter is 90 - 100% of the reel diameter. In this context, the peripherals may mean the interval in which the pinion diameter is 95 - 100% of the reel diameter. The machinery 10 comprises at least a motor and a gear being engageable with the pinion / drive 11 of the reel. Machinery and pinion can be at one side of the reel. The

machinery and the pinion can be at both sides of the reel. During control of the reel movement, the stiffness of the tubing having a large diameter, which is coiled on the reel, will impose considerable forces on the reel, and it will therefore not be attractive with a reel being driven by machinery near, or in connection with, the reel hub.

The transverse deck portion 4c, which extends between two substantially parallel deck portions 4a, 4b and forms the "bottom" of the U - shaped deck 4a, 4b, 4c comprising a bridge, living quarters 22, etc., and is installed at the front end of this deck portion 4c. The laying arm 15 is shown with a coiled tubing 17, and is shown positioned centrally under the transverse deck portion 4c. The two generally parallel pontoons will also have a minimum distance L_w apart from each other.

Figure 6 shows a barge 5 from above. The barge 5 comprises fender protection 12 for protection against a loading zone of a vessel according to the invention. The fender protection 12 will prevent damages during impacts between the laying vessel and the barge when bringing the barge in and out, as well as when doing transfer of cargo. The barge 5 is shown with two reels 6 having a coiled tubing of large diameters and a barge width B_w . In this context, a large diameter is meant to describe the coiled tubing having a diameter of 16". The barge will typically comprise the usual equipment for propulsion and ballasting, so that the barge may be raised, lowered and adjusted according to the load. The barge 5 is adapted for securing two reels 6, as there are two pairs of releasable securing elements for reel at sea (not shown), for the attachment of each reel on the barge 5. Securing elements for reel at sea will be released when the load from the reel is being transferred to the pipe laying vessel. The reels must stand erect with the reel hub in a horizontal direction, and in a manner so that longitudinal axis of the reel is located transversal to the longitudinal axis of the barge.

The releasable securing elements for reel at sea may comprise mechanical actuators for releasing or securing the reels onto the barge 5.

During transfer of a reel from the barge to the laying vessel, the barge may be ballasted at the same time as the laying vessel is being deballasted, until the entire weight of the reel has been transferred. The barge 5 has two identical structures or

securing elements for reel at sea, at each end of the barge. One structure is used to secure the empty reel 6 being removed from the pipe laying vessel, when the tubing has been uncoiled and installed on the seabed, while the second structure is used to secure for a reel 6 filled with tubing. Both securing elements for reel at sea are designed with the same strength, so that both may be used to transport reels 6 with and without tubing. The barge will also be equipped with a skidding arrangement 14, which means that when it arrives a port, the empty reel 6 may be skidded onshore, while a reel filled with 6 tubing may be skidded on board. Alternatively, the tubing may be coiled directly on board the barge when it is docked. While the barge 5 is on its way from the laying vessel, then the laying vessel may install the tubing.

Figure 7 is a top view showing the barge 5 in Figure 6 placed in a loading zone on a semi - submersible pipe laying vessel for uptake of large reels 6. The vessel comprises a deck structure with the two substantially parallel deck portions 4a, 4b spaced apart from each another, and the transverse deck portion 4c extending between the two substantially parallel deck portions 4a, 4b. The deck portions form the U - shaped deck 4a, 4b, 4c with an open portion. The open portion is a part of defining a loading zone. The reel shaft supporting units 7 are positioned at each of the two substantially parallel deck portions 4a, 4b. The laying arm 15, for payout of the coiled tubing on the reel 6, is placed below the transverse deck portion 4c.

A method of loading and unloading of a cable on a submersible vessel with a barge, as described above, may comprise bringing the vessel to a lower position with the ballasting equipment, guide the barge 5 with the at least one reel 6 with coiled tubing into the loading zone of the vessel, align the reel shaft support unit 7 with the reel shaft 8, raise the vessel with the ballasting equipment (not shown) until the reel shaft support unit 7 comes in contact with the deck 4a, 4b, release the releasable securing elements for reel at sea on the barge 5 in order to release the reel 6 from the barge 5, further raise the vessel in order to lift the reel 6 off the barge 5, guide the barge 5 out from the loading zone of the vessel; and lay the coiled tubing on the seabed with the laying arm 15 for payout of the coiled tubing.

The method may further comprise replacement of a first reel 6 on the vessel with a second reel 6 on the barge 5, by moving the barge 5 into the loading zone, as the

barge has a first reel 6 mounted on the first portion for uptake of the first reel, and the second portion for uptake of a reel will be available for uptake of a reel, and since the second portion for uptake of a reel, which is free, is guided under a reel 6 secured to the vessel, the vessel being in a raised position, lowering of the vessel onto the reel onto the vessel may be secured onto the barge 5, securing the reel on the barge with releasable securing elements for reel at sea, and releasing the reel from a reel shaft support unit 7 at each of the two substantially parallel deck portions 4a, 4b of the vessel, lowering the vessel to the barge 5 with two reels 6 while running clear of the vessel, and guide the barge out from the loading zone, turning the barge around and guide the second portion for uptake of a second reel 6 into the loading zone, as a second reel is being secured onto the second portion, and repeat the operation of transferring the reel from the barge to the vessel.

PATENT CLAIMS

1. Semi - submersible vessel for laying coiled tubing uncoiled from a reel (6) on the vessel down to a seabed, the vessel comprising:

equipment for ballasting and at least one propulsion unit;

a pool forming a U - shaped loading zone (17) with an opening (18) in at least one of the vessel's ends, said U - shaped loading zone (17) being adapted for insertion of a vessel with at least one reel (6) for uptake of coiled tubing, as the loading zone (17) has a loading zone width L_w , a loading zone height L_h and a loading zone length L_l ; said reel having a reel width D_w and a reel diameter D_d ; as the loading zone width L_w is larger than the reel width D_w and the loading zone length L_l is larger than half the reel diameter D_d ,

a first deck portion (4a) along a first side of the loading zone (17) and a second deck portion (4b) along a second side of the loading zone (17), as the first deck portion (4a) is substantially parallel to the second deck portion (4b) ;

a reel shaft support unit (7) on each of the first and second substantially parallel deck portion (4a, 4b);

a first pontoon (1) and a second pontoon (1) substantially parallel with the first pontoon at a minimum distance L_w therebetween;

at least a first transverse strut (3b) extending between the first and the second pontoon (1);

wherein the first and second substantially parallel deck portion (4a, 4b) extend at a distance above and substantially parallel to respectively the first and the second pontoon (1);

a transverse deck portion (4c) extending between the first and second substantially parallel deck portion (4a, 4b);

at least a first and a second supporting column (2a, 2c) extending between each of the first and the second pontoon (1) and the respective first and second parallel

extended deck portion (4a, 4b), as each of the first supporting column (2a) and of the second supporting column (2c) has a height so as to form the smallest distance L_h between each reel shaft support unit (7);

one laying arm (15) for payout of the coiled tubing; and

machinery (10) for operation of the reel, comprising at least a motor and a gear for engagement with a pinion mainly along the reel periphery.

2. Vessel according to claim 1, further comprising a second transverse strut (3) extending between the first and the second pontoon (1), said first transverse strut is located at a front end of the first and the second pontoon (1) and the other transverse strut (3) is located at an aft end of said first and second pontoon (1).

3. Vessel according to claim 1, further comprising a third supporting column (2b) between the first supporting column (2a) and the second supporting column (2c) between each pontoon and the respective deck portion.

4. Vessel according to claim 1, further comprising an arrangement (16) for securing the laying arm (15), secured onto a transverse beam extending below the transverse deck portion (4c).

5. Vessel according to claim 4, wherein the arrangement (16) for attachment of the laying arm (15) is secured prior to the second supporting columns (2c) at the front end of each pontoon (1); and
wherein the arrangement (16) for securing the laying arm (15) is adapted to be able to adjust an angle for the laying arm (15) in a vertical plane between a vertical or near - vertical angle and a horizontal or near horizontal angle.

6. Vessel according to any of the preceding claims 2 – 5, wherein the laying arm (15) further comprises means for straightening the coiled tubing before it is being laid.

7. Vessel according to any of the preceding claims 2 – 6, wherein the first and second transverse strut (3a, 3b), extending between the pontoons (1), are secured at a lower end of the pontoons (1).

8. Vessel according to any of the preceding claims, further comprising dynamic positioning equipment for automatic control of the vessel.
9. System for offshore pipe laying, comprising a vessel according to any of the preceding claims, and a barge (5) having a barge height B_h and a barge width B_w being smaller than a smallest loading zone width L_w of the vessel, as the barge is adapted to be inserted into loading zone (17) of the vessel; and comprises releasable securing elements (13) for reel at sea, for securing at least one reel onto the barge (5).
10. System according to claim 9, further comprising fender protection (12) placed between the barge (5) and the vessel when the barge is guided into the loading zone (17) of the vessel.
11. System according to claim 10, wherein the fender protection (12) is secured to the barge (5).
12. System according to claim 9, wherein the barge (5) is adapted for attachment of two reels (6), as there are two releasable securing elements (13) for reel at sea, for securing each reel onto the barge (5).
13. System according to claim 12, wherein the releasable securing elements (13) for the reel at sea comprise mechanical actuators for releasing or securing the reels onto the barge (5).
14. A method for loading and unloading of a cable between a vessel for laying of coiled tubing uncoiled from a reel on the vessel to a seabed and a barge having at least one reel with coiled tubing and a reel shaft with a substantially horizontal longitudinal axis substantially perpendicular to a longitudinal axis of the barge, as the vessel comprises equipment for ballasting and a pool which forms a U - shaped loading zone (17) with an opening (18) in at least one of the vessel's ends, adapted for the introduction of the barge with the at least one reel (6), as the loading zone (17) has a loading zone width L_w , a loading zone height L_h and a loading zone

length L_I , for uptake of the reel (6), and as the reel has a reel width D_w and a reel diameter D_d , and as the loading zone width L_w is larger than the reel width D_w and loading zone length L_I is larger than half of the reel diameter D_d , as the pipe laying vessel further comprises a first deck portion (4a) along a first side of the loading zone (17) and a second deck portion (4b) along a second side of the loading zone (17), as the first deck portion (4a) is substantially parallel to the second deck portion (4b), a reel shaft support unit (7) on each of the two substantially parallel deck portions (4a, 4b) comprising:

- to guide the vessel to a lower position with the ballasting equipment;
- to guide the barge (5) with the at least one reel (6) with coiled tubing into the loading zone (17) of the vessel;
- to align the reel shaft support unit (7) with the reel shaft (8);
- raise the vessel with the ballasting equipment to the reel shaft support unit (7) from the reel shaft (8);
- release the securing elements (13) for reel at sea on the barge (5) to release the reel (6) from the barge (5);
- to further raise the vessel to lift the reel (6) off from the barge (5);
- to guide the barge (5) out from the loading zone of the vessel; and
- to lay the coiled tubing onto the seabed.

15. A method according to claim 14, wherein the method further comprises replacing a first reel (6) on the vessel with a second reel (6) on the barge (5), as the barge comprises a first portion for uptake of a first reel (6) placed with a reel shaft (8) having a substantially horizontal longitudinal axis substantially perpendicular to a longitudinal axis of the barge (5), and a second portion for uptake of a second reel (6) placed with a reel shaft (8) with a substantially horizontal longitudinal axis substantially perpendicular to a longitudinal axis of the barge (5), as the method further comprises the steps of:

- to guide the barge (5) into the loading zone, as the barge has a first reel (6) secured at the first portion for uptake of the first reel, and the second portion for

uptake of a reel is available for uptake of a reel, and as the second portion for uptake of a reel, which is free, is guided under a reel (6) secured to the vessel, while the vessel is in a raised position;

to lower the vessel until the reel on the vessel may be secured on the barge (5);

to secure the reel in the barge with releasable securing elements (13) for reel at sea, and release the reel from a reel shaft support unit (7) at each of the two substantially parallel deck portions (4a, 4b) of the vessel;

to lower the vessel until the barge (5) with two reels (6) is going clear off the vessel and guide the barge out from the loading zone;

to turn the barge around and guide the second portion for uptake of a second reel (6) into the loading zone, as a second reel is secured onto the second portion;
and

to repeat the operation of transferring the reel from the barge to the vessel.

16. Use of a vessel according to any of the claims 1 - 8 for laying a coiled tubing with a diameter of 16" (41cm).

AMENDED CLAIMS

received by the International Bureau on 19 November 2014 (19.11.2014)

PATENT CLAIMS

1. Semi - submersible vessel for laying coiled tubing (18) uncoiled from a reel (6) on the vessel down to a seabed, the vessel comprising:

equipment for ballasting and at least one propulsion unit;

a pool forming a U - shaped loading zone (19) with an opening in at least one of the vessel's ends, said U - shaped loading zone (19) being adapted for insertion of a vessel with at least one reel (6) for uptake of coiled tubing (18), as the loading zone (19) has a loading zone width L_w , a loading zone height L_h and a loading zone length L_l ; said reel having a reel width D_w and a reel diameter D_d ; as the loading zone width L_w is larger than the reel width D_w and the loading zone length L_l is larger than half the reel diameter D_d ,

a first deck portion (4a) along a first side of the loading zone (19) and a second deck portion (4b) along a second side of the loading zone (19), as the first deck portion (4a) is substantially parallel to the second deck portion (4b);

a reel shaft support unit (7) on each of the first and second substantially parallel deck portion (4a, 4b);

a first pontoon (1) and a second pontoon (1) substantially parallel with the first pontoon at a minimum distance L_w therebetween;

at least a first transverse strut (3b) extending between the first and the second pontoon (1);

wherein the first and second substantially parallel deck portion (4a, 4b) extend at a distance above and substantially parallel to respectively the first and the second pontoon (1);

a transverse deck portion (4c) extending between the first and second substantially parallel deck portion (4a, 4b);

at least a first and a second supporting column (2a, 2c) extending between each of the first and the second pontoon (1) and the respective first and second parallel

- extended deck portion (4a, 4b), as each of the first supporting column (2a) and of the second supporting column (2c) has a height so as to form the smallest distance L_h between each reel shaft support unit (7);
- one laying arm (15) for payout of the coiled tubing (18); and
- machinery (10) for operation of the reel, comprising at least a motor and a gear for engagement with a pinion mainly along the reel periphery.
2. Vessel according to claim 1, further comprising a second transverse strut (3) extending between the first and the second pontoon (1), said first transverse strut is located at a front end of the first and the second pontoon (1) and the other transverse strut (3) is located at an aft end of said first and second pontoon (1).
3. Vessel according to claim 1, further comprising a third supporting column (2b) between the first supporting column (2a) and the second supporting column (2c) between each pontoon and the respective deck portion.
4. Vessel according to claim 1, further comprising an arrangement (16) for securing the laying arm (15), secured onto a transverse beam extending below the transverse deck portion (4c).
5. Vessel according to claim 4, wherein the arrangement (16) for attachment of the laying arm (15) is secured prior to the second supporting columns (2c) at the front end of each pontoon (1); and
wherein the arrangement (16) for securing the laying arm (15) is adapted to be able to adjust an angle for the laying arm (15) in a vertical plane between a vertical or near - vertical angle and a horizontal or near horizontal angle.
6. Vessel according to any of the preceding claims 2 – 5, wherein the laying arm (15) further comprises means for straightening the coiled tubing (18) before it is being laid.
7. Vessel according to any of the preceding claims 2 – 6, wherein the first and second transverse strut (3a, 3b), extending between the pontoons (1), are secured at a lower end of the pontoons (1).

8. Vessel according to any of the preceding claims, further comprising dynamic positioning equipment for automatic control of the vessel.
9. System for offshore pipe laying, comprising a vessel according to any of the preceding claims, and a barge (5) having a barge height and a barge width B_w being smaller than a smallest loading zone width L_w of the vessel, as the barge is adapted to be inserted into loading zone (19) of the vessel; and comprises releasable securing elements (13) for reel at sea, for securing at least one reel onto the barge (5).
10. System according to claim 9, further comprising fender protection (12) placed between the barge (5) and the vessel when the barge is guided into the loading zone (19) of the vessel.
11. System according to claim 10, wherein the fender protection (12) is secured to the barge (5).
12. System according to claim 9, wherein the barge (5) is adapted for attachment of two reels (6), as there are two releasable securing elements (13) for reel at sea, for securing each reel onto the barge (5).
13. System according to claim 12, wherein the releasable securing elements (13) for the reel at sea comprise mechanical actuators for releasing or securing the reels onto the barge (5).
14. A method for loading and unloading of a cable between a vessel for laying of coiled tubing (18) uncoiled from a reel on the vessel to a seabed and a barge having at least one reel with coiled tubing (18) and a reel shaft with a substantially horizontal longitudinal axis substantially perpendicular to a longitudinal axis of the barge, as the vessel comprises equipment for ballasting and a pool which forms a U - shaped loading zone (19) with an opening in at least one of the vessel's ends, adapted for the introduction of the barge with the at least one reel (6), as the loading zone (19) has a loading zone width L_w , a loading zone height L_h and a loading zone length L_l ,

for uptake of the reel (6), and as the reel has a reel width D_w and a reel diameter D_d , and as the loading zone width L_w is larger than the reel width D_w and loading zone length L_l is larger than half of the reel diameter D_d , as the pipe laying vessel further comprises a first deck portion (4a) along a first side of the loading zone (19) and a second deck portion (4b) along a second side of the loading zone (19), as the first deck portion (4a) is substantially parallel to the second deck portion (4b), a reel shaft support unit (7) on each of the two substantially parallel deck portions (4a, 4b) comprising:

- to guide the vessel to a lower position with the ballasting equipment;
- to guide the barge (5) with the at least one reel (6) with coiled tubing (18) into the loading zone (19) of the vessel;
- to align the reel shaft support unit (7) with the reel shaft (8);
- raise the vessel with the ballasting equipment to the reel shaft support unit (7) from the reel shaft (8);
- release the securing elements (13) for reel at sea on the barge (5) to release the reel (6) from the barge (5);
- to further raise the vessel to lift the reel (6) off from the barge (5);
- to guide the barge (5) out from the loading zone of the vessel; and
- to lay the coiled tubing (18) onto the seabed.

15. A method according to claim 14, wherein the method further comprises replacing a first reel (6) on the vessel with a second reel (6) on the barge (5), as the barge comprises a first portion for uptake of a first reel (6) placed with a reel shaft (8) having a substantially horizontal longitudinal axis substantially perpendicular to a longitudinal axis of the barge (5), and a second portion for uptake of a second reel (6) placed with a reel shaft (8) with a substantially horizontal longitudinal axis substantially perpendicular to a longitudinal axis of the barge (5), as the method further comprises the steps of:

- to guide the barge (5) into the loading zone, as the barge has a first reel (6) secured at the first portion for uptake of the first reel, and the second portion for

uptake of a reel is available for uptake of a reel, and as the second portion for uptake of a reel, which is free, is guided under a reel (6) secured to the vessel, while the vessel is in a raised position;

to lower the vessel until the reel on the vessel may be secured on the barge (5);

to secure the reel in the barge with releasable securing elements (13) for reel at sea, and release the reel from a reel shaft support unit (7) at each of the two substantially parallel deck portions (4a, 4b) of the vessel;

to lower the vessel until the barge (5) with two reels (6) is going clear off the vessel and guide the barge out from the loading zone;

to turn the barge around and guide the second portion for uptake of a second reel (6) into the loading zone, as a second reel is secured onto the second portion; and

to repeat the operation of transferring the reel from the barge to the vessel.

16. Use of a vessel according to any of the claims 1 - 8 for laying a coiled tubing (18) with a diameter of 16" (41 cm).

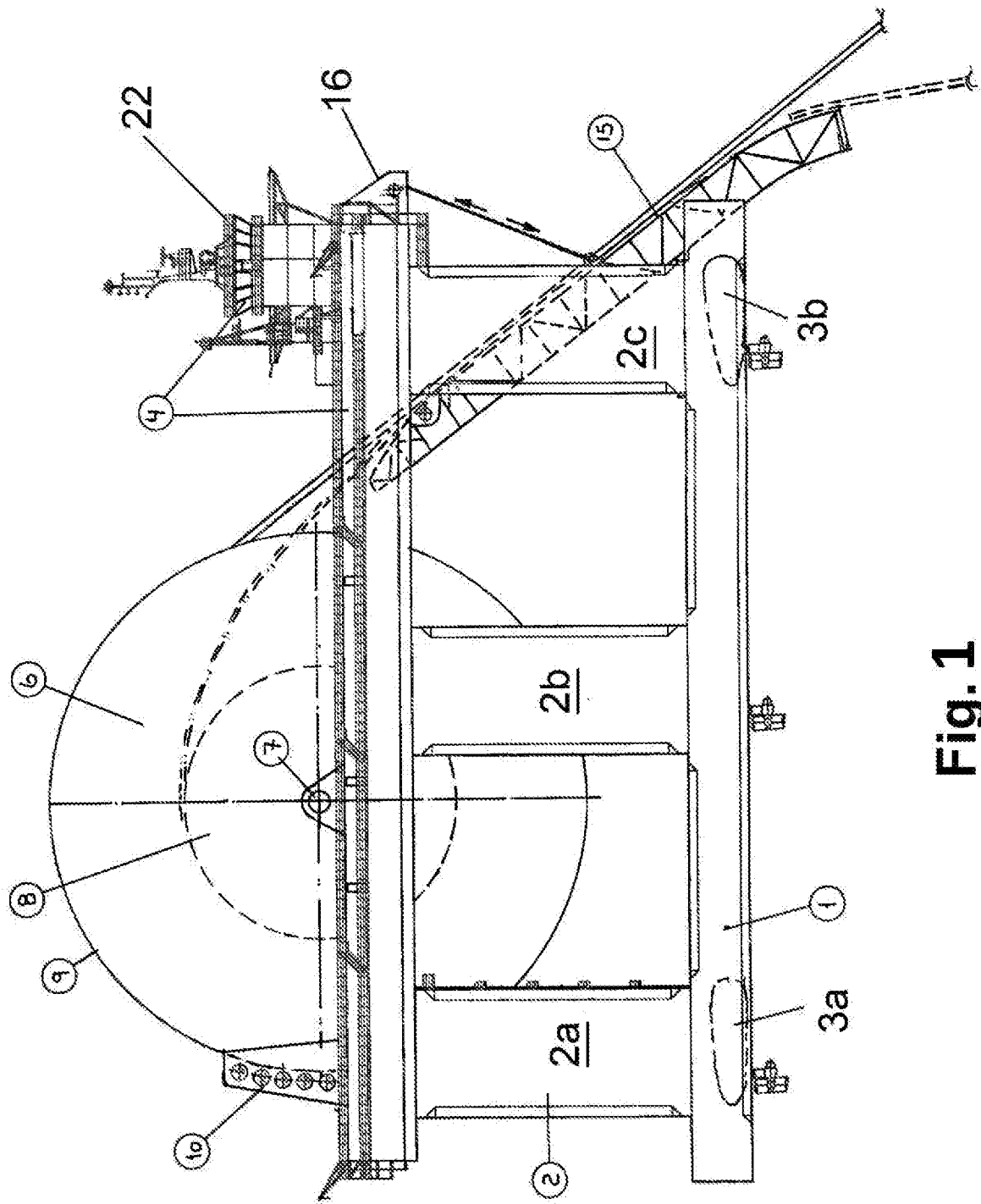
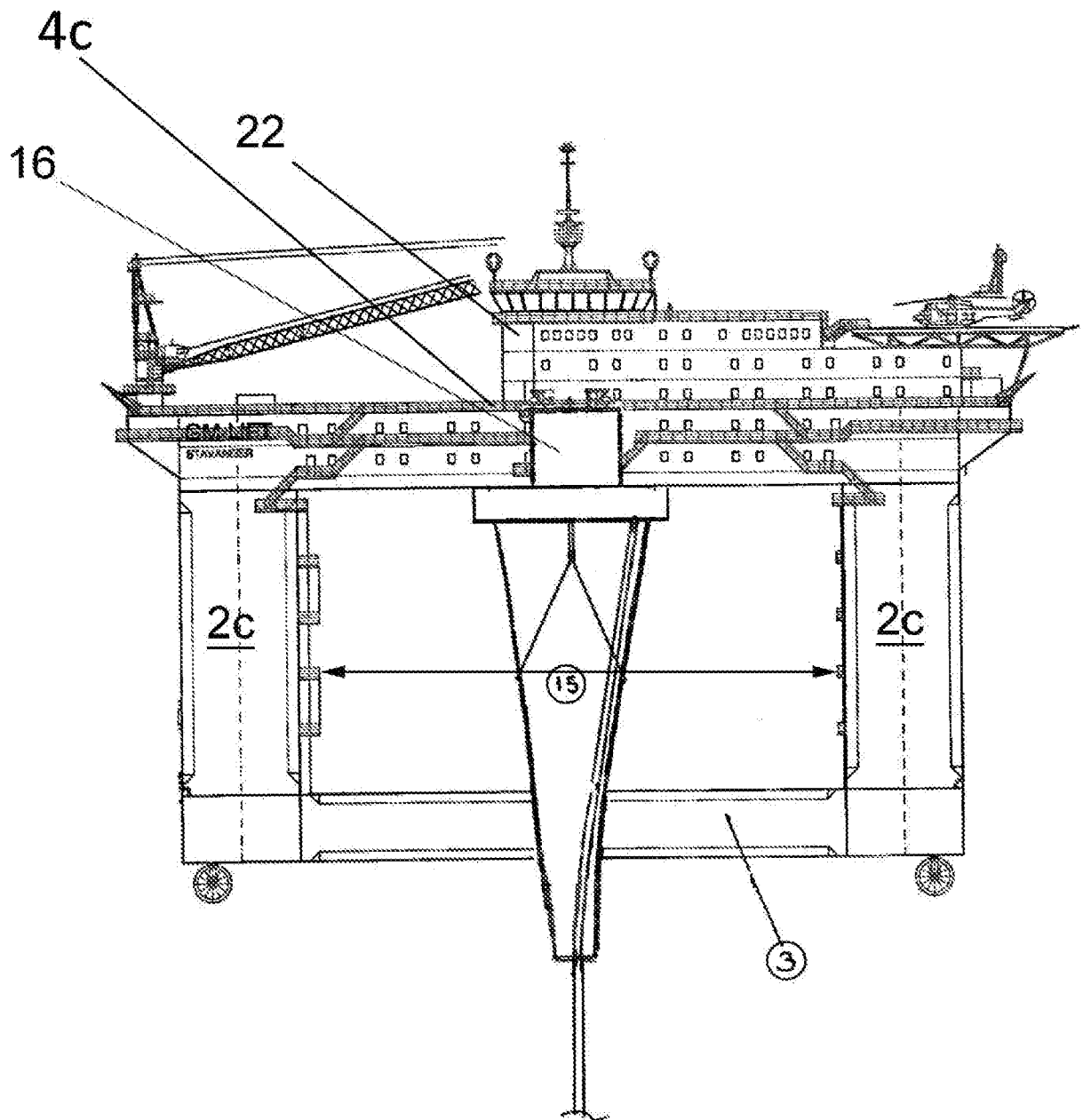


Fig. 1

**Fig. 2**

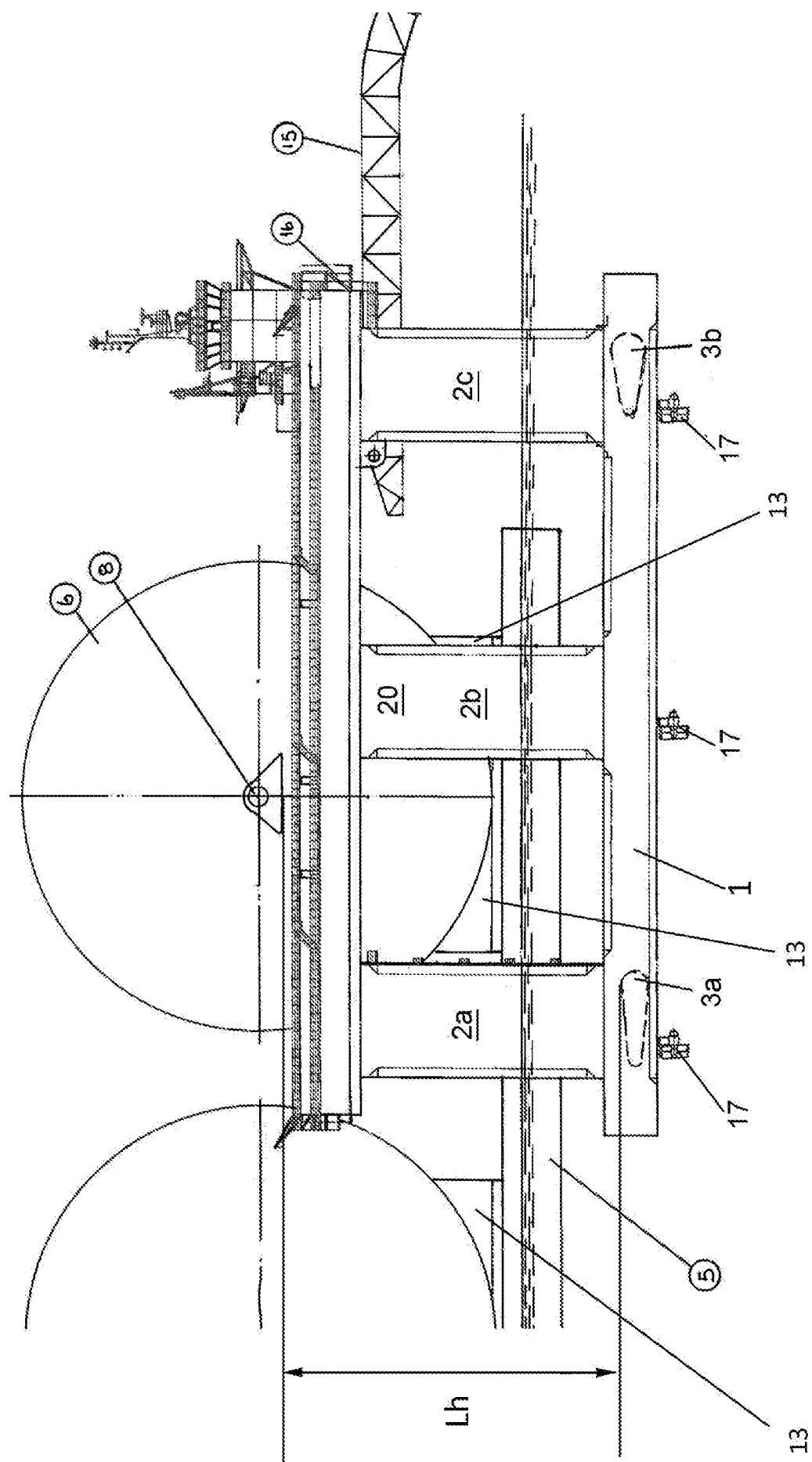


Fig. 3

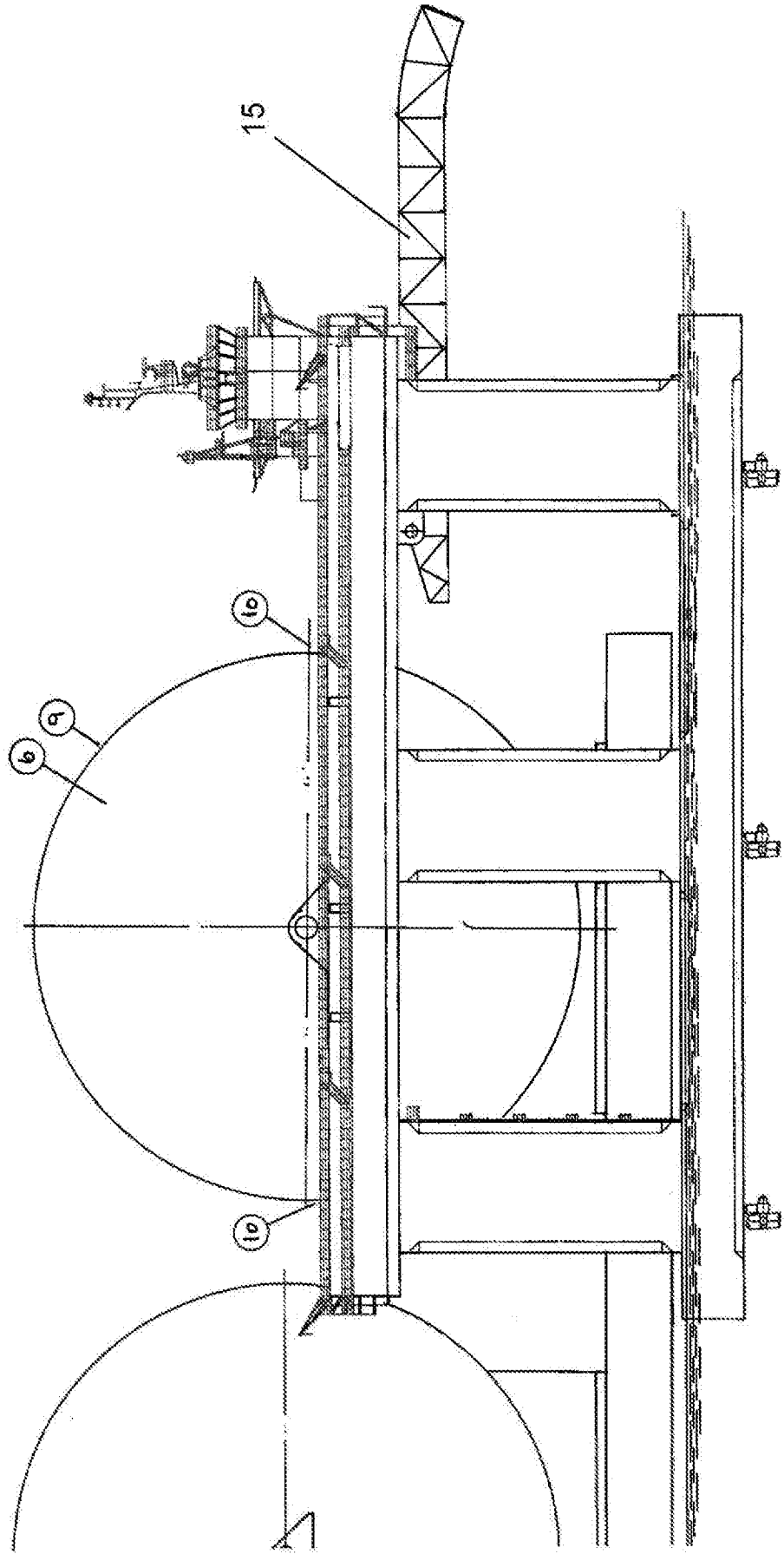


Fig. 4

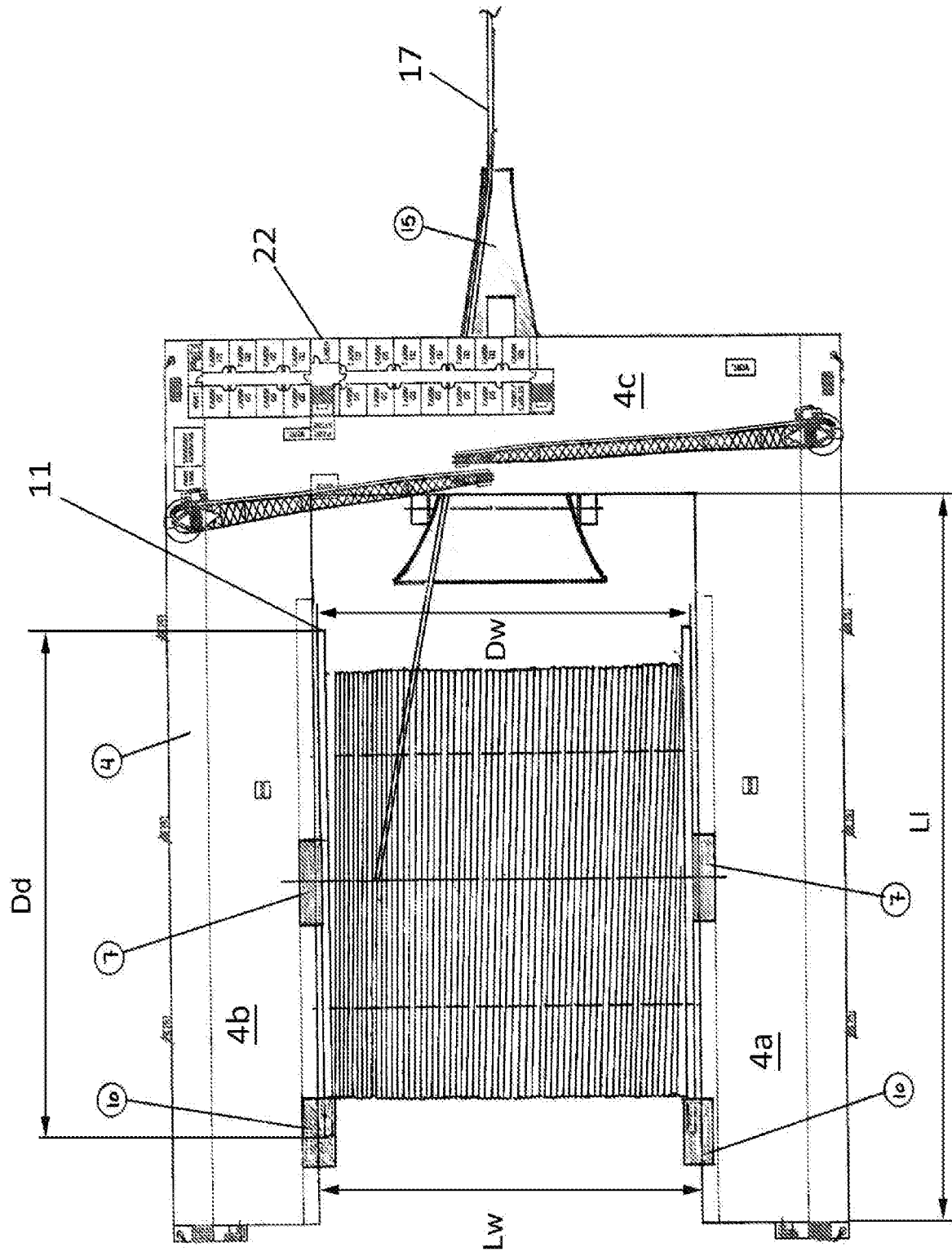


Fig. 5

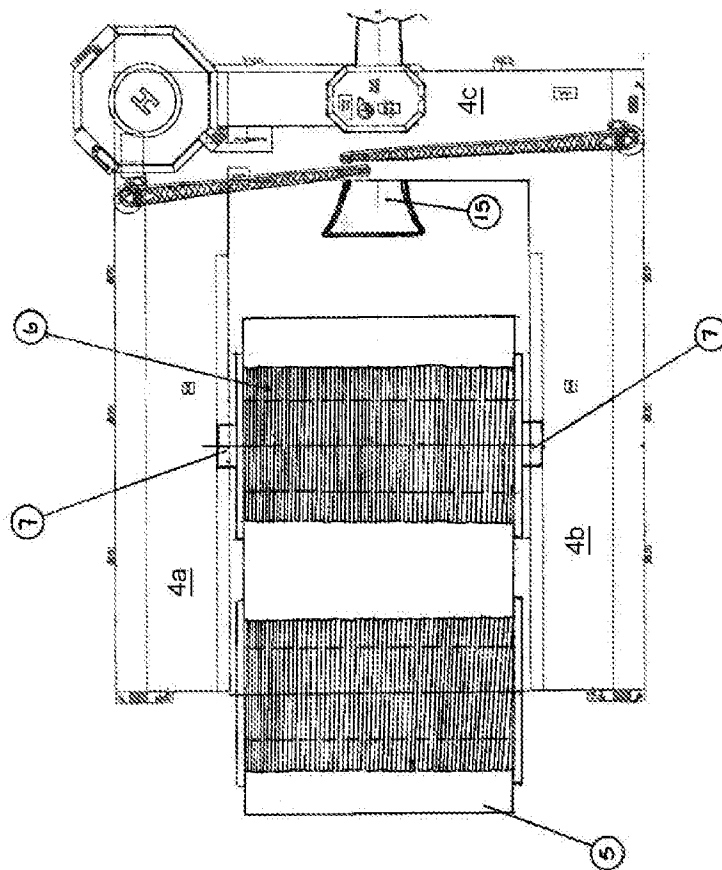
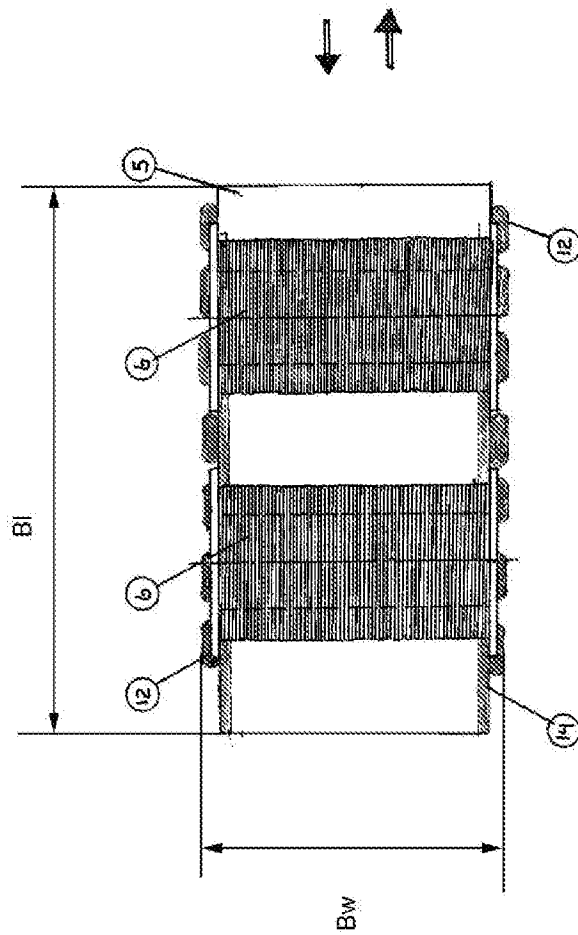


Fig. 7



Fi. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO2014/050111

A. CLASSIFICATION OF SUBJECT MATTER

IPC: B63B 35/03 (2006.01), B63B 35/00 (2006.01), B63B 35/04 (2006.01), F16L 1/12 (2006.01), F16L 1/20 (2006.01)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B63B, F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

DK, NO, SE, FI: Classes as above.

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI, FULL-TEXT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2001/74657 A1 (MCDERMOTT, SA J R.) 2001.10.11 abstract; claim 1; figures 1-6, 16-17	1-16
A	EP 0302038 A1 (KVAERNER SUBSEA CONTRACTING) 1989.02.01 abstract; sections [0005]-[0010], and [0029]; claim 1; figures 1-16	1-16
A	CN 102039988 A (SHANGHAI RICHTECH INC) 2011.05.04 abstract; figures 1-6c	1-16
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A	US 2010/107956 A1 (FOCE, S.) 2010.05.06 abstract; sections [0021],[0022], and [0070]; figures 1-9	1-16
A	GB 2439295 A (ACERGY UK LTD) 2007.12.27 abstract; figures 1-4	1-16
P,A	WO 2013/133716 A1 (HEEREMA MARINE CONTRACTORS NL) 2013.09.12 whole document	1-16

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

19/09/2014

Date of mailing of the international search report

22/09/2014

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/NO2014/050064

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