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(54) A SYSTEM AND METHOD FOR MOORING OF AND SUPPLY OF FLUID OR SUPPLY OF FLUID AND ELECTRICAL POWER TO A VESSEL

(57) The present invention relates to a system and method for mooring of and supply of fluid or mooring of and supply of fluid and supply electrical power to a vessel, the system comprising a mooring buoy, a mooring connection being a combined mooring and power source connection by comprising a mooring line and a fluid pipe or the mooring line, the fluid pipe and an electric conductive cable for supply of said electrical power and a retractable vessel connector provided at an end of the mooring connection, wherein the vessel connector is a combined mooring connector and a fluid connector or a combined mooring connector, fluid connector and electrical connector. The system further comprising or involves a gripping device arranged on a vessel wherein the gripping device is configured to grip and lock said vessel connector to moor said vessel to said mooring buoy.

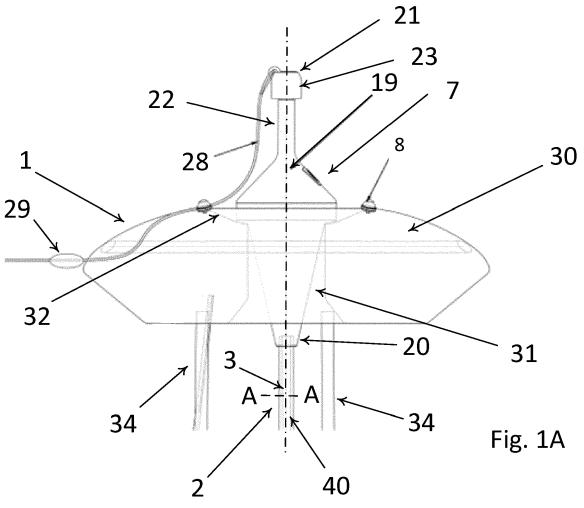

Fig. 1A

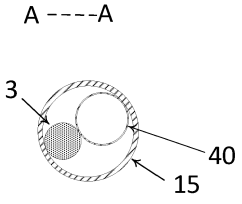

Fig. 1B

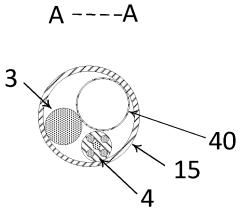

Fig. 1C

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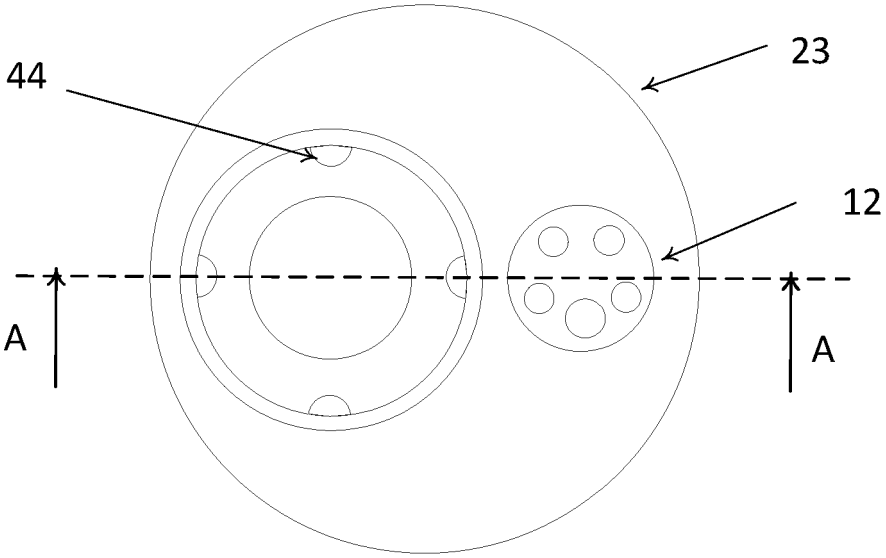

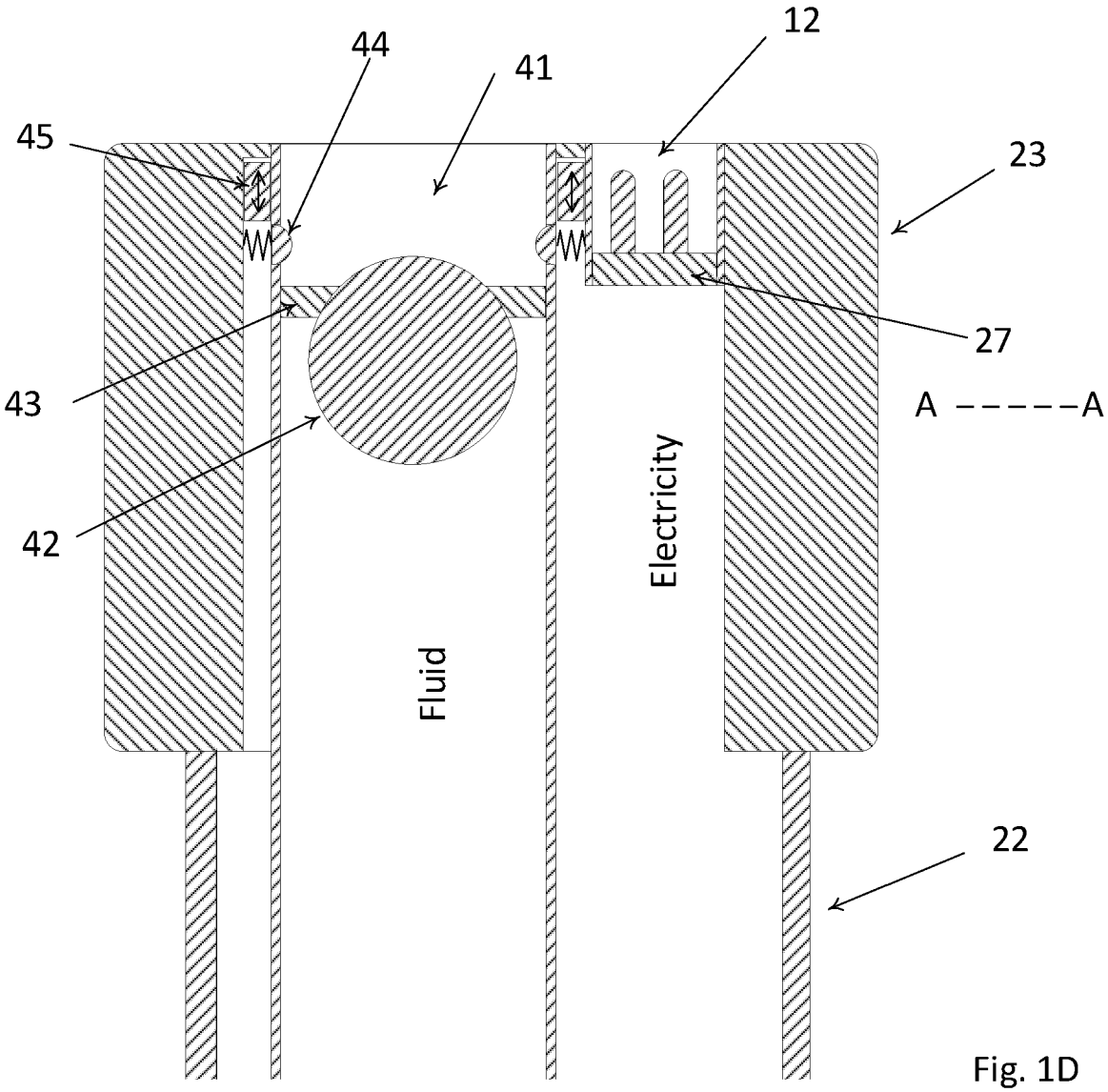

Fig. 1D

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a system and method for mooring of and supply of fluid or for mooring of, supply of fluid and supply of electrical power to a vessel, the system comprising a mooring buoy, a mooring connection being a combined mooring and power source connection by comprising a mooring line and a fluid pipe or the mooring line, the fluid pipe and an electric conductive cable for supply of said electrical power and a retractable vessel connector provided at an end of the mooring connection, wherein the vessel connector is a combined mooring connector and a fluid connector or a combined mooring connector, fluid connector and electrical connector. The system further comprising or involves a gripping device arranged on a vessel wherein the gripping device is configured to grip and lock said vessel connector to moor said vessel to said mooring buoy.

BACKGROUND OF THE INVENTION

[0002] Offshore wind turbine installations can be used to power offshore plants producing various fluidic fuel(s) such as hydrogen and oxygen by an electrolytic process during which seawater (preferably desalinated seawater) is split into hydrogen and oxygen. Such fluids are valuable in the sense that the fluid may be used in a fuel cell to produce electricity. Electrical power generated by an offshore wind power plant can especially be used for fluid production and storage on site in periods where there is wind but low or no direct electrical power consumption.

[0003] Such fluid(s) produced at an off-shore position can be used to drive the propulsion system of a vessel, by use of a fuel cell, of a vessel or may be used to produce electricity to power onboard electrical equipment. In combination with this or as an alternative, the fluid may be stored in tanks onboard the vessel and transported to e.g. an onshore docking facility receiving the fluid. In both these scenarios, the vessel needs to be in fluidic connection with a fluid source providing the fluid, such as the offshore plant, typically for longer times.

[0004] It is well known that the sea may be calm or rough and anchoring of a vessel at an offshore position may be a delicate operation which becomes increasingly more dangerous when the sea becomes rough. When a transfer of a fluid, which may be burnable or even explosive at atmospheric conditions, is to be carried out anchoring operations becomes even more dangerous.

[0005] In some instances, there may also be a need to transfer electrical power together with the fluid to the vessel, and this complicates the anchoring operation even more.

[0006] During transfer of fluid to a vessel, the vessel may be in a waiting position. During such periods of time, the vessel may still be in need for powering various electrically powered equipment, such as climate control, communications, entertainment, lighting, refrigeration, water desalination and treatment etc. Such power load is typically referred to as hotel electrical power.

[0007] Vessels typically have two sets of engines, one for propulsion of the vessel and another, often referred to as an auxiliary engine(s), for driving and electrical generator providing electrical power to cover the hotel electrical power, where the motor used for propulsion is shutdown while the engine driving the electrical generator is running during waiting periods. During such waiting periods the vessel typically is anchored up, which anchoring may be assisted by a positioning system using electrically driven thrusters to maintain the vessel in a desired position, e.g. with the bow facing wind and/or waves.

[0008] While use of the auxiliary engine(s) does provide a workable solution, some of the drawbacks of the solution are excessive emission of exhaust gasses and storage of fuel which takes up storage capacity of the vessel.

[0009] Since the auxiliary engines drive an electrical generator it may be tempting to seek a solution in which the electrical power is supplied from a different electrical source than the auxiliary engines driving the generator, which different electrical source is external to the vessel.

[0010] Such a different source may be a wind turbine farm, an inland placed power production facility or even an off-shore power cable transporting electrical power over sea.

[0011] Moreover, charging of electrical power is also relevant for vessels which are partly (hybrid), mainly or solely driven by electric propulsion means such as electric ferries, electric cargo vessels and the like. In this case, there is a need for power supply to charge electric power storage means on the vessel such as batteries by an electrical source external to the vessel. Charging facilities for such vessels can be distributed at strategic geographic locations in order to guarantee charging possibilities along a vessel's travel route in or between harbours. From a logistic point of view, charging facilities for charging of batteries can typically be arranged in vicinity to shore or offshore based wind turbine farms to make use of the generated renewable energy. However, also other sources for electric power may be used and supplied at these charging points.

[0012] While it may be tempting to provide electrical power to the vessel from one or more of such different sources, such a connection requires a cabled connection to be onboarded the ship and connected to the electrical consuming equipment onboard the vessel.

[0013] Thus, when considering connecting the vessel to a fluid source or a fluid source in combination with an external electrical source, one is faced with the problem of mooring the vessel in manner that does not interfere with the fluid connection and/or the electrical connection and vice versa. At the same time, safety for persons handling the mooring, fluid connection and electrical connection has to be taken into consideration. In addition, com-

mon anchoring techniques may also be time and labour consuming and it may be considered advantageous to have a safe, efficient and fast anchoring.

[0014] Hence, an improved mooring of and fluid connection or improved mooring, fluid and electrical connection to a vessel would be advantageous, and in particular a more efficient and/or reliable mooring of and fluid connection or mooring, fluid connection and electrical connection to a vessel would be advantageous.

OBJECT OF THE INVENTION

[0015] In particular, it may be seen as an object of the present invention to provide a mooring of and fluid connection or mooring of and fluid and electrical connection to a vessel that solves one or more of the above-mentioned problems.

[0016] It is a further object of the present invention to provide an alternative to the prior art.

SUMMARY OF THE INVENTION

[0017] Thus, the above described object and several other objects are intended to be obtained in a first aspect of the invention by providing a system for mooring of and supply of power fluid or mooring of, supply of power fluid and supply of electrical power to a vessel, the system comprising:

- a mooring buoy being configured to float on a sea surface and to be anchored to a seabed;
- a mooring connection being a combined mooring and power source connection by comprising
    - a mooring line and a fluid pipe for supply of said fluid, or
    - said mooring line, said fluid pipe and further an electric conductive cable for supply of electrical power;
- wherein said mooring line is configured to take-up tension arising from a vessel being moored to said mooring buoy by use of the mooring connection while essentially no mooring tension is applied to fluid pipe or the electrical conductive cable, said mooring line is connected to said mooring buoy or anchored to the seabed at the seabed;
- a retractable vessel connector provided at an end of the mooring connection, said vessel connector being a combined mooring connector and fluid connector or a combined mooring connector, fluid connector and electrical connector, and
- a gripping device arranged on a vessel, said gripping device being configured to grip and lock said vessel connector to moor said vessel to said mooring buoy or to the seabed.

[0018] Mooring as used herein is preferably used to refer to a procedure to anchor the vessel to the seabed or the floating mooring buoy and keep vessel connected e.g. during delivery of fluid or fluid and electrical power. Safe mooring should preferably withstand several forces, such as wind, the current, the tide and waves. In preferred embodiments, the strength of the mooring line as well as other elements, such as fasteners for fastening the mooring line, anchors or the like, involved in mooring are typically selected to withstand such forces occurring during mooring. In preferred embodiments, the mooring line as disclosed herein is configured to take-up at least a substantial amount of tension, such as take-up the whole amount of tension, arising from the vessel being moored to a mooring buoy.

[0019] In preferred embodiments, a system for mooring and supply of fluid or supply of fluid and electrical power is typically designed to meet regulations pertaining to mooring, such as regulations according to International Maritime Organization (IMO), typically MSC.1/Circ. 1619, at the date of employment. Such embodiments typically cover mooring of vessels within a gross-tonnage from 500GT to 400,000GT.

[0020] *"Power fluid"* also referred to as *"Fluid"* herein refers to a fluid that carries energy releasable by one or more chemical reactions. Non-limiting examples are, biogas, natural gas, such as liquefied natural gas (LNG), hydrogen, ammonia, nitrogen, oxygen an alkane gas, methanol, ethanol propane, butane gasoline, intermediate fuel oil, synthetic oil, diesel oil, such as marine diesel or electro-fuels. The fluid may be liquefied (if not already a liquid under atmospheric conditions) by pressurization and/or cooling. In some preferred embodiments, the power fluid is one more derivatives of hydrogen, such as ammonia, which could be used as fuel or used in fertilizer industry.

[0021] By embodiments according to the first aspect, the mooring and provision of fluid connection and optional additional electrical connection have been made safe and easy. As mooring, fluid connection and optional electrical connection may be viewed as only requiring that the vessel connector is brought onboard the vessel and to the gripping device, risk involved in handling a mooring line, fluid line and optionally electrical conductive cable independently has been mitigated. Thus, the connection point for the fluid pipe, the optional electric cable and the mooring is in the same place and no additional mooing means for the connector are needed when the connector is locked by the gripping device.

[0022] In preferred embodiments, the vessel connector may have fluid coupling to which the fluid pipe is fluidic connected and, when the system comprising said electric conductive cable, the vessel connector may further have an electrical plug and/or electrical socket to which the electric conductive cable may be electrically connected.

[0023] In preferred embodiments, the mooring connection may further comprise a tubular jacket preferably enclosing at least a section of the mooring line, at least the fluid pipe, and, when the system comprising said con-

ductive cable, the tubular jacket may further enclose at least a section of the electric conductive cable. Such a tubular jacket may preferably extend from vessel connector.

[0024] In preferred embodiments, the mooring line, the fluid pipe and, when present, the electric conductive cable may be co-axially arranged with electric conductive cable arranged inside said mooring line. In other embodiments, the mooring line, the fluid pipe and, when present, the electrical cable may be arranged as an umbilical structure.

[0025] In preferred embodiments, the mooring line, the fluid pipe and, when present, the electric conductive cable may be arranged side-by-side preferably without being intertwined and/or meshed.

[0026] In preferred embodiments, the gripping device may comprise one or more engaging element(s) preferably configured to engage the vessel connector to grip and lock said vessel connector.

[0027] Preferably, the engaging element may be retractable from a first position where it engages said vessel connector to a second position where it does not engage said vessel connector. Such a retraction may be a reciprocating movement.

[0028] In preferred embodiments the engaging element(s) may comprise a chain stopper. Such a chain stopper may be a chain stopper used for engaging an anchor chain of a conventional anchor. In preferred embodiments, the engaging element(s) of the gripping device may be a fork, a gripper, a hook with release function such as a towing hook, a smit or a towing bracket.

[0029] In preferred embodiments, the gripping device may be arranged at a deck position of the vessel, said deck position is preferably a position on a weather deck, preferably at the bow of the vessel. However, the gripping device may be arranged at other suitable positions of the vessel.

[0030] In preferred embodiments, the system may further comprise a winch preferably configured to reel-in a rope, cord, cable, wire or the like connected to said vessel connector. Preferably, such a winch may be positioned relatively to the gripping device so that the winch upon reeling-in pulls the vessel connector to the gripping device.

[0031] In preferred embodiments, the vessel connector may further comprise a pick-up line connected to the vessel connector. Such a pick-up line may preferably be dimensioned to allow for the vessel connector to be hoisted or winched on-board said vessel. In preferred embodiments, the pick-up line may have a positive buoyancy and/or being provided with buoyancy elements to prevent fully submerge of the pick-up line, when the pick-up line is in water.

[0032] In preferred embodiments, the vessel connector may have a longitudinal axis along which the vessel connector extends, a proximal end from which the mooring connection extends towards the mooring buoy and a distal end opposite the proximal end. Preferably, the vessel connector may comprise at a distance from the proximal end an elongate section preferably comprising a protrusion arranged closer to the distal end than the elongate section, and the gripping device may comprise two prongs dimensioned and shaped to receive the elongate section while preventing the protrusion to pass in-between the prongs.

[0033] In preferred embodiments, the vessel connector may have a longitudinal axis along which the vessel connector extends, a proximal end from which the mooring connection extends towards the mooring buoy and a distal end opposite the proximal end, wherein the vessel connector may comprise an outwardly tapering section extending from the proximal end towards the distal end. Preferably, the outwardly tapering section may have a smallest cross section at the proximal end.

[0034] In preferred embodiments, the vessel connector may comprise a shell construction preferably defining at least an outer contour or an outer shell of the vessel connector. Preferably, such a shell construction may comprise an interior placed mechanical connection point or area to which the mooring line may be mechanically connected, and, when the system comprises the electric conductive cable, said shell construction may further comprise an interior placed electrical connection point or area to which cords of the electrical conductive cable may be electrically connected.

[0035] In preferred embodiments, the vessel connector may be rotational symmetric around a longitudinal axis of the vessel connector.

[0036] In preferred embodiments, the mooring buoy may comprise a floatable body preferably having a vertical through-going opening, as viewed from a position with the mooring buoy floating on a horizontal sea surface. Preferably, the vessel connector and the vertically through-going opening may be mutually shaped and dimensioned to releasable accommodate at least a part of the vessel connector in said vertical through-going opening.

[0037] In preferred embodiments, an upper section of the through-going opening may be funnel shaped preferably with a decreasing cross section in downward direction of the vertical through-going opening.

[0038] In preferred embodiments, the mooring line may extend in its retractable position in a loop a distance downwards through the through the vertical through-going opening.

[0039] In preferred embodiments, the floating body may comprise fastening elements, preferably arranged on an underside of the floatable body for fastening anchor lines to the floatable body, wherein the anchor lines are used to anchor the floating body.

[0040] In preferred embodiments, the buoyancy of the mooring buoy may be larger than the total gravitational forces of the mooring buoy, the vessel connector and preferably also the mooring connection.

[0041] In preferred embodiments, a fraction or even all of the supply of electrical power may be used to charge

electrical power storage on-board the vessel, such as on-board batteries.

[0042] In a second aspect, the invention relates to a vessel connector having a longitudinal axis along which the vessel connector extends, a proximal end configured to receive a mooring connection and a distal end opposite the proximal end. Preferably,

- the vessel connector may comprise at a distance from the proximal end an elongate section preferably comprising a protrusion arranged closer to the distal end than the elongate section, said protrusion being configured to co-operate with a gripping device preferably comprising two prongs dimensioned and shaped to receive the elongate section while preventing the protrusion two pass in-between the prongs.

[0043] In preferred embodiments the elongated section may be flexible/bendable.

[0044] In a third aspect, the invention relates to a method of mooring of and supply of fluid or mooring of, supply of fluid and supply of electrical power to a vessel. Preferred embodiments comprises:

- providing a system according to the first aspect at an off-shore position and anchoring the mooring buoy to the seabed;
- connecting the fluid pipe to a fluid source;
- when the system comprising the electric conductive cable, connecting the electrical conductive cable to an electric power supply;
- navigating a vessel to a position in close proximity to the off-shore position to allow access from the vessel to the vessel connector;
- hoisting or winch the vessel connector on-board a vessel and to the gripping device;
- engaging the gripping device to grip the vessel connector thereby mooring the vessel;
- connecting the fluid pipe to a fluid inlet of the vessel, which fluid inlet is configured to lead received fluid to a receptacle, such as a storage tank;

- when the electric conductive cable is present, connecting the electric conductive cable to a distribution board of the vessel, which distribution board is preferably configured to distribute electrical power to one or more electrical power consuming devices on-board the vessel and
- transferring of fluid or fluid and electric power to said vessel.

[0045] In a particularly preferred embodiment, the supplied fluid is a gas, preferably hydrogen.

BRIEF DESCRIPTION OF THE FIGURES

[0046] The present invention and in particular preferred embodiments thereof will now be described in more detail with regard to the accompanying figures. The figures show ways of implementing the present invention and are not to be construed as being limiting to other possible embodiments falling within the scope of the attached claim set.

Figure 1 illustrates a first embodiment of a system for mooring of and supply of fluid or fluid and electrical power to a vessel. The vessel connector is illustrated positioned in the mooring buoy, with the interior placed part of the vessel connector and the through going opening in the mooring buoy illustrated by grey lines. In addition, an enlarged cross section view along A-A of fig. 1 is provided illustrating details of the mooring connection extending downwards from the vessel connector; fig. 1B shows in a cross sectional view an embodiment comprising a mooring line and a fluid pipe, and fig. 1C shows in a cross sectional view an embodiment comprising a mooring line, a fluid pipe and an electric conductive cable. Fig. 1D schematically illustrates an embodiment in which a fluid coupling and an electrical plug or socket are provided in a protrusion of the vessel connector (upper part of Fig. 1D is a top view and lower part is a cross sectional view).

Figure 2 illustrates the vessel connector of the first embodiment;

Figure 3 illustrates the vessel connector of the first embodiments being winched into a gripping device (Fig. 3A) and gripped in the gripping device (Fig. 3B);

Figure 4 schematically illustrates typical steps involved in mooring of and supply of fluid or fluid and electrical power to a vessel according to a preferred embodiment of the invention.

Figure 5 schematically illustrates typical steps involved in mooring of a supply fluid or fluid and electrical power to a vessel according to the preferred embodiment of fig. 4.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0047] Reference is made to fig. 1 illustrating a first embodiment of a system for mooring of and supply of fluid or mooring of, supply of fluid and supply of electrical power to a vessel. As illustrated, the system comprises a mooring buoy 1 being configured to float on a sea surface and to be anchored to a seabed. The mooring buoy 1 is typically anchored to the seabed by the anchor lines 34 which at the seabed may be connected to one or more anchoring devices, such as weights of substantial mass allowing the mooring buoy 1 to maintain a substantially stationary position when a vessel is moored to the buoy 1.

[0048] The system further comprising a mooring connection 2. Such a mooring connection 2 is in the illustrated embodiment configured to be a combined mooring line and power source connection. The mooring connection 2 may comprise a mooring line 3 and a fluid pipe 40 for supply of fluid (gas and/or liquid). Alternatively, the mooring connection may comprise a mooring line 3, a fluid pipe 40 and an electric conductive cable 4. These two alternatives are disclosed in fig. 1B and fig. 1C respectively, where fig. 1B illustrates in a cross sectional view a fluid pipe 40 and a mooring line 3, and fig. 1C illustrates in a cross sectional view a fluid pipe 40, a mooring line 3 and an electrical conductive cable 4. It is noted that fig. 1B and 1C are not to be taken as being limited to other relative dimensions as e.g. the mooring line 3 is dimensioned inter alia according to the size of the vessel to moor.

[0049] In preferred embodiments, the mooring line 3 is configured to take-up at least a substantial amount of tension arising from a vessel being moored to said mooring buoy 1 by use of the mooring connection 2 while essentially no mooring tension is applied to the fluid pipe 40 or when present the electrical conductive cable 4. In such embodiments, the remaining amount of tension arising from the vessel may be taken-up by other mooring devices and/or outbalanced by a dynamic positioning system.

[0050] In other preferred embodiments, the mooring line 3 is configured to take-up the whole amount of tension arising from a vessel being moored to said mooring buoy 1 by use of the mooring connection 2 while essentially no mooring tension is applied to the fluid pipe 40 or when present the electrical conductive cable 4. Such embodiments may comprise a one point mooring, in which the vessel is not moored by use of other mooring devices.

[0051] Preferred embodiments may be adapted to moor larger and/or smaller vessels. In preferred embodiments, the mooring line 3 is configured to take-up tension arising from a vessel, having a gross-tonnage larger than 50GT, such as larger than 200GT, preferably larger than 500GT and smaller than 400,000GT, preferably smaller than 300,000GT, being moored to said mooring buoy 1 by use of the mooring connection 2 while essentially no mooring tension is applied to the fluid pipe 40 or when present the electrical conductive cable 4.

[0052] In preferred embodiments, the mooring is a one point mooring, in the sense that the vessel is moored only by an embodiment of a system according to the present invention.

[0053] Fig. 1D schematically illustrates an embodiment in which a fluid coupling 41 and an electrical plug or socket 12 are provided at an upper end of the vessel connector. In the illustrated embodiment the fluid coupling 41 and the plug or socket 12 are provided in a protrusion 23, which protrusion will be detailed below. When no electrical conductive cable 4 is embodied, the plug or socket 12 is typically left out. Kindly observe, that due to orientation of the views used in fig. 1D, the mooring line 3 is not visible, although the mooring line 3 is present. Further, the optional pick-up line 28 is left out to render the figure clearer.

[0054] In the illustrated embodiment, the fluid coupling 41 is a female part of a coupling and comprises a check valve having a ball 42 seated against a valve seat 43 to prevent fluid from flowing out of the fluid pipe 40 before the valve is opened. In the illustrated embodiment, the ball 42 is forced towards the seat by the fluid in the fluid pipe 40 being at a higher pressure than the surrounding pressure. The coupling also comprises a number of spring actuated retainers (four are illustrated) which cooperate with a male part coupling (not illustrated). When the male part is introduced into the female part, the spring-actuated retainers 44 are pushed back allowing the male part to travel into the female part and push the ball 42 away from the valve seat 43. In this position, the retainers 44 engage with indentations of the male part to lock the male part in the position where the valve is open and fluid can flow towards the vessel. A locking device 45 is provided to prevent the retainers 44 from disengaging. The locking device is configured to move between a position where the retainers 44 cannot move outwardly and the illustrated position where the retainers 44 can move outwardly allowing disengagement of the male part. Suitable seals are typically provided to make the connection between the male and female part fluid tight.

[0055] In preferred embodiments, the fluid pipe 40 is connected to the fluid coupling by suitable fittings (not illustrated) optionally in combination with heat shrinking, welding or the like to provide a fluid tight connection between the fluid pipe 40 and the fluid coupling 41.

[0056] The mooring line 3 is configured to take-up tension arising from a vessel being moored to the mooring buoy 1 by use of the mooring connection 2 while essentially no mooring tension is applied to fluid pipe 40 and, when present, to the electrical conductive cable 4. Such a take-up of tension by the mooring line 3 is typically provided by that the mooring line 3, the fluid pipe 40 and the electrical conductive cable 4 are not connected in manner where tension can be transferred from the mooring line 3 to the fluid pipe 40 or to the electrical conductive cable 4.

[0057] The mooring connection 2 is an elongate element and the mooring line 3 is in the illustrated embodiment connected to the mooring buoy at an end to the mooring buoy 1. This is perhaps most clearly visible in fig. 5 wherein the mooring line 3 extends downward from the vessel connector 7 in a loop below the mooring boy 1 by being connected at one end to the mooring buoy 1. The connection of the mooring line 3 to the mooring buoy 1 is made sufficiently strong to withstanding forces arising from a vessel being moored to the buoy 1 through the mooring line 3. In other embodiments, the mooring line 3 may be anchored to the seabed at the seabed.

[0058] The system also comprises a vessel connector 7 (Fig. 1 and 2). This vessel connector 7 is typically provided at an end of the mooring connection 2. The vessel

connector 7 serves at least two purposes namely of being a combined mooring connector and fluid connector or a combined mooring connector, fluid connector and electrical connector, where the mooring connector is used to moor a vessel, the fluid connector used to supply fluid to the vessel and the electrical connector is used to supply electricity to the vessel.

[0059] It is to be noted, that although the disclosure herein has focussed on supplying the vessel with fluid and in some embodiments also with electrical power, the invention can also be used to use a vessel to supply fluid or fluid and electrical power to off-shore devices, such as ROV or other vessels. In addition to providing fluid or fluid and electrical power, the invention may also be used for supplying signals, such as a data signal. Although such data may be transferred by use of the electrical conductive cable, a separate data cable, such as an optical fibre or an electrical conductive cable may be applied. In such embodiments, the separate data cable is typically combined into the combined mooring, fluid, and electrical connection.

[0060] A gripping device 13 is arranged on a vessel 14 to moor and the gripping device 13 is configured to grip and lock said vessel connector 7 to moor the vessel 14 to the mooring buoy 1 (Fig 3 A and B).

[0061] The fluid pipe 40 is typically made of a flexible material so as to prevent the fluid pipe 40 from taking-up an essential tension which could otherwise arise from the mooring. The fluid pipe 40 may be reinforced by strands or fibres being embedded in the flexible material and/or a braiding made of strands or fibres may be applied to the fluid pipe 40. This will increase the fluid pipe 40's ability to withstand elevated pressure while still being bendable due to the flexibility.

[0062] The fluid pipe 40 may preferably also be provided with a length allowing it to hang freely when the vessel is moored by the mooring line 3. The fluid pipe 40 will, due to the mass of the fluid pipe 40, exert pulling forces on the vessel. However, as the mooring of the vessel is provided by the mooring line 3, a pull from the vessel during mooring will essentially be taken up by the mooring line. By this, the mooring may be seen as not only involving the mooring forces exerted by the vessel itself but includes forces exerted by the weight of the fluid pipe 40 and, when present, the forces exerted by the weight of the electric conductive cable 4.

[0063] Thus, in some embodiments, the fluid pipe 40 typically has a length being longer than the mooring line 3. Depending on the type of fluid and the pressure at which the fluid is delivered, the dimensioning and selecting of material are made to avoid damage of the fluid pipe 40 during use. As will be detailed below, the fluid pipe extends from a fluid source, which may be a fluid producing off-shore rig or a plant/device splitting desalinated seawater by electrolyze powered by electricity produced by e.g. one or more off-shore wind turbines. However, the invention is not limited to such fluid sources, as a fluid source may also be a land based fluid production facility, such as a facility producing biogas. In such situations, the fluid pipe 40 extends from the land based facility to the system for mooring. In a particularly preferred embodiment the produced and transferred fluid is hydrogen.

[0064] The fluid pipe 40 may be assembled by piecing together pipe segments to form the fluid pipe 40 or may be a continuous fluid pipe. Further, the fluid pipe may extend from a sea-based distribution device 37' similar to the distribution device 37 disclosed in connection with the electric conductive cable with reference to fig. 4.

[0065] The electric conductive cable has typically a length being longer than the mooring line 3, and extends from a power source via the mooring buoy 1. It is to be noted that the electric conductive cable does not necessarily extend uninterrupted from the electrical power source as it may be connected to a distribution device 37 (see fig. 4) for distributing electrical power to a number of systems for mooring and supply of electrical power to a vessel as disclosed herein. In such embodiments, the distribution device 37 is connected to an electrical power source. Such an electrical power source may be a wind turbine, such as a wind turbine farm or any other electrical source or producing system. The electrical power source may positioned off-shore or on-shore.

[0066] As illustrated in fig. 1 and 2, the vessel connector 7 being connected to the mooring line 3 at the end of the mooring connection 2. It is to be noted that the mooring connection 2 may extend into the vessel connector 7, as most clearly visible in fig. 2.

[0067] To connect the electric conductive cable to the vessel, the vessel connector 7 comprises an electrical plug and/or electrical socket 12 to which the electric conductive cable 4 is electrically connected. The plug and/or socket 12 is typically arranged behind a water tight and openable cover to avoid water to get into contact with the plug and/or socket 12.

[0068] In a preferred embodiment, the mooring connection 2 has a tubular jacket 15 enclosing at least a section of the mooring line 3 the fluid pipe 40 and when present also the electric conductive cable 4. The tubular jacket 15 extends a distance from vessel connector 7. The tubular jacket 15 is typically dimensioned so that the mooring line 3, the fluid pipe 40 and when present the electric conductive cable 4 can move substantially freely of each other inside the tubular jacket 15 whereby the tubular jacket 15 may serve as a protective element for the mooring line, the fluid pipe 40 and when present also the electric conductive cable while assembling the mooring line, the fluid pipe and, when present, also the electrical conductive cable into an assembled element for easy handling.

[0069] The mooring line 3 and the electric conductive cable 4 may be co-axially arranged with electric conductive cable 4 arranged inside said mooring line 3 (or vice versa). In addition, the mooring line 3 and the fluid pipe 40 may be co-axially arranged with the mooring line 3 arranged inside the fluid pipe 409 (or vice versa). In such embodiments, it is generally preferred that the electric

conductive cable 4 and the mooring line 3 are dimensioned relatively to each other to allow the two elements to move relatively to each other in their longitudinal directions to avoid a tension carried by the mooring line 3 at least during mooring being transferred to the electric conductive cable 4.

[0070] In another embodiment (see fig. 2) the mooring line 3, the fluid pipe 40 and, when present, also the electric conductive cable 4 are arranged side-by-side preferably without being intertwined and/or meshed. To make such a side-by-side configuration an assembled element, a tubular jacket 15 as disclosed above may be provided (see also fig. 1B-C, enlarged cross section A-A).

[0071] Reference is now made to fig. 3A and 3B illustrating inter alia a preferred embodiment of a gripping device 13. As illustrated the gripping device 13 comprising a retractable engaging element 16 where the engaging element 16 being retractable from a first position where it engages said vessel connector 7 to a second position where it does not engage vessel connector 7. In the illustrated embodiment, the engaging element 16 is configured to reciprocate between a position where it does not engage the vessel connector 7, illustrated in fig. 3A, and a position where it does engage. In preferred embodiments, the non-engaging position is a position where the engaging element 16 is retracted to a lower position such as towards or even below deck level of the vessel.

[0072] The gripping device 13 is preferably arranged at a deck position of the vessel, said deck position is preferably a position on a weather deck, preferably at the bow of the vessel. The position is typically the position at which the vessel would be moored when moored e.g. to a quay.

[0073] Alternative engaging elements 16 of the gripping device 13 can typically be a chain stopper, a fork, a gripper, a hook with release function such as a towing hook, a smit or a towing bracket.

[0074] As also illustrated in fig. 3A and 3B, the system may further comprise a winch 17 configured to reel-in a rope, cord, cable, wire or the like connected to said vessel connector 7, which in fig. 3A and 3B is illustrated by a pick-up line 28. The pick-up line 28 is also shown in fig. 1 and the intended use of the pick-up line 28 is to hoist the vessel connector 7 onboard the vessel and into the gripping device, first by picking up the pick-up line 28 and subsequently reel it in by use of the winch 17. Accordingly, the winch 17 is preferably positioned relatively to the gripping device 13 so that the winch upon reeling-in pulls the vessel connector 7 to the gripping device 13.

[0075] The pick-up line 28 connected to the vessel connector is accordingly, preferably dimensioned to allow for the vessel connector 2 to be hoisted or winched onboard said vessel. Preferably, the pick-up line 28 has a positive buoyancy and/or being provided with buoyancy elements 29 (see fig. 1) to prevent fully submerge of the pick-up line 28, when the pick-up line 28 is in water.

[0076] As perhaps most clearly seen from fig. 1, the vessel connector 7 has a longitudinal axis 19 along which the vessel connector 7 extends, a proximal end 20 from which the mooring connection 2 respectively extends to the mooring point (e.g. seabed or mooring buoy), to the fluid source, and in embodiments comprising an electric conductive cable also to the electrical power source. The vessel connector 7 also has a distal end 21 opposite the proximal end 20. In the disclosed embodiments, the outer contour of vessel connector 7 is rotational symmetric about the longitudinal axis 19, although the invention is not limited to such symmetric shapes.

[0077] It is generally preferred to provide the vessel connector 7 with a positive buoyancy so as to allow it for floating on the sea surface. Depending on the buoyancy of the mooring line 3, the fluid pipe 40 and when present the electric conductive cable 4, the buoyancy provided to the vessel connector 7 may be sufficient to prevent the mooring line 3, the fluid pipe 40, and/or, when present, the electrical conductive cable from submerging the vessel connector 7. In other embodiments, the mooring line 3, the fluid pipe 40 and/or, when present, the electrical conductive cable 4 may be provided with buoyancy providing elements.

[0078] The vessel connector 7 has at a distance from the proximal end 20 an elongate section 22 comprising a protrusion 23 arranged closer to the distal end 21 than the elongate section 22. The elongate section 22 is preferably a straight section having a uniform cross sectional diameter along the elongate section, but other shapes may be used such as tapering shapes. The purpose of the straight elongate section 22 in combination with protrusion 23 is to define an edge which can abut one or more elements of the gripping device 13 when a pull is provided in the vessel connector 7 from the mooring lines in a direction towards the mooring buoy 1. In a preferred embodiment, the elongated section 22 can have a certain degree of flexibility/non-stiffness. This will allow that this part of the connector can be bended during the raising and mooring operation for example when lifting up the connector on the weather board of a vessel. This may be provided by the elongate section 22 being made from rubber, such as steel reinforced rubber.

[0079] In the embodiment shown in fig. 3A and 3B, the gripping device 13 comprising two prongs 24 dimensioned and shaped to receive the elongate section while preventing the protrusion 23 to pass in-between the prongs 24. As illustrated, the two prongs 24 defines an open ended funnel shaped upper section with a more narrow and straight section below. The narrow section can accommodate the elongate section 22 while preventing the protrusion 23 to pass through by the edge of the protrusion 23 abutting the prongs 24. Thereby, the vessel connector 7 is prevented from moving further in a direction away from the winch 17 aligned with the longitudinal axis 19 than delimited by the protrusion 23. During operation, the vessel connector 7 is pulled towards the gripping device 13 by the winch 17 while the prongs 24 are in a retracted position allowing the vessel connector to

be positioned in a position allowing the prongs 24 to grip the vessel connector 7 when moved upwards as shown in fig. 3B to engage the vessel connector 7.

[0080] After the prongs 24 have engaged the vessel connector 7, the tension in the pick-up line 28 may be released as now the gripping device is the tension carrying element. Is it preferred to connect the fluid pipe 40 and, when present, the electric conductive cable to provide fluid and electrical power to the vessel after the vessel connector 7 has been engaged and after the tension of the pick-up line has been released. The advantage of this is a reduced risk for operating personal avoiding to enter an area where a mooring line is tensioned. For example when connecting the fluid pipe 40 and/or the electrical cable 4.

[0081] The gripping device 13 is typically arranged at a position elevated relatively to the mooring buoy 1 whereby the mooring connection 2 extend slanted downwardly from the vessel towards the mooring buoy 1. In addition, the gripping device 13 is typically arranged and dimensioned so that the longitudinal axis 19 of the vessel connector 7 is horizontal or substantially horizontal. By this, upward directed forces acting on the vessel connector 7 is typically eliminated or at least mitigated to an extend where there is no need for preventing the vessel connector 7 from moving upward in the gripping element 13 whereby the mooring connection can be established by the prongs moving upwardly.

[0082] The illustrated vessel connector 7 has an outwardly tapering section extending from the proximal end 20 towards the distal end 21, wherein the outwardly tapering section 5 has a smallest cross section at the proximal end 20. By providing the vessel connector 7 with such an outwardly tapering section, the vessel connector 7 may show a self-centring function when the vessel connector is arranged in an opening of the mooring buoy 1. With reference to fig. 1 the vessel connector 7 is placed in such an opening 31 of the mooring buoy 1 and due to the weight of the mooring connection 2 which extend through the opening and the vessel connector 7, and the weight of the vessel connector 7, the vessel connector 7 is pulled by gravity into the opening 31. The opening 31 in the illustrated embodiment has a funnel shaped upper section assisting in placing the vessel connector 7 in the opening 31.

[0083] In preferred embodiments, the vessel connector 7 comprising a shell construction defining at least an outer contour or an outer shell of the vessel connector 7. The shell construction is preferably selected to provide the vessel connector 7 a low weight while still assuring sufficient strength to allow it to take-up mooring forces. Reinforcement elements may be arranged inside the shell to increase mechanical strength. The low weight may further provide a positive buoyancy to the vessel connector 7 preventing it from sinking in case of being dropped on the sea.

[0084] As illustrated in fig. 2, the shell construction preferably has an interior placed mechanical connection point or area 26 to which the mooring line 3 is mechanically connected. In embodiments comprising an electric conductive cable , an interior placed electrical connection point or area 27 to which cords of the electrical conductive cable 4 is electrically connected may be provided. An interior electrical connection is provided between the electrical connection point or area 27 and the plug and/or socket 12.

[0085] The fluid pipe 40 is connected to a fluid coupling (an embodiment of a fluid coupling 41 is illustrated in Fig. 1D) placed interior of the vessel connector 7. The fluid coupling 41 is typically mechanically connected to the vessel connector 7 at an interior placed mechanical fluid pipe connecting point or area (which may be the same as for the electric conductive cable, when present). Such a fluid pipe connecting point or area is typically designed to be load carrying part so that the fluid coupling 41 may be released from tension arising from the weight of the fluid pipe 40 (the fluid coupling 41 is typically arranged at the end of the fluid pipe 40).

[0086] The vessel connector 7 may have an access hatch 25 providing access to the interior placed electrical connection point of area 27 from the outside of the vessel connector 7. Such a configuration has been found to be practical e.g. in case of replacing a damaged electrical conductive cable and/or for providing space for manoeuvring cords inside the vessel connector 7.

[0087] Similarly, an access hatch may be provided to provide access to the fluid pipe 40 and the fluid coupling 41. This access hatch may be common for the fluid pipe 40 and the electrical connection point and is practical e.g. in case of replacing or repairing the fluid coupling 41, the fluid pipe 40 or the connection between the fluid pipe 40 and the fluid coupling 41.

[0088] The mooring line 3 is selected in accordance with the required strength and length to moor a vessel and non-limiting examples on mooring lines 3 are rope, cord, cable, wire, chain or the like.

[0089] While the mooring buoy may be raised from the seabed by other means, the mooring buoy 1 according to preferred embodiments comprises a floatable body 30. By floatable body is typically meant that it floats due to buoyancy, which is the case for the embodiment shown in fig. 1. As shown in fig. 1, the floatable body 30 has a vertical through-going opening 31, as viewed from a position with the mooring buoy 1 floating on a horizontal sea surface. The vessel connector 7 and the vertically through-going opening 31 are mutually shaped and dimensioned to releasable accommodate at least a part of the vessel connector 7 in said vertical through-going opening 31. By releasable accommodated is typically meant that the vessel connector 7 can be pulled up from its position in the through going-opening 31. The mooring buoy typically floats both, when the vessel connector is retracted into the buoy or when moored to a vessel.

[0090] As illustrated in fig. 1, an upper section of the through-going opening may be funnel shaped 32 with a decreasing cross section in downward direction of the

vertical through-going opening 31, which as disclosed above may assist the location of the vessel connector 7 in the through-going opening 31.

[0091] Since the mooring buoy 1 is to be used to moor a vessel, the mooring buoy 1 is in some embodiments anchored to the seabed. In preferred embodiments, the anchoring is made by anchoring the floating body 30 to the seabed and to this, the floating body typically has fastening elements, such as an eye, arranged on an underside of the floatable body 30 for fastening anchor lines 34 to the floatable body 30.

[0092] Preferably, the proximate end 8 of the mooring line is connected to the floating body of the mooring buoy 1 as described above. In an alternative embodiment, the mooring line may extend via the through-opening in the mooring buoy to the seabed or to a fixed installation and is directly connected with its proximate end there. Thereby the mooring line also serves as anchor line.

[0093] As it is preferred in many embodiments, that the mooring buoy 1 floats on the sea surface, the buoyancy of the mooring buoy 1 is preferably made larger than the total gravitational forces of anchoring chains, cables and the like of the mooring buoy 1 and the vessel connector 7. Depending on the buoyancy of the mooring line, the buoyancy of the mooring buoy 1 may be made so that it also carries the load of the mooring connection 2.

[0094] The invention also relates to a method of mooring, supply of fluid or and supply of fluid and electrical power to a vessel. In a preferred embodiment, such a method involves providing a system for mooring, supply of fluid or supply of fluid and electrical power, as disclosed herein, at an off-shore position and anchoring the mooring buoy (1) to the seabed. Off-shore position is to be understood in a broad context as it may be close to the coast, such as in a harbour or it may be further away from the cost.

[0095] The fluid pipe 40 is fluidic connected to a fluid source. In preferred embodiments, the fluid source may be an off-shore installation extracting natural gas. In such embodiments, the fluid pipe 40 is fluidic connected to a supply of natural gas of an off-shore installation so as to receive gas extracted from the off-shore i nsta llation.

[0096] In other embodiments the fluid source is an off-shore electrolyse installation to which the fluid pipe 40 is fluidic connected. In the electrolyse installation, seawater is desalinated and split into hydrogen and oxygen by an electrolyse process. Electrical power to power the desalination and electrolyse is preferably provided by one or more off-shore wind turbines. The produced hydrogen is typically stored in a suitable storage tank (fluid source) until transferred to a vessel comprising one or more tanks for storing of the hydrogen onboard. The transfer is carried out through the fluid pipe 40. The storage tank may be provided on-site where the hydrogen (or other fluid) is produced and/or in a storage tank comprised in the mooring buoy 1.

[0097] With the system provided, the fluid pipe 40 is connected to the fluid source, and when present, the electrical conductive cable 4 is connected to an electric power supply (not shown in figures). It is noted that such fluid connection and an electrical connection may be provided or even re-established before or after the mooring buoy 1 is anchored to the seabed.

[0098] A vessel is navigated to a position in close proximity to the off-shore position to allow access from the vessel to the vessel connector 7. With the vessel in this position, the vessel connector 7 is hoisted or winched on-board vessel and to the gripping device 13.

[0099] With the vessel connector 7 positioned in the gripping device 13, the gripping device is engaged to grip the vessel connector 7, where after the vessel has been moored. The winch or hoist used to pull the vessel connector 7 on-board winch or hoist may now be released. Thus, the only mooring point on board of the vessel may then be achieved through engagement of the vessel connector 7 with the on-board gripping device which takes up all tension of the mooring.

[0100] While the fluid pipe 40 and, when present, the electrical conductive cable can be connected to provide fluid and power to the vessel at essentially any time the vessel connector 7 is within reach of the vessel, it is generally preferred to make the fluid connection and the electrical connection after the vessel connector 7 has been gripped by the gripping device 13. The fluid connection is provided by connecting the fluid pipe through e.g. the coupling shown in fig. 1D. The electrical connection is provided by connecting the electric conductive cable 4 to a distribution board 36 of the vessel, typically by use of cable 38 having plug(s) and/or socket(s) mating the plug(s) and/or socket(s) of the vessel connector 7 and the distribution board 36 as shown in fig. 4. Such a distribution board 36 is typically configured to distribute electrical power to one or more electrical power consuming devices and/or electric power storage on-board the vessel. It is further preferred that the electrical cable is only supplied with power from a power source when an electric connection has actually been established on board of the vessel. The electric connector maybe washed with freshwater to remove salt before the connecting.

[0101] Although it may be preferred that the fluid pipe 40 is not pressurised prior to be connected to a vessel, this may be impractical, and the invention encompasses both situations. On-board a vessel, the fluid pipe 40 is fluidic connected to a fluid inlet of the vessel, typically by use of a flexible pipe which mate with the fluid coupling 41 of the vessels connector 7. The fluid inlet is typically fluidic connected to a storage tank on-board the vessel. In embodiments where the fluid is a gas, the gas may be pressurised on-board the vessel to increase the loading capacity of the vessel.

[0102] It is generally preferred that the electrical conductive cable is not live but electrically disconnectable from the power supply by an electrical switch (not illustrated) so as to reduce the risk of electric shock during handling of inter alia the vessel connector 7 and during establishment of electrical connection onboard the ves-

sel from the vessel connector 7. Such an electrical switch may be positioned at various places, such as on the buoy 1 or at a remote location, such as at the electrical power supply or other locations. It may even be placed in or on the vessel connector 7. In embodiments where the electrical switch is positioned remote from the vessel preventing manually activation and deactivation, the electrically switch is typically remotely operated. Such a remote operation may comprise transmitting an activation code or deactivation code (when to disconnect the vessel connector 7) e.g. through the electric conductive cable or data cable, an SMS, and via radio transmission. Security may be built into the transmission of the codes such as an authentication protocol to avoid unintended activation and deactivation.

[0103] A flow of fluid in the fluid pipe 40 may also be activatable by e.g. a remote operated valve, which may be activated to allow fluid by an electrical switch as disclosed above.

[0104] Reference is made to fig. 4 schematically illustrating typical steps involved in mooring, supply of fluid and, when the electric conductive cable is present, supply electrical power to a vessel 14 by use of a system according to the present invention. It is noted that fig. 4 comprises figures 4A-L, where figs. 4A, B illustrate a vessel approaching the mooring buoy 1, and figs. 4C illustrates the mooring buoy 1 floating on the water, and fig. 4D illustrates an optional distribution device 37 for distributing electrical power to a number of systems for mooring and providing electrical power to a vessel. Figs. 4E-L schematically illustrates different stages during mooring and supply of electrical power to a vessel 14.

[0105] As perhaps most clearly visible in fig. 4B a system for mooring, supply of fluid and, where the electric conductive cable is present, supply of electrical power to a vessel as otherwise disclosed herein is arranged at an off-shore position. The mooring buoy 1 is anchored to the seabed by use anchoring lines 34.

[0106] The fluid pipe 40 (not illustrated) is connection to a fluid source and the electrical conductive cable 4 is, when present, connected to an electric power supply (not illustrated). In the illustrated embodiment, the electrical conductive cable 4 is connected to the electrical power supply via an optional distribution device 37 having a not illustrated electrical connection to the power supply.

[0107] As presented herein, it is generally preferred that the electrical conductive cable is not live but electrically disconnectable from the power supply by an electrical switch (not illustrated) so as to reduce the risk of electric shock during handling of inter alia the vessel connector 7 and during establishment of electrical connection onboard the vessel from the vessel connector 7.

[0108] Upon mooring and supply of fluid or fluid and power, a vessel 14 is navigated to a position in close proximity to the off-shore position of the mooring buoy 1 to allow access from the vessel to the vessel connector 7.

[0109] With reference to fig. 4C such a position is typically a position where a pick-up line 28 is within reach from the vessel 14. If a pick-up line 28 is not embodied, the vessel is typically navigated to a position where the vessel connector 7 is within reach from the vessel 14 and a pick-up line can be applied to the vessel connector 7. In the following, typical involved steps after having positioned the vessel are disclosed.

[0110] As illustrated in fig. 4E a deckhand uses a boat hook to pick the pick-up line 28 and brings the pick-up line 28 onboard the vessel 14 (see fig. 4F). With the pick-line 28 onboard, the pick-up line 28 is arranged in a winch 17 which winches, by reeling in the pick-up line 28, the vessel connector 7 on-board the vessel 14 and to the gripping device 13 as illustrated in fig. 4H. It is noted that the gripping device shown in fig. 4 is illustrated in greater details in fig. 3A, B.

[0111] With the vessel connector 7 located in the gripping device 13, the gripping device engages (as illustrated in fig. 3B) to grip the vessel connector 7. By this, the mooring tension is now carried by the gripping device 13 and the tension in the pick-up line 28 can be released, if desired, as illustrated in fig. 4J.

[0112] The fluid pipe 40 and the electric conductive cable 4, when present, can now safely be connected to a fluid inlet and a distribution board 36 of the vessel. The fluid inlet is typically configured to lead the fluid to one or more storage facilities, such one or more tanks and the distribution board 36 is typically configured to distribute electrical power to one or more electrical power consuming devices and/or power storage devices on-board the vessel. The fluid connection is typically carried out by a fluid line and the electrical connection is typically carried out by a cable 38 both of which may be guided from the fluid inlet and/or the distribution board 36 by a common or separate guide(s) 39 to the moored vessel connector 7. In embodiments, in which the electric conductive cable 4 is connected to a power supply through an electrical switch, the switch is turned on. For the fluid pipe 40, a fluid coupling, such as the one detailed in connection with Fig. 1D which automatically opens and closes for fluid flow upon being connected and disconnected.

[0113] Fig. 5 illustrates some of the steps disclosed in connection with fig. 4 seen in a different perspective. Figs. 5A-5C illustrates that the deckhand pulls the pick-up line 28 onboard the vessel. Fig. 5C illustrates that the mooring connection 2 is about to be pulled on-board the vessel. Fig. 5D illustrates the vessel being moored and illustrates that the mooring line 3 is tight whereas the electrical conductive cable 4 is hanging loose, that is the mooring forces are taken up by the mooring line 3. Similarly, although not illustrated, the fluid pipe 40 is hanging loose and the mooring forces are taken up by the mooring line 3.

[0114] Once the vessel is moored and connection(s) made, transfer of fluid, and when the electric conductive cable is present, transfer of electric power can commence.

[0115] Instead of mooring the vessel connector through the gripping device on board of the vessel, it is principally also possible to only use the vessel connector

for supply of fluid and when present charging purposes only and to keep the vessel in a stable position by other means such as by anchoring, a Dynamic positioning system or other means during the supply of fluid/charging process/power transfer.

[0116] Although the present invention has been described in connection with the specified embodiments, it should not be construed as being in any way limited to the presented examples. The scope of the present invention is set out by the accompanying claim set. In the context of the claims, the terms "comprising" or "comprises" do not exclude other possible elements or steps. Also, the mentioning of references such as "a" or "an" etc.. should not be construed as excluding a plurality. The use of reference signs in the claims with respect to elements indicated in the figures shall also not be construed as limiting the scope of the invention. Furthermore, individual features mentioned in different claims, may possibly be advantageously combined, and the mentioning of these features in different claims does not exclude that a combination of features is not possible and advantageous.

List of reference symbols used:

[0117]

1 Mooring buoy
2 Mooring connection
3 Mooring line
4 Electric conductive cable
5 Outwardly tapering section
7 Vessel connector
8 Beacon
9 Loop for pick-up line
12 Plug and/or socket
13 Gripping device
14 Vessel
15 Tubular jacket
16 Engaging element, preferably being extractable
17 Winch
18 Rope, cord, cable, wire or the like
19 Longitudinal axis
20 Proximal end
21 Distal end
22 Elongate section
23 Protrusion
24 Prongs
25 Access hatch
26 Interior placed mechanical connection point or area
27 Interior placed electrical connection point or area
28 Pick-up line
29 Buoyancy element
30 Floatable body
31 Vertical through-going opening
32 Funnel shaped section
34 Anchor line
35 Power supply
36 Distribution board
37 Distribution device
38 Cable
39 Guide
40 Fluid pipe
41 Fluid coupling
42 Ball
43 Valve seat
44 Retainer
45 Locking device

Claims

1. A system for mooring of and supply of power fluid or mooring of, supply of power fluid and supply of electrical power to a vessel, the system comprising:

- a mooring buoy (1) being configured to float on a sea surface and to be anchored to a seabed;
- a mooring connection (2) being a combined mooring and power source connection by comprising
  - a mooring line (3) and a fluid pipe (40) for supply of said fluid, or
  - said mooring line (3), said fluid pipe (4) and further an electric conductive cable (4) for supply of electrical power;
- wherein said mooring line (3) is configured to take-up tension arising from a vessel being moored to said mooring buoy (1) by use of the mooring connection (2) while essentially no mooring tension is applied to the fluid pipe (40) or the electrical conductive cable (4), said mooring line (3) is connected to said mooring buoy or anchored to the seabed at the seabed;
- a retractable vessel connector (7) provided at an end of the mooring connection (2), said vessel connector (7) being a combined mooring connector and fluid connector or a combined mooring connector, fluid connector and electrical connector, and
- a gripping device (13) arranged on a vessel (14), said gripping device (13) being configured to grip and lock said vessel connector (7) to moor said vessel (14) to said mooring buoy (1) or to the seabed.

2. A system according to claim 1, wherein the vessel connector (7) comprising a fluid coupling (41) to which the fluid pipe is fluidic connected and, when the system comprising said electric conductive cable (4), the vessel connector (7) further comprising an electrical plug and/or electrical socket (12) to which

the electric conductive cable (4) is electrically connected.

3. A system according to claim 1 or 2, wherein the mooring connection (2) further comprising a tubular jacket (15) enclosing at least a section of the mooring line (3) the fluid pipe (40), and, when the system comprising said conductive cable (4), the tubular jacket (15) further enclosing at least a section of the electric conductive cable (4), the tubular jacket extends from vessel connector (7).

4. A system according to any one of claim 1-3, wherein the mooring line (3), the fluid pipe (40) and, when the system comprising the electric conductive cable (4), also the electric conductive cable (4) are co-axially arranged inside said mooring line (3) or are arranged side-by-side preferably without being intertwined and/or meshed.

5. A system according to any one of the preceding claims 1-4, wherein the gripping device (13) comprising one or more engaging element(s) (16) configured to engage the vessel connector (7) to grip and lock said vessel connector (7).

6. A system according to claim 5, wherein the engaging element (16) is retractable from a first position where it engages said vessel connector (7) to a second position where it does not engage said vessel connector (7).

7. A system according to any one of claims 1-6, wherein the system further comprising a winch (17) configured to reel-in a rope, cord, cable, wire or the like connected to said vessel connector (7), said winch (17) being positioned relatively to the gripping device (13) so that the winch upon reeling-in pulls the vessel connector (7) to the gripping device (13).

8. A system according to any one of claims 1-7, wherein the vessel connector (7) further comprising a pick-up line (28) connected to the vessel connector (7), said pick-up line being dimensioned to allow for the vessel connector (7) to be hoisted or winched onboard said vessel, said pick-up line (28) having a positive buoyancy and/or being provided with buoyancy elements (29) to prevent fully submerge of the pick-up line (28), when the pick-up line (28) is in water.

9. A system according to any one of claims 1-8, wherein the vessel connector (7) has a longitudinal axis (19) along which the vessel connector (7) extends, a proximal end (20) from which the mooring connection (2) extends towards the mooring buoy (1) and a distal end (21) opposite the proximal end (20), wherein

- the vessel connector (7) comprises at a distance from the proximal end (20) an elongate section (22) comprising a protrusion (23) arranged closer to the distal end (21) than the elongate section (22), and
- the gripping device (13) comprising two prongs (24) dimensioned and shaped to receive the elongate section while preventing the protrusion (23) to pass in-between the prongs (24).

10. A system according to any one of claims 1-9, wherein the vessel connector (7) has a longitudinal axis (19) along which the vessel connector (7) extends, a proximal end (20) from which the mooring connection (2) extends towards the mooring buoy (1) and a distal end (21) opposite the proximal end (20), wherein the vessel connector (7) comprising an outwardly tapering section extending from the proximal end (20) towards the distal end (21), the outwardly tapering section (5) has a smallest cross section at the proximal end (20).

11. A system according to any one of claims 1-10, wherein the vessel connector comprising a shell construction defining at least an outer contour or an outer shell of the vessel connector (7), said shell construction comprising

- an interior placed mechanical connection point or area (26) to which the mooring line (3) is mechanically connected,
- an interior placed fluid pipe connecting point or area to which the fluid pipe (40) is mechanically connected, and

when the system comprising the electric conductive cable (4) said shell construction further comprising an interior placed electrical connection point or area (27) to which cords of the electrical conductive cable (4) is electrically connected.

12. A system according to any one of claims 1-11, wherein the vessel connector (7) is rotational symmetric around a longitudinal axis of the vessel connector (7).

13. A system according to any of claims 1-12, wherein the mooring buoy (1) comprising a floatable body (30) having a vertical through-going opening (31), as viewed from a position with the mooring buoy (1) floating on a horizontal sea surface, wherein the vessel connector (7) and the said vertically through-going opening (31) are mutually shaped and dimensioned to releasable accommodate at least a part of the vessel connector (7) in said vertical through-going opening (31).

14. A system according to any of the claims 1-13, where-

in the mooring line extends in its retractable position in a loop a distance downwards through the through the vertical through-going opening (31).

15. A system according to any one of the preceding claims, wherein the buoyancy of the mooring buoy (1) is larger than the total gravitational forces of the mooring buoy (1), the vessel connector (7) and preferably also the mooring connection (2).

16. A system according to any one of the preceding claims, wherein said mooring line (3) is configured to take-up at least a substantial amount of tension arising from a vessel being moored to said mooring buoy (1) by use of the mooring connection (2) while essentially no mooring tension is applied to the fluid pipe (40) or when present to the electrical conductive cable (4).

17. A system according to any one of the preceding claims, wherein said mooring line (3) is configured to take-up the whole amount of tension arising from a vessel being moored to said mooring buoy (1) by use of the mooring connection (2) while essentially no mooring tension is applied to the fluid pipe (40) or when present to the electrical conductive cable (4).

18. A system according to any one of the preceding claims, wherein said mooring line (3) is configured to take-up tension arising from a vessel, having a gross-tonnage larger than 50GT, such as larger than 200GT, preferably larger than 500GT and smaller than 400,000GT, preferably smaller than 300,000GT being moored to said mooring buoy (1) by use of the mooring connection (2) while essentially no mooring tension is applied to the fluid pipe (40) or when present to the electrical conductive cable (4).

19. A system according to any one of the preceding claims, wherein the fluid is chosen from the group consisting of biogas, natural gas, such as liquefied natural gas (LNG), hydrogen, ammonia, nitrogen, oxygen an alkane gas, methanol, ethanol propane, butane gasoline, intermediate fuel oil, synthetic oil, diesel oil, such as marine diesel or electro-fuels, either being in liquid phase or gas phase.

20. A system according to any one of the preceding claims, wherein the said grip and lock of said vessel connector (7) by said gripping device (13) constitute a single mooring point on-board said vessel, such as an only mooring point on-board said vessel.

21. A vessel connector (7) having a longitudinal axis (19) along which the vessel connector (7) extends, a proximal end (20) configured to receive a mooring connection and a distal end (21) opposite the proximal end (20), wherein

- the vessel connector (7) comprising at a distance from the proximal end (20) an elongate section (22) comprising a protrusion (23) arranged closer to the distal end (21) than the elongate section (22), said protrusion being configured to co-operate with a gripping device (13) comprising two prongs (24) dimensioned and shaped to receive the elongate section while preventing the protrusion (23) two pass in-between the prongs (24).

22. A vessel connector according to claim 21, wherein the elongated section (22) is flexible/bendable.

23. A method of mooring of and supply of fluid or mooring of and supply of fluid and supply of electrical power to a vessel, the method comprising:

- providing a system according to any one of the preceding claims at an off-shore position and anchoring the mooring buoy (1) to the seabed;
- connecting the fluid pipe (40) to a fluid source;
- when the system comprising the electric conductive cable connecting the electrical conductive cable (4) to an electric power supply (35);
- navigating a vessel to a position in close proximity to the off-shore position to allow access from the vessel to the vessel connector (7);
- hoisting or winch the vessel connector (7) onboard a vessel and to the gripping device (13);
- engage the gripping device to grip the vessel connector (7) thereby mooring the vessel;
- connect the fluid pipe (40) to a fluid inlet of the vessel, which fluid inlet is configured to lead received fluid to a receptacle, such as a storage tank;
- when the electric conductive cable is present, connect the electric conductive cable (4) to a distribution board (36) of the vessel, which distribution board (36) is configured to distribute electrical power to one or more electrical power consuming devices on-board the vessel, and
- transferring the fluid and when present the electric power to the vessel.

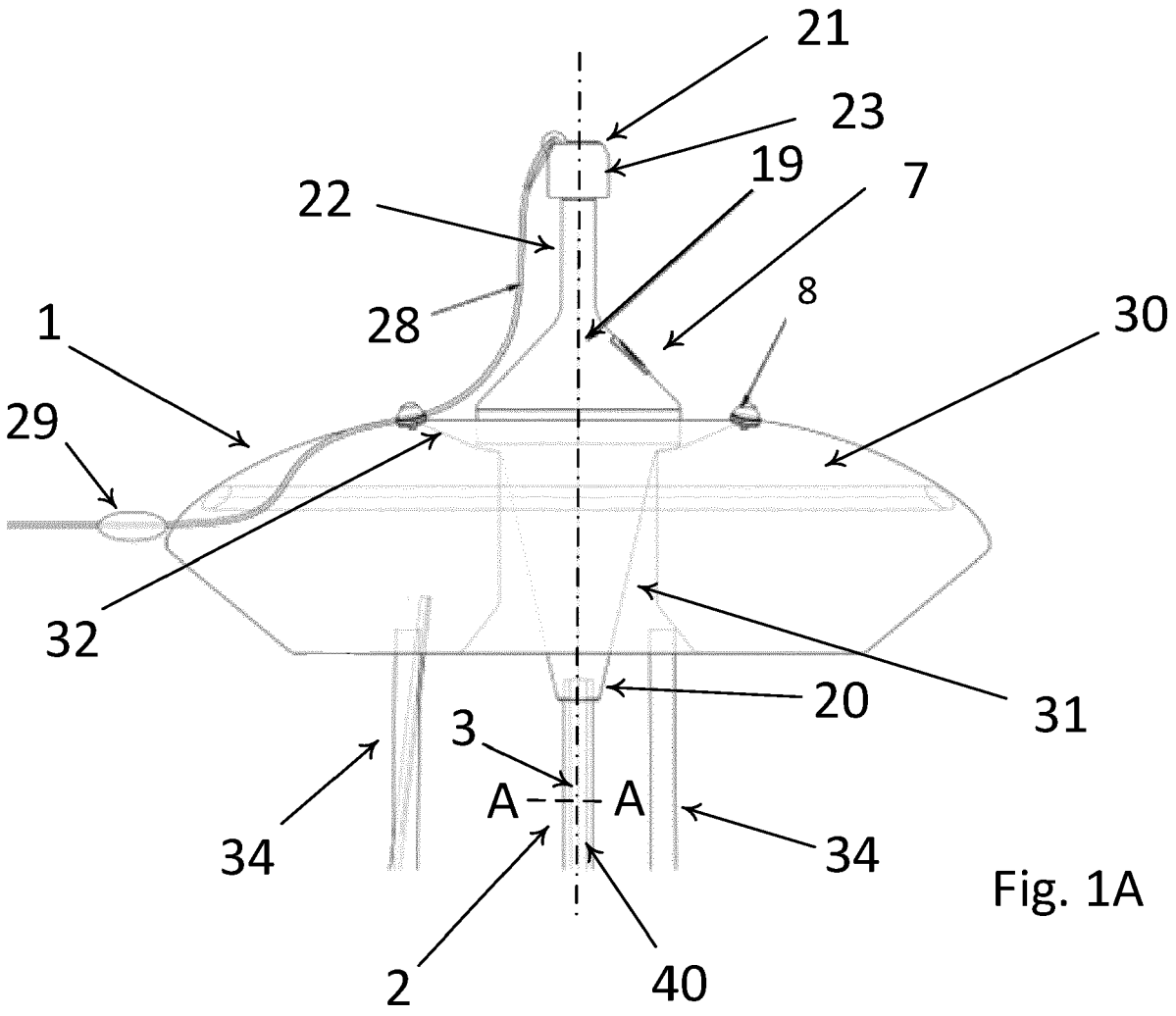

Fig. 1A

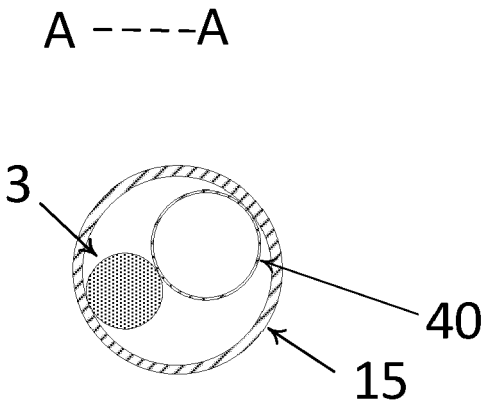

Fig. 1B

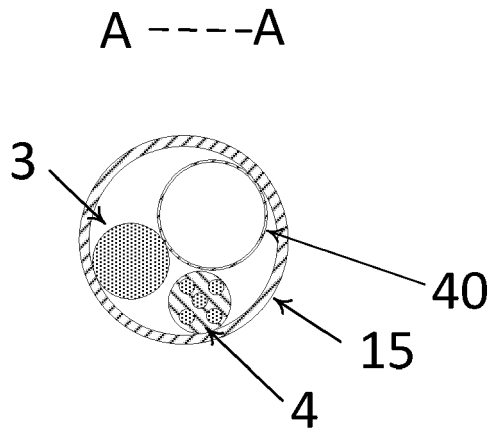

Fig. 1C

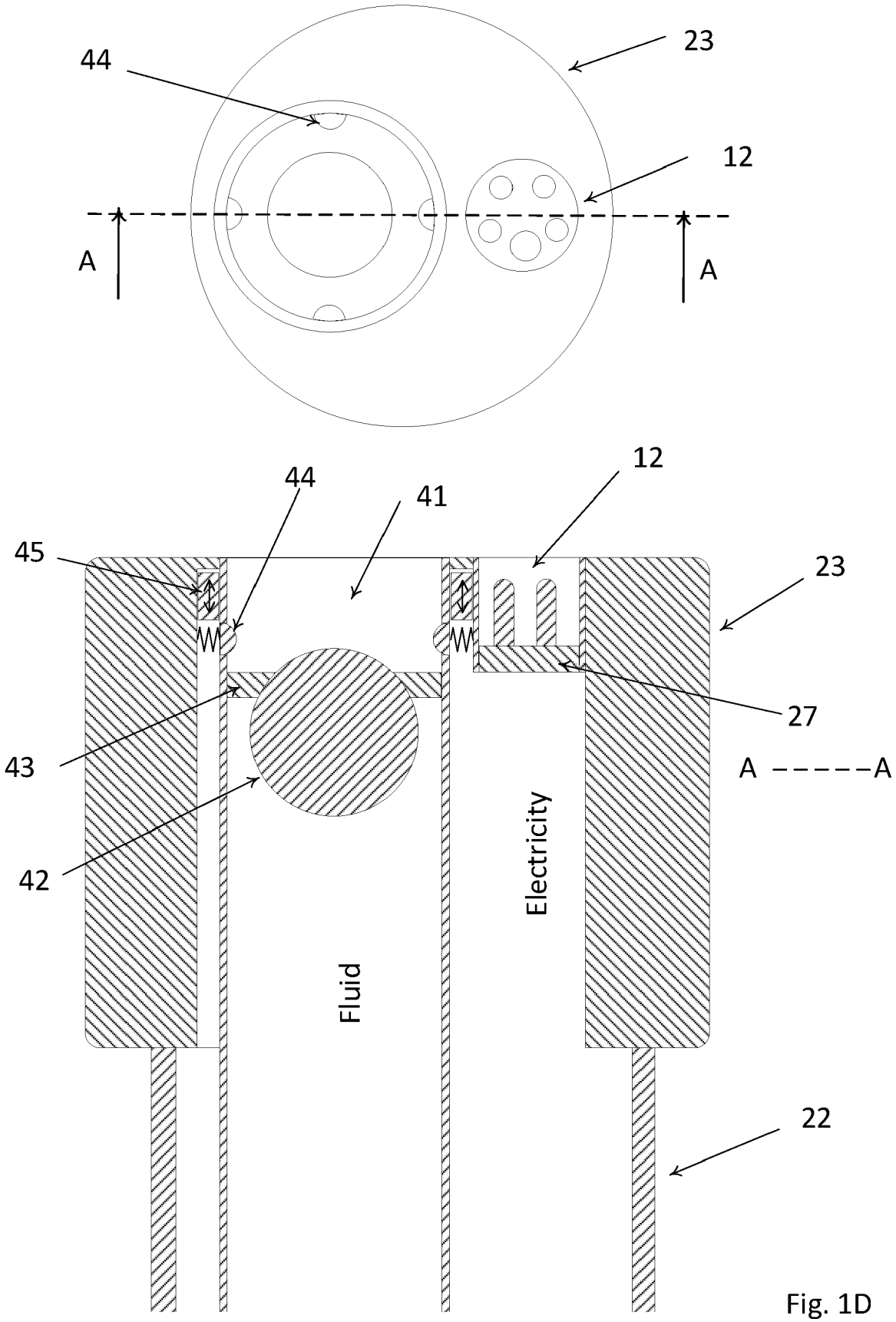

Fig. 1D

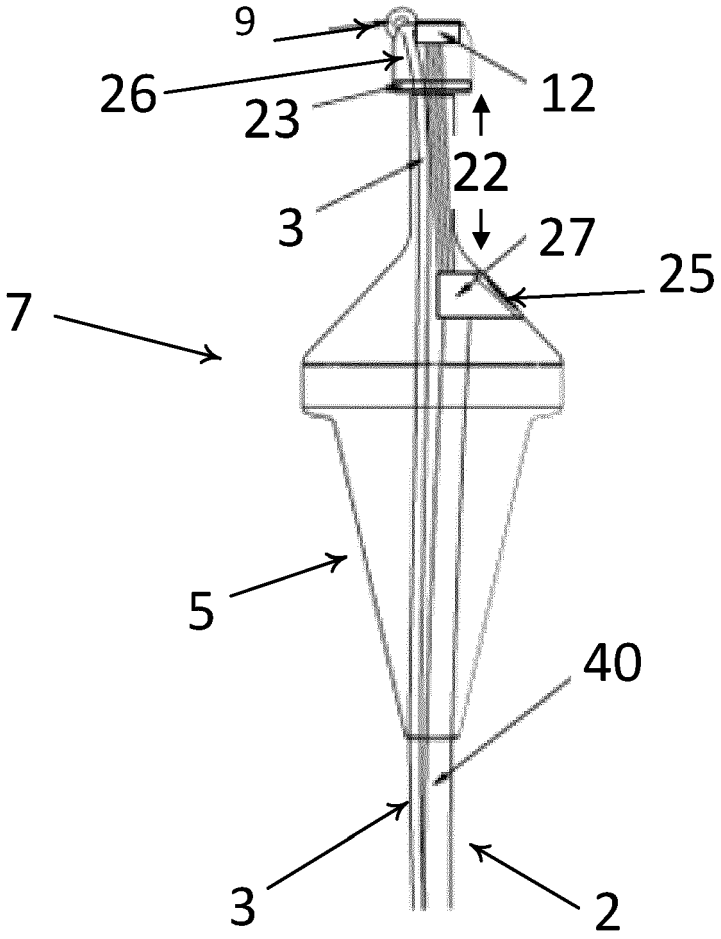

Fig. 2

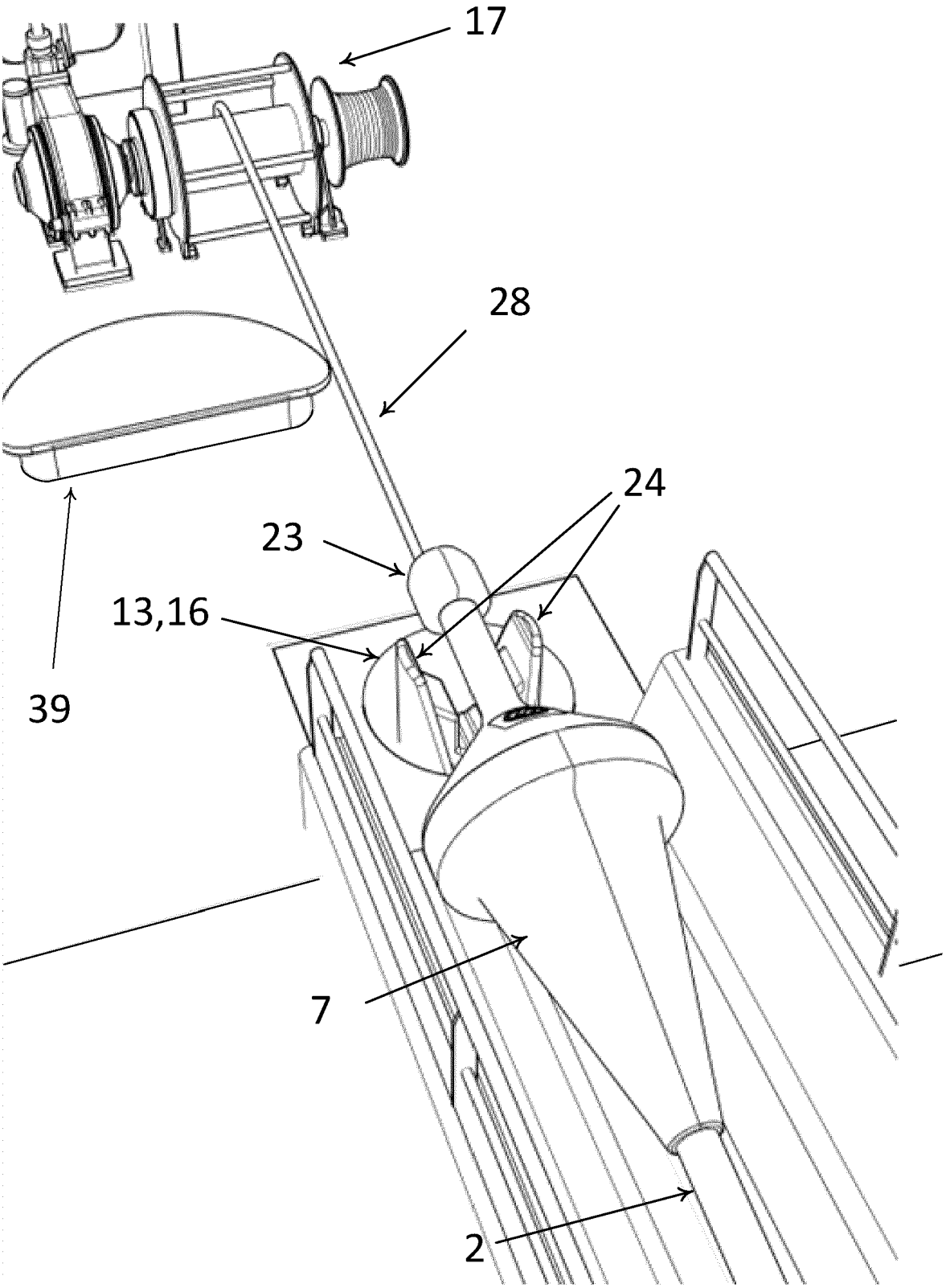

Fig. 3A

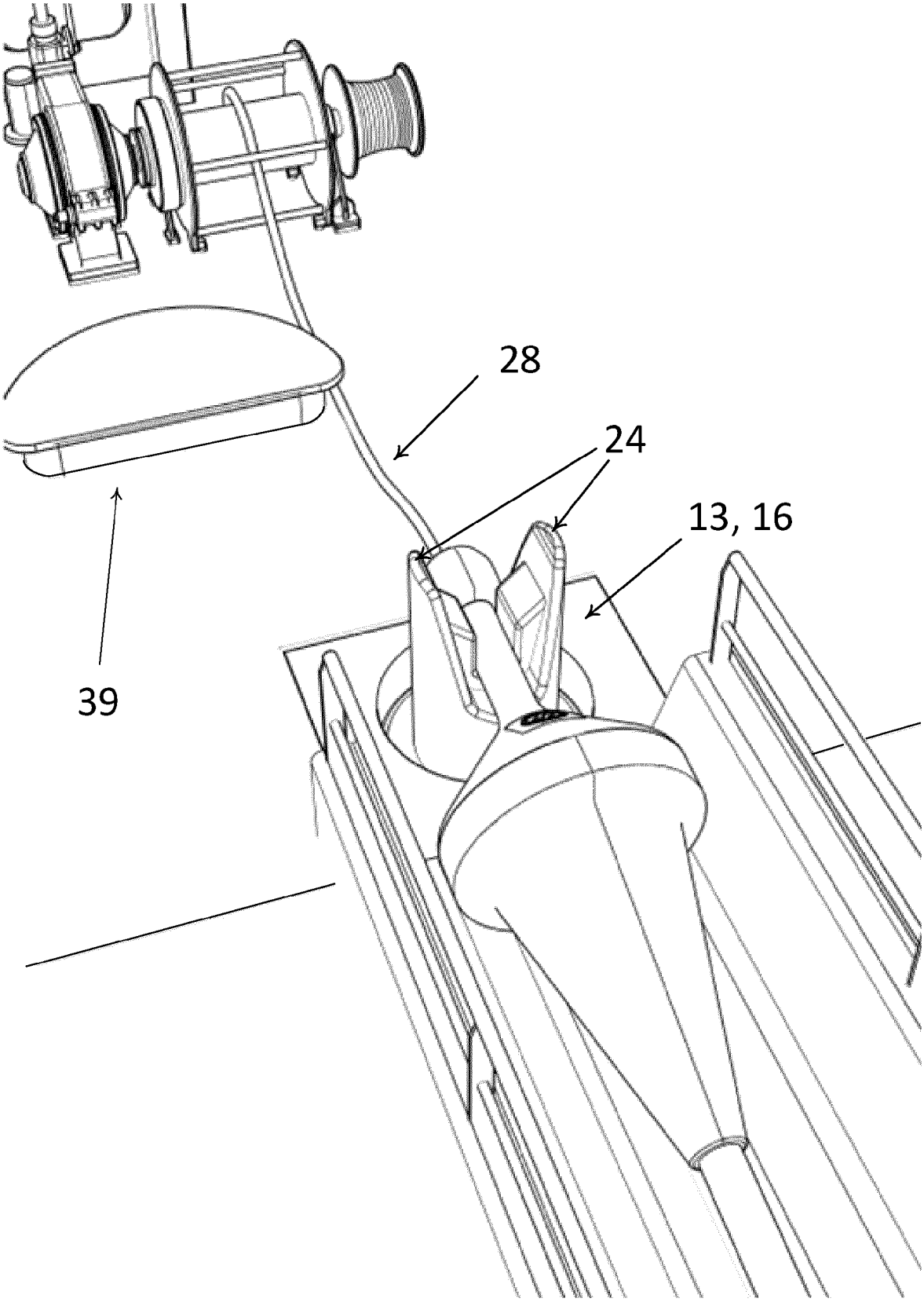

Fig. 3B

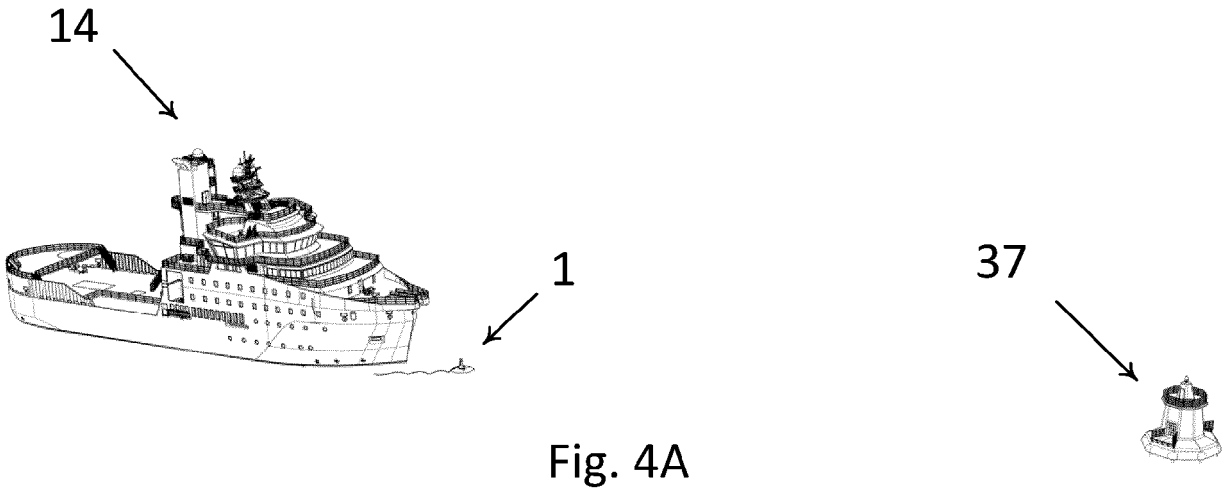

Fig. 4A

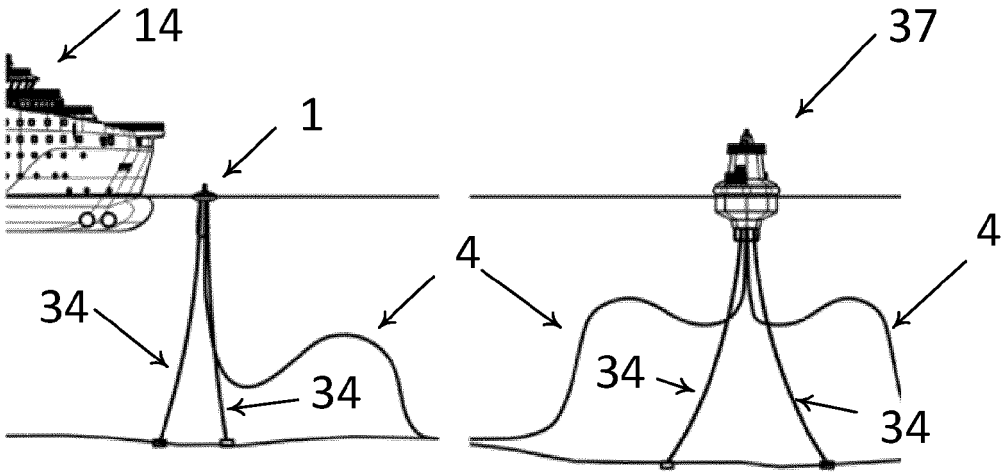

Fig. 4B

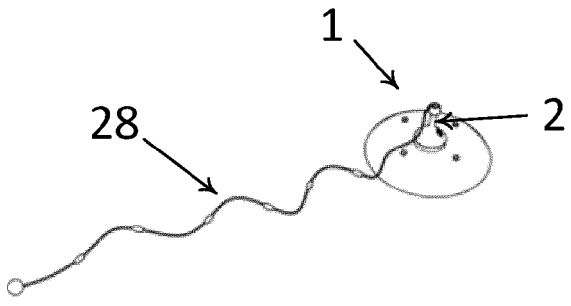

Fig. 4C

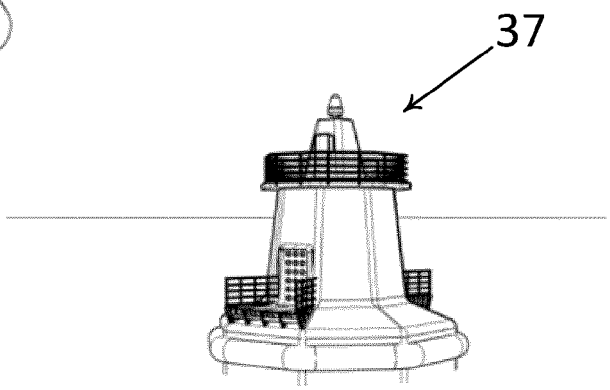

Fig. 4D

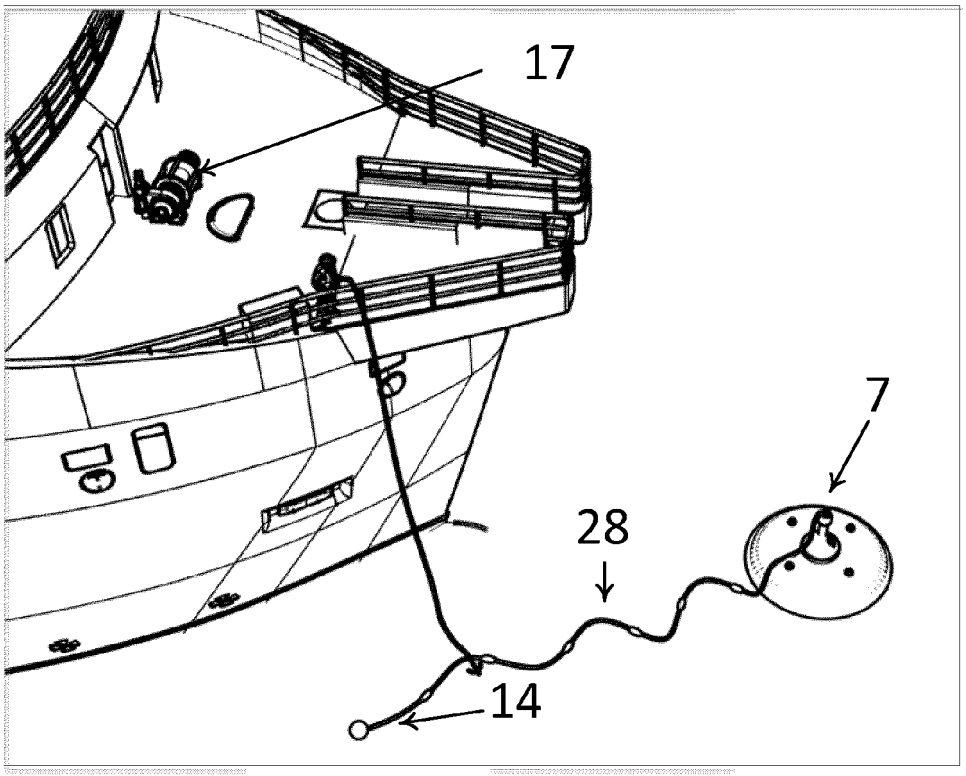

Fig. 4E

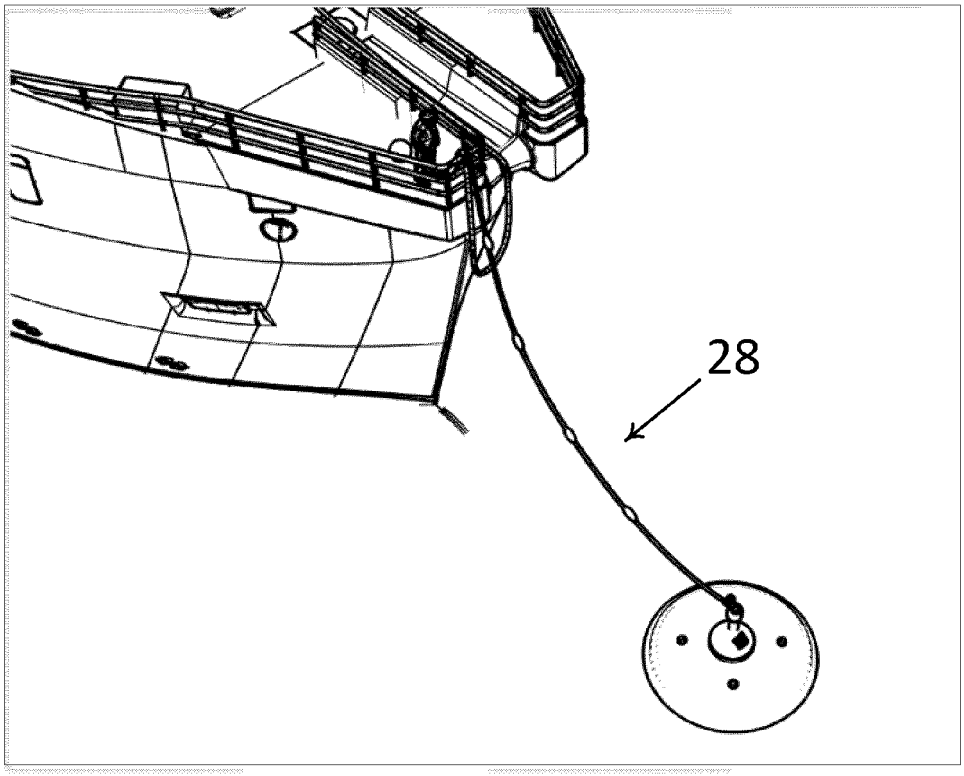

Fig. 4F

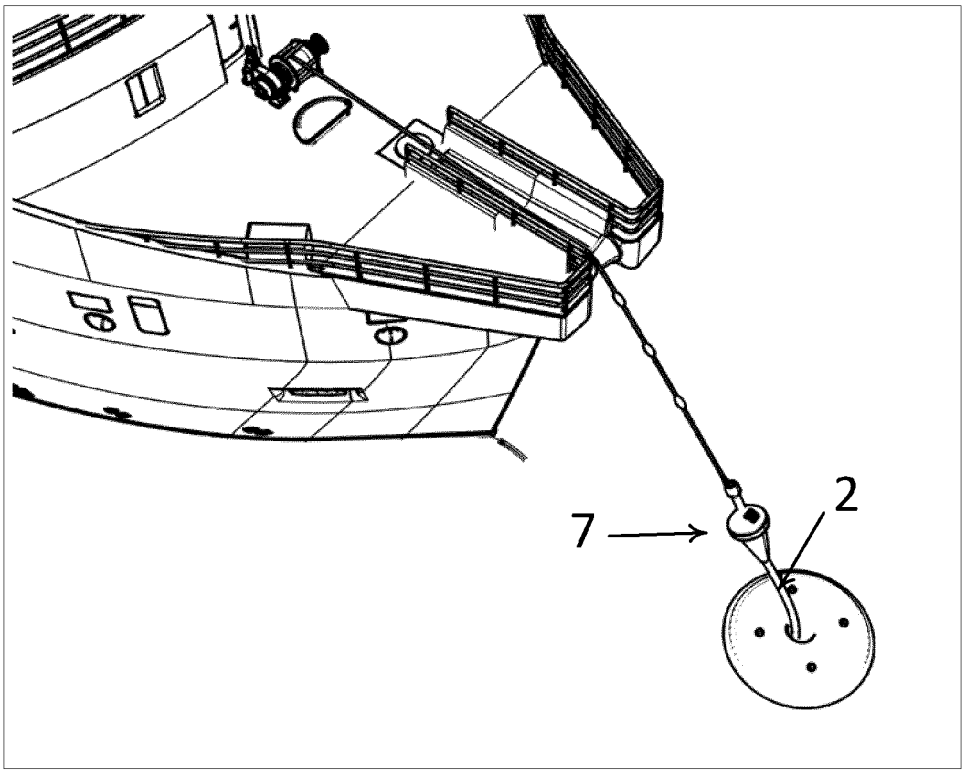

Fig. 4G

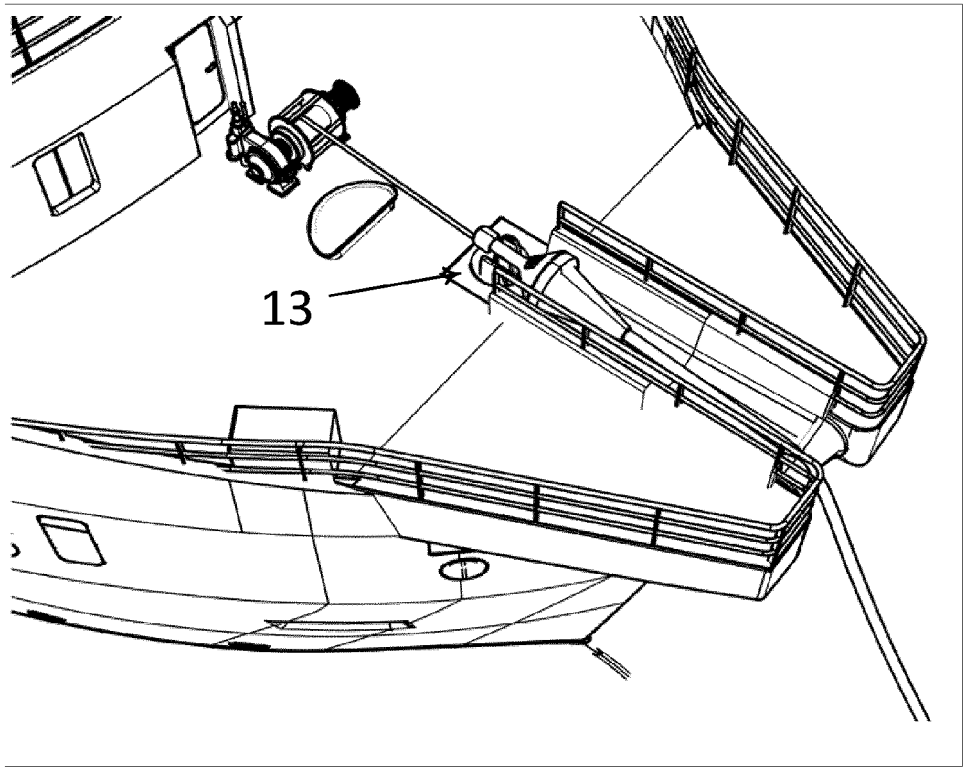

Fig. 4H

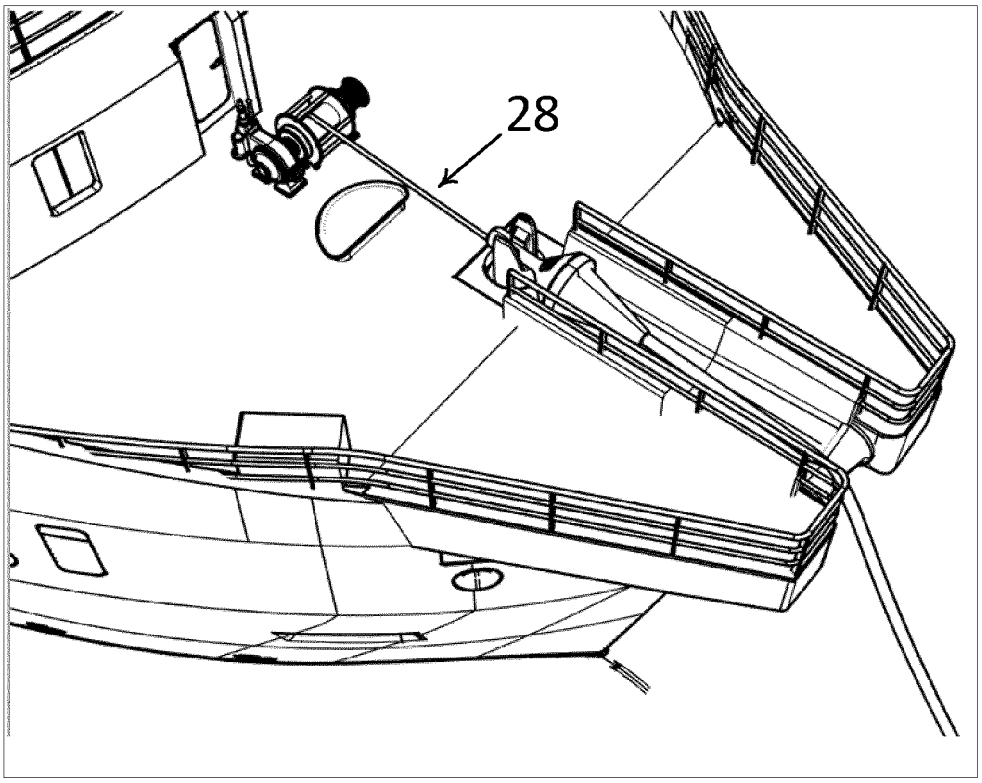

Fig. 4I

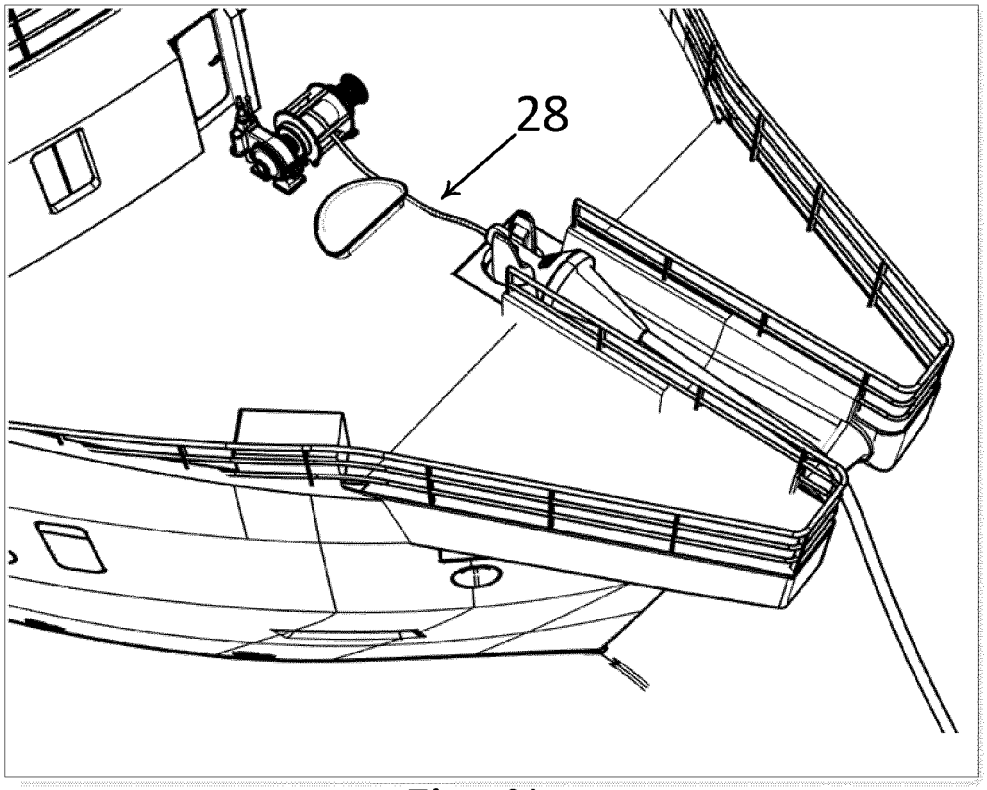

Fig. 4J

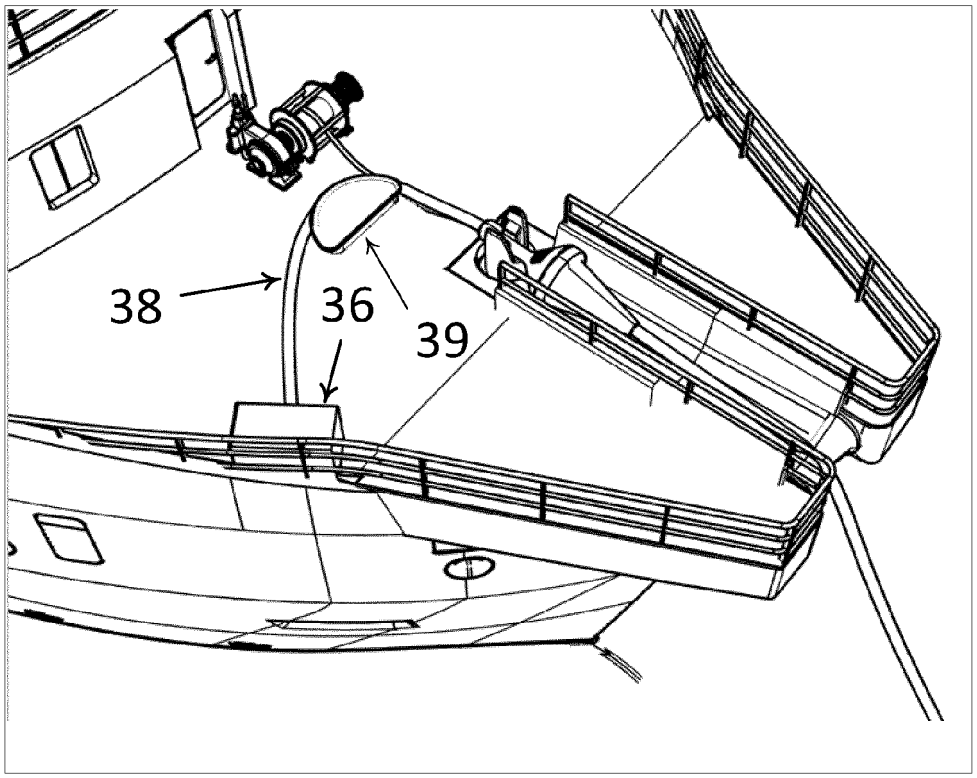

Fig. 4K

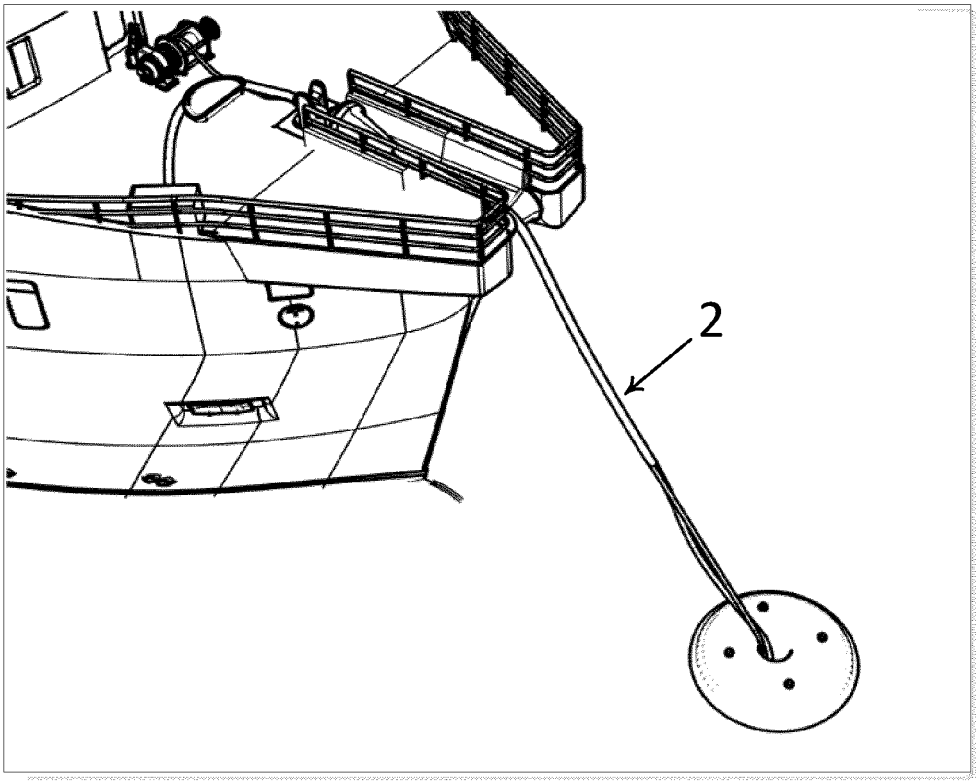

Fig. 4L

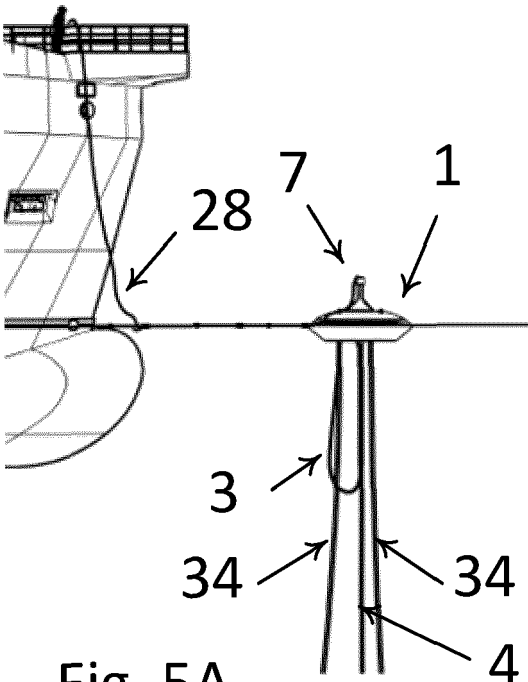

Fig. 5A

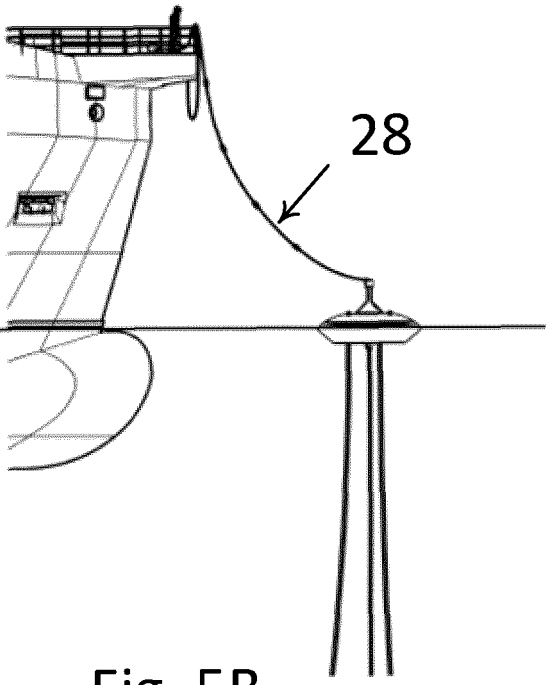

Fig. 5B

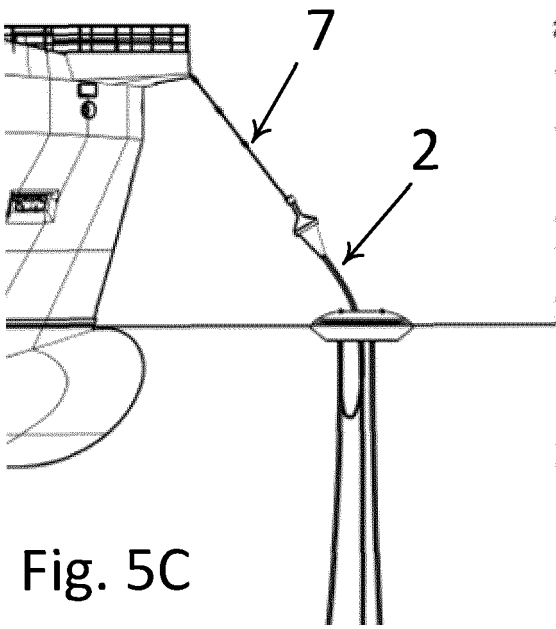

Fig. 5C

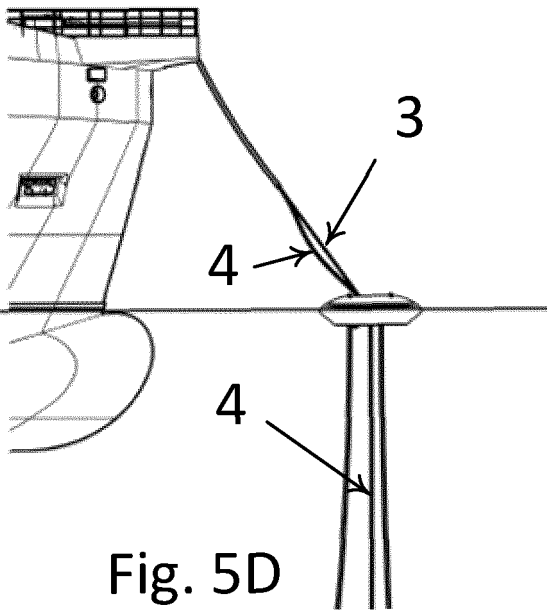

Fig. 5D

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EUROPEAN SEARCH REPORT

Application Number
EP 22 20 1069

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	27 March 2023	Buron, Emmanuel

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 20 1069

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