

**SYSTEMS AND PROCESSES FOR MOORING A VESSEL AND
TRANSFERRING ENERGY TO OR FROM THE VESSEL**

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to U.S. Provisional Patent Application No. 63/607,515, filed on December 7, 2023, which is incorporated by reference herein.

FIELD

[0002] Embodiments described generally relate to offshore systems and processes for mooring vessels and transferring energy to or from the vessel. More specifically, such embodiments relate to mooring a vessel at an offshore location to a buoy that allows the vessel to rotate around the buoy while simultaneously transferring energy to or from the vessel.

BACKGROUND

[0003] In the offshore energy industry, it is common to transfer fluids from a source to a vessel at an offshore location or from a vessel to an onshore or offshore location. Traditionally this has been accomplished via Catenary Anchor Leg Mooring Systems (CALM) and Single Anchor Leg Mooring Systems (SALM) that are configured to transfer a fluid to or from a vessel.

[0004] Recently with the advent of offshore renewable energy, it is now desirable to have systems configured to moor a vessel and to transfer energy in the form of electrical power to the vessel from a power generation location or to transfer energy from the vessel to a power receiving location, respectively, and few options exist.

[0005] There is a need, therefore, for new systems and processes for mooring a vessel and transferring energy to and/or from the vessel.

SUMMARY

[0006] System and processes for mooring a vessel and transferring energy to or from the vessel are provided. In some embodiments, the system can include a buoy that includes a fixed part rotatively coupled to a rotating part. The system can include a first swivel disposed on the buoy that includes a fixed part rotatively coupled to a rotating part. The fixed part of the first swivel can be coupled to the fixed part of the buoy. The rotating part of the first swivel can be configured to rotate with the rotating part of the buoy. A second swivel can be disposed on the buoy comprising a fixed part rotatively coupled to a rotating part. The fixed part of the second swivel can be coupled to the rotating part of the buoy, and a spool can be coupled to and configured to rotate with the rotating part of the second swivel. A central longitudinal axis of

the first swivel is oriented vertically with respect to the buoy and a central longitudinal axis of the second swivel is oriented substantially horizontally with respect to the buoy.

[0007] A process for mooring a vessel is also provided. In some embodiments, the process can include positioning the vessel near an offshore mooring system. In some embodiments, the offshore mooring system can include a buoy that includes a fixed part rotatively coupled to a rotating part. The system can include a first swivel disposed on the buoy comprising a fixed part rotatively coupled to a rotating part. The fixed part of the first swivel can be coupled to the fixed part of the buoy. The rotating part of the first swivel can be configured to rotate with the rotating part of the buoy. A second swivel can be disposed on the buoy comprising a fixed part rotatively coupled to a rotating part. The fixed part of the second swivel can be coupled to the rotating part of the buoy, and a spool can be coupled to and configured to rotate with the rotating part of the second swivel. A central longitudinal axis of the first swivel is oriented vertically with respect to the buoy and a central longitudinal axis of the second swivel is oriented substantially horizontally with respect to the buoy. The process can also include connecting the vessel to the rotating part of the buoy via a hawser.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The various aspects and advantages of the preferred embodiment of the present invention will become apparent to those skilled in the art upon an understanding of the following detailed description of the invention, read in light of the accompanying drawings which are made a part of this specification.

[0009] Figure 1 depicts a partial cross-sectional elevation view of an illustrative system for mooring a vessel that is configured to transfer energy to or from the vessel, according to one or more embodiments described.

[0010] Figure 2 depicts a plan view of the system depicted in Figure 1.

DETAILED DESCRIPTION

[0011] A detailed description will now be provided. Each of the appended claims defines a separate invention, which for infringement purposes is recognized as including equivalents to the various elements or limitations specified in the claims. Depending on the context, all references to the “invention”, in some cases, refer to certain specific or preferred embodiments only. In other cases, references to the “invention” refer to subject matter recited in one or more, but not necessarily all, of the claims. It is to be understood that the following disclosure describes several exemplary embodiments for implementing different features, structures, or functions of the invention. Exemplary embodiments of components, arrangements, and

configurations are described below to simplify the present disclosure; however, these exemplary embodiments are provided merely as examples and are not intended to limit the scope of the invention. Additionally, the present disclosure may repeat reference numerals and/or letters in the various exemplary embodiments and across the figures provided herein. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various exemplary embodiments and/or configurations discussed in the Figures. Moreover, the formation of a first feature over or on a second feature in the description that follows includes embodiments in which the first and second features are formed in direct contact and also includes embodiments in which additional features are formed interposing the first and second features, such that the first and second features are not in direct contact. The exemplary embodiments presented below may be combined in any combination of ways, i.e., any element from one exemplary embodiment may be used in any other exemplary embodiment, without departing from the scope of the disclosure. The figures are not necessarily drawn to scale and certain features and certain views of the figures can be shown exaggerated in scale or in schematic for clarity and/or conciseness.

[0012] Additionally, certain terms are used throughout the following description and claims to refer to particular components. As one skilled in the art will appreciate, various entities may refer to the same component by different names, and as such, the naming convention for the elements described herein is not intended to limit the scope of the invention, unless otherwise specifically defined herein. Also, the naming convention used herein is not intended to distinguish between components that differ in name but not function. Furthermore, in the following discussion and in the claims, the terms “including” and “comprising” are used in an open-ended fashion, and thus should be interpreted to mean “including, but not limited to.”

[0013] All numerical values in this disclosure are exact or approximate values (“about”) unless otherwise specifically stated. Accordingly, various embodiments of the disclosure may deviate from the numbers, values, and ranges disclosed herein without departing from the intended scope.

[0014] Further, the term “or” is intended to encompass both exclusive and inclusive cases, i.e., “A or B” is intended to be synonymous with “at least one of A and B,” unless otherwise expressly specified herein. The indefinite articles “a” and “an” refer to both singular forms (i.e., “one”) and plural referents (i.e., one or more) unless the context clearly dictates otherwise. The terms “up” and “down”; “upward” and “downward”; “upper” and “lower”; “upwardly” and “downwardly”; “above” and “below”; and other like terms used herein refer to relative

positions to one another and are not intended to denote a particular spatial orientation since the apparatus and methods of using the same may be equally effective at various angles or orientations.

[0015] It should also be understood that the phrases “disposed therein”, “disposed within” and other similar phrases, when describing a component, e.g., an arm or ball, describe the component as being partially disposed therein/within or completely disposed therein/within. For example, if the component is a ball disposed on the end of an arm that can be disposed within a socket, the phrase “the ball can be disposed within the socket” means the ball can be disposed partially within the socket or completely within the socket.

[0016] The terms “rotate”, “rotation”, “rotatable”, and “rotating” are used interchangeably and refer to the partial or complete turning of a body around an axis or center point.

[0017] The terms “perpendicular” and “perpendicularly”, as used herein, refer to two lines or vectors that are coplanar and, therefore, do intersect one another at a 90 degree angle. Further, the term “substantially” when used in the context of “substantially perpendicular” means a first line and a second line are orientated at angles of about 80 degrees, about 83 degrees, about 85 degrees, about 87 degrees, or about 89 degrees to, about 91 degrees, about 93 degrees, about 95 degrees, about 97 degrees, or about 100 degrees with respect to one another. Further, the term “substantially” when used in the context of “substantially parallel” means an axis and a plane (e.g., the surface of a body of water) are orientated at angles of about 160 degrees, about 165 degrees, about 170 degrees, about 175 degrees, or about 180, or about 185 degrees, or about 190 degrees, or about 195 degrees, or about 200 degrees with respect to one another.

[0018] The terms “orthogonal” and “orthogonally” refer to two lines or vectors that are not coplanar and therefore do not intersect but can appear to be perpendicular when viewed from a particular angle. For example, a first line being orthogonal to a second line, the first line can lie in a first plane and the second line can lie in a second plane, where the first and second planes are parallel with respect to one another and the first line and the second line are oriented at 90 degrees with respect to one another when viewed along an axis that is normal to the first and second planes. Further it should be understood that the term “substantially” when used in the context of “substantially orthogonal” means the first and second lines are orientated at angles of about 80 degrees, about 83 degrees, about 85 degrees, about 87 degrees, or about 89 degrees to, about 91 degrees, about 93 degrees, about 95 degrees, about 97 degrees, or about 100 degrees with respect to one another when viewed along an axis that is normal to the first and second planes.

[0019] A global effort to reduce carbon emissions and pollution has led to the review of trends in the marine industry. One area of interest is expanding the use of onshore electric power and renewable energy as fuel sources. Vessels at sea or in a harbor that are not quayside are not typically afforded the benefit of onshore electric power, which allows the vessel to switch off on-board fossil fuel engines and/or battery systems. Additionally, in the near future, similar to the Electric Vehicles (EVs), it is expected that offshore vessels such as tugboats, crew transfer vessels (CTVs), service operation vessels (SOVs), and other vessels will be fully electric. As such, there is a need for offshore electric charging stations.

[0020] Figure 1 depicts a partial cross-sectional elevation view of an illustrative system 100 for mooring a vessel that is configured to transfer energy to or from the vessel, according to one or more embodiments. Figure 2 depicts a plan view of the system 100 shown in Figure 1. The system 100 can include a buoy 103, a first swivel 109, a second swivel 115, and a spool 121. The buoy 103 can be a turret buoy or a turntable buoy. The buoy 103 can include a fixed part 105 rotatively coupled to a rotating part 107. The fixed part 105 of the buoy 103 can be moored to a seabed via a plurality of mooring lines (two are shown, 104). The system 100 can also include a hawser system 106 that can be configured to moor the vessel to the rotating part 107 of the buoy 103 such that the vessel is permitted to rotate with the rotating part 107 of the buoy 103 about the fixed part 105 of the buoy 103.

[0021] In some embodiments, the fixed part 105 of the buoy 103 can be rotatively connected to the rotating part 107 of the buoy 103 via a bearing arrangement 108. The bearing arrangement 108 can be configured to allow the rotating part 107 of the buoy 103 to rotate about the fixed part 105 of the buoy 103. In some embodiments, the bearing arrangement 108 can be configured to support an axial load, a horizontal load, and an overturning moment load. In some embodiments, the bearing arrangement 108 can be or can include, but is not limited to, a plain bearing; a three-race roller bearing; a slewing bearing, e.g., a slow-rotating slew bearing with multi-race cylindrical rollers; a yaw bearing, e.g., a roller yaw bearing or a gliding yaw bearing. Bearing arrangements suitable for use in rotatively coupling the fixed part 105 of the buoy 103 to the rotating part 107 of the buoy 103 are well known to those skilled in the art.

[0022] The first swivel 109 can include a fixed part 111 rotatively coupled to a rotating part 113 of the first swivel 109. The first swivel 109 can be disposed on the buoy 103. More particularly, the fixed part 111 of the first swivel 109 can be coupled to or otherwise disposed

on the fixed part 105 of the buoy 103. The rotating part 113 of the first swivel 109 can be configured to rotate with the rotating part 107 of the buoy 103.

[0023] The second swivel 115 can include a fixed part 117 rotatively coupled to a rotating part 119 of the second swivel 115. The second swivel 115 can be disposed on the buoy 103. More particularly, the fixed part 117 of the second swivel 115 can be coupled to or otherwise disposed on the rotating part 107 of the buoy 103. As such, the fixed part 117 of the second swivel 115 can be configured to rotate with the rotating part 107 of the buoy 103. The spool 121 can be coupled to and configured to rotate with the rotating part 119 of the second swivel 115.

[0024] In some embodiments, the first swivel 109 can be a first slip ring and the second swivel 115 can be a second slip ring. In such embodiments, the first and second slip rings 109, 115 can be configured to conduct electricity therethrough while the rotating parts 113, 119 of the first and second slip rings 109, 115 rotate relative to the fixed parts 111, 117 of the first and second slip rings 109, 115, respectively. In some embodiments, the first and second slip rings 109, 115 can be configured to transmit an electric power of at least 1 MW, at least 3 MW, at least 5 MW, at least 10 MW, at least 15 MW, or at least 20 MW. In other embodiments, the first swivel 109 can be a first fluid swivel and the second swivel 115 can be a second fluid swivel. In such embodiments, the first and second fluid swivels 109, 115 can each define at least one flow path therethrough that can be configured to convey a fluid therethrough while the rotating parts 113, 119 of the first and second fluid swivels 109, 115 rotate relative to the fixed parts 111, 117 of the first and second fluid swivels. In some embodiments, the first and second fluid swivels can be configured to transfer water, one or more hydrocarbons, ammonia, carbon monoxide, carbon dioxide, one or more alcohols, or any combination thereof.

[0025] A central longitudinal axis 123 of the first swivel 109 can be oriented vertically with respect to the buoy 103 and a central longitudinal axis 125 of the second swivel 115 can be oriented substantially horizontally with respect to the buoy 103. In some embodiments, the central longitudinal axis 123 of the first swivel 109 and the central longitudinal axis 125 of the second swivel 115 can be substantially perpendicular with respect to one another. In some embodiments, the central longitudinal axis 123 of the first swivel 109 and the central longitudinal axis 125 of the second swivel 115 can intersect and be perpendicular with respect to one another. In other embodiments, the central longitudinal axis 123 of the first swivel 109 and the central longitudinal axis 125 of the second swivel 115 can be skewed with respect to one another. In still other embodiments, the central longitudinal axis 123 of the first swivel

109 can lie in a first plane and the central longitudinal axis 125 of the second swivel 115 can lie in a second plane, where the first and second planes are parallel with respect to one another and the central longitudinal axis 123 of the first swivel 109 and the central longitudinal axis 125 of the second swivel 115 are oriented at 90 degrees with respect to one another when viewed along an axis that is normal to the first and second planes. In other embodiments, the central longitudinal axis 123 of the first swivel 109 and an axis of rotation of the rotating part 107 of the buoy 103 can be colinear and the central longitudinal axis 125 of the second swivel 115 can be oriented substantially horizontally with respect to the buoy 103.

[0026] In some embodiments, when the first and second swivels 109, 115 are slip rings, the system 100 can further include a first conduit 127 and a second conduit 133, where the first and second conduits 127, 133 are configured to transfer electricity therethrough. The first conduit 127 can have a first end 129 connected to the rotating part 113 of the first swivel 109 and a second end 131 connected to the fixed part 117 of the second swivel 115. The second conduit 133 can have a first end 135 connected to the rotating part 119 of the second swivel 115 and a second end 137 configured to be connected to the vessel (not shown) when the vessel is moored to the buoy 103. In such embodiments, the fixed part 111 of the first swivel 109 can be configured to connect to a first end 141 of a subsea conduit 139 configured to transfer electricity therethrough and a second end 143 of the subsea conduit 139 can be configured to connect to a source/sink 145 that can provide electricity to the subsea conduit 139 or receive electricity from the subsea conduit 139. In some embodiments, when the first and second swivels 109, 115 are slip rings, the source 145 can be or can include, but is not limited to, one or more wind turbine generators, one or more hydrocarbon driven generators, one or more onshore or offshore electrical generation facilities, one or more batteries, one or more solar panels or any combination thereof.

[0027] In other embodiments, when the first and second swivels 109, 115 are fluid swivels, the system 100 can further include the first conduit 127 and the second conduit 133, where the first and second conduits 127, 133 are configured to transfer a fluid therethrough. In such embodiments, the subsea conduit 139 can also be configured to transfer a fluid therethrough and the source/sink 145 can be configured to provide one or more fluids to the subsea conduit 139 or receive one or more fluids from the subsea conduit 139.

[0028] In some embodiments, the system 100 can also include one or more electrical motors 147 disposed on the rotating part 107 of the buoy 103. The electrical motor 147 can be configured to rotate the spool 121 in a payout direction and in a retrieval direction. In some

embodiments, the first conduit 127 can be configured to provide electrical power to the electrical motor 147. In some embodiments, a transformer can be used to adjust a voltage of the electricity being transferred via the first conduit 127 so that the voltage provided to the electrical motor 147 corresponds to the voltage needed to operate the electrical motor 147. In such embodiments, one or more additional conduits can be used to provide electrical power to the electrical motor 147. In other embodiments, the system 100 can further include one or more batteries 149 disposed on the rotating part 107 of the buoy 103. In such embodiments, the one or more batteries 149 can be configured to provide electrical power to the motor 147. In some embodiments, the system 100 can further include one or more solar panels 151 disposed on the rotating part 107 of the buoy 103, as shown, or on the fixed part 105 of the buoy 103, not shown. In such embodiments, the one or more solar panels 151 can be configured to charge the one or more batteries 149 and/or to provide electrical power to the motor 147. In other embodiments, the one or more batteries 149 can be configured to be charged via the subsea conduit 139, when the subsea conduit 139 is configured to transfer electrical power from the source 145 to the buoy 103.

[0029] In some embodiments, the second conduit 133 can be configured to be coiled about the spool 121 when the second conduit 133 is disconnected from the vessel. In other embodiments, a first portion or segment of the second conduit 133 can be configured to be coiled about the spool 121 when disconnected from the vessel and a second portion or segment of the second conduit 133 can be configured to float on a surface of a body of water when disconnected from the vessel. In some embodiments, the second electrical conduit 133 can be configured to be at least partially coiled about the spool 121 when disconnected from the vessel and to at least partially float on a surface of a body of water when connected to the vessel.

[0030] In some embodiments, the system 100 can also include a switch or valve 153 and a remote telemetry system 155. When the system 100 includes the switch 153, the switch 153 can be disposed on the rotating part 107 of the buoy 103 and configured to electrically isolate the second conduit 133 from the electrical power source/sink 145, when the first, second, and third conduits 127, 133, 139 are configured to transfer electrical power therethrough. In other embodiments, when the system 100 includes the valve 153, the valve 153 can be disposed on the rotating part 107 of the buoy 103 and configured to fluidly isolate the second conduit 133 from the fluid source/sink 145. The remote telemetry system 155 can be configured to control the electric motor 147 and the switch 153 from a remote location. In some embodiments, the

remote telemetry system 155 can be configured to be controlled via a wireless control unit, a subsea control unit, or an onshore control unit.

[0031] In some embodiments, the system 100 can also include a drive system 159 that can be disposed on the buoy 103 and configured to rotate the rotating part 107 of the buoy 103 with respect to the fixed part 105 of the buoy 103. In such embodiments, when the vessel is moored to the buoy 103, the drive system 159 can be configured to rotate the rotating part 107 of the buoy 103 to reduce a lag between a rate of rotation of the rotating part 107 of the buoy 103 with respect to a rate of rotation of the vessel about the buoy 103. The drive system 159 can include a drive motor connected to an engageable pinion and a circular rack. In some embodiments, the drive motor and the engageable pinion of the drive system 159 can be disposed on the rotating part 107 of the buoy 103 and the circular rack can be disposed on the fixed part 105 of the buoy 103. In other embodiments, the drive motor and engageable pinion of the drive system 159 can be disposed on the fixed part 105 of the buoy 103 and the circular rack of the drive system 159 can be disposed on the rotating part 107 of the buoy 103. In some embodiments the drive system 159 can be powered by the battery 149 and/or the solar panels 151 disposed on the buoy 103. In other embodiments, the drive system can be powered via electrical power provided via the subsea conduit 139 when the subsea conduit transfers electrical power from the source 145.

[0032] In some embodiments, a process for mooring a vessel can include positioning the vessel near the system 100. The process can also include connecting the vessel to the rotating part 107 of the buoy 103. In some embodiments, when the first swivel 109 and the second swivel 115 are each slip rings configured to conduct electricity therethrough while the rotating part of the first and second slip rings rotate relative to the fixed part of the first and second slip rings and when the second electrical conduit is at least partially coiled about the spool, the process can also include operating the spool 121 in a payout direction to cause the second end 137 of the second electrical conduit 133 to deploy from the spool 121. The process can also include connecting the second end 137 of the second electrical conduit 133 to the vessel to provide electrical power thereto.

[0033] In some embodiments, the process can also include rotating the rotating part 107 of the buoy 103 with respect to the fixed part 105 of the buoy 103 via the drive system 1059 prior to or during connection of the vessel to the buoy 103. In some embodiments, the process can also include rotating the rotating part 107 of the buoy 103 with respect to the fixed part 105 of the

buoy 103 via the drive system 159 prior to or during connection of the second end 137 of the second electrical conduit 133 to the vessel.

[0034] The present disclosure relates to any one or more of the following numbered embodiments:

[0035] A1. A system for mooring a vessel, comprising: a buoy comprising a fixed part rotatively coupled to a rotating part; a first swivel disposed on the buoy comprising a fixed part rotatively coupled to a rotating part, wherein the fixed part of the first swivel can be coupled to the fixed part of the buoy, and wherein the rotating part of the first swivel can be configured to rotate with the rotating part of the buoy; a second swivel disposed on the buoy comprising a fixed part rotatively coupled to a rotating part, wherein the fixed part of the second swivel can be coupled to the rotating part of the buoy; and a spool coupled to and configured to rotate with the rotating part of the second swivel, wherein a central longitudinal axis of the first swivel can be oriented vertically with respect to the buoy and a central longitudinal axis of the second swivel can be oriented substantially horizontally with respect to the buoy.

[0036] A2. A system for mooring a vessel, comprising: a buoy comprising a fixed part rotatively coupled to a rotating part; a first swivel disposed on the buoy comprising a fixed part rotatively coupled to a rotating part, wherein the fixed part of the first swivel can be coupled to the fixed part of the buoy, and wherein the rotating part of the first swivel can be configured to rotate with the rotating part of the buoy; a second swivel disposed on the buoy comprising a fixed part rotatively coupled to a rotating part, wherein the fixed part of the second swivel can be coupled to the rotating part of the buoy; and a spool coupled to and configured to rotate with the rotating part of the second swivel, wherein a central longitudinal axis of the first swivel and an axis of rotation of the rotating part of the buoy are colinear and a central longitudinal axis of the second swivel can be oriented substantially horizontally with respect to the buoy.

[0037] A3. The system of A1 or A2, wherein: the first swivel is a first slip ring, the second swivel is a second slip ring, and the first and second slip rings are each configured to conduct electricity therethrough while the rotating part of the first and second slip rings rotate relative to the fixed part of the first and second slip rings.

[0038] A4. The system of A3, further comprising: a first electrical conduit having a first end connected to the rotating part of the first swivel and a second end connected to the fixed part of the second swivel; and a second electrical conduit having a first end connected to the rotating part of the second swivel and a second end configured to be connected to the vessel when the vessel is moored to the buoy.

[0039] A5. The system of A4, wherein the fixed part of the first swivel is configured to connect to a first end of a subsea electrical conduit, and wherein a second end of the subsea electrical conduit is configured to connect to an electrical power source.

[0040] A6. The system of A5, wherein the electrical power source comprises one or more wind turbine generators.

[0041] A7. The system of any one of A4 to A6, further comprising an electrical motor disposed on the rotating part of the buoy, wherein the electrical motor is configured to rotate the spool in a payout direction and in a retrieval direction.

[0042] A8. The system of any one of A4 to A7, wherein the second electrical conduit is configured to be at least partially coiled about the spool when disconnected from the vessel and to at least partially float on a surface of a body of water when connected to the vessel.

[0043] A9. The system of A7 or A8, wherein the first electrical conduit is configured to provide electrical power to the electrical motor.

[0044] A10. The system of any one of A7 to A9, further comprising a battery configured to provide electrical power to the electrical motor.

[0045] A11. The system of A10, wherein the battery is configured to be charged via a solar panel disposed on the buoy or via the subsea electrical conduit.

[0046] A12. The system of any one of A4 to A11, further comprising a switch and a remote telemetry system, wherein: the switch is disposed on the buoy and configured to electrically isolate the second electrical conduit from the electrical power source, and the remote telemetry system is configured to control the electric motor and the switch from a remote location.

[0047] A13. The system of A12, wherein the remote telemetry system is configured to be controlled via a wireless control unit, via a subsea control conduit, or via an onshore control unit.

[0048] A14. The system of A1 or A2, wherein: the first swivel is a first fluid swivel, the second swivel is a second fluid swivel, and the first and second fluid swivels each define at least one flow path therethrough configured to convey a fluid therethrough while the rotating part of the first and second fluid swivels rotate relative to the fixed part of the first and second fluid swivels.

[0049] A15. The system of A14, further comprising: a first fluid conduit having a first end connected to the rotating part of the first fluid swivel and a second end connected to the fixed part of the second fluid swivel; and a second fluid conduit having a first end connected to the

rotating part of the second fluid swivel and a second end configured to be connected to the vessel when the vessel is moored to the buoy.

[0050] A16. The system of A15, wherein the fixed part of the first fluid swivel is configured to connect to a first end of a subsea fluid conduit, and wherein a second end of the subsea fluid conduit is configured to connect to a fluid source.

[0051] A17. The system of any one of A14 to A16, further comprising an electrical motor disposed on the rotating part of the buoy, wherein the electrical motor is configured to rotate the spool in a payout direction and in a retrieval direction, and wherein the second fluid conduit is configured to be at least partially coiled about the spool when disconnected from the vessel and to float on a surface of a body of water when connected to the vessel.

[0052] A18. The system of A17, further comprising a battery and a solar panel disposed on the rotating part of the buoy, wherein the solar panel is configured to charge the battery, and wherein the battery is configured to provide electrical power to the electrical motor.

[0053] A19. The system of any one of A1 to A18, further comprising a drive system disposed on the buoy configured to rotate the rotating part of the buoy with respect to the fixed part of the buoy.

[0054] A20. The system of A19, where, when the vessel is moored to the buoy, the drive system is configured to rotate the rotating part of the buoy to reduce a lag between a rate of rotation of the rotating part of the buoy with respect to a rate of rotation of the vessel about the buoy.

[0055] A21. The system of A19 or A20, wherein the drive system comprises a drive motor connected to an engageable pinion and a circular rack.

[0056] A22. The system of any one of A19 to A21, wherein the drive system is powered by a battery disposed on the buoy.

[0057] A23. The system of A21 or A22, wherein the drive motor and the engageable pinion are disposed on the rotating part of the buoy and the circular rack is disposed on the fixed part of the buoy.

[0058] A24. The system of A21 or A22, wherein the drive motor and engageable pinion are disposed on the fixed part of the buoy and the circular rack is disposed on the rotating part of the buoy.

[0059] A25. The system of any one of A1 to A24, wherein the buoy is a turret buoy.

[0060] A26. The system of any one of A1 to A24, wherein the buoy is a turntable buoy.

[0061] A27. The system of any one of A1 to A26, further comprising a mooring leg configured to moor the buoy to a seabed and a hawser system configured to moor the vessel to the rotating part of the buoy.

[0062] B1. A process for mooring a vessel, comprising: positioning the vessel near an offshore mooring system, wherein the offshore mooring system comprises: a buoy comprising a fixed part rotatively coupled to a rotating part; a first swivel disposed on the buoy comprising a fixed part rotatively coupled to a rotating part, wherein the fixed part of the first swivel is coupled to the fixed part of the buoy, and wherein the rotating part of the first swivel is configured to rotate with the rotating part of the buoy; a second swivel disposed on the buoy comprising a fixed part rotatively coupled to a rotating part, wherein the fixed part of the second swivel is coupled to the rotating part of the buoy; and a spool coupled to and configured to rotate with the rotating part of the second swivel, wherein a central longitudinal axis of the first swivel is oriented vertically with respect to the buoy and a central longitudinal axis of the second swivel is oriented substantially horizontally with respect to the buoy; and connecting the vessel to the rotating part of the buoy via a hawser.

[0063] B2. A process for mooring a vessel, comprising: positioning the vessel near an offshore mooring system, wherein the offshore mooring system comprises: a buoy comprising a fixed part rotatively coupled to a rotating part; a first swivel disposed on the buoy comprising a fixed part rotatively coupled to a rotating part, wherein the fixed part of the first swivel is coupled to the fixed part of the buoy, and wherein the rotating part of the first swivel is configured to rotate with the rotating part of the buoy; a second swivel disposed on the buoy comprising a fixed part rotatively coupled to a rotating part, wherein the fixed part of the second swivel is coupled to the rotating part of the buoy; and a spool coupled to and configured to rotate with the rotating part of the second swivel, wherein a central longitudinal axis of the first swivel and an axis of rotation of the rotating part of the buoy are colinear and a central longitudinal axis of the second swivel is oriented substantially horizontally with respect to the buoy; and connecting the vessel to the rotating part of the buoy.

[0064] B3. The process of B1 or B2, wherein the first swivel and the second swivel are each slip rings configured to conduct electricity therethrough while the rotating part of the first and second slip rings rotate relative to the fixed part of the first and second slip rings, wherein the system further comprises: a first electrical conduit having a first end connected to the rotating part of the first swivel and a second end connected to the fixed part of the second swivel; a second electrical conduit having a first end connected to the rotating part of the second swivel

and a second end configured to be connected to the vessel when the vessel can be moored to the buoy; and a subsea electrical conduit having a first end connected to the fixed part of the first swivel and a second end connected to an electrical power source.

[0065] B4. The process of B3, wherein the second electrical conduit is at least partially coiled about the spool, the process further comprising: operating the spool in a payout direction to cause the second end of the second electrical conduit to deploy from the spool; and connecting the second end of the second electrical conduit to the vessel to provide electrical power thereto.

[0066] B5. The process of B3 or B4, wherein the buoy further comprises a drive system disposed on the buoy, the process further comprising rotating the rotating part of the buoy with respect to the fixed part of the buoy via the drive system prior to or during connection of the vessel to the buoy.

[0067] B6. The process of B3 or B4, wherein the buoy further comprises a drive system disposed on the buoy, the process further comprising rotating the rotating part of the buoy with respect to the fixed part of the buoy via the drive system prior to or during connection of the second end of the second electrical conduit to the vessel.

[0068] Certain embodiments and features have been described using a set of numerical upper limits and a set of numerical lower limits. It should be appreciated that ranges including the combination of any two values, e.g., the combination of any lower value with any upper value, the combination of any two lower values, and/or the combination of any two upper values are contemplated unless otherwise indicated. Certain lower limits, upper limits and ranges appear in one or more claims below. All numerical values are "about" or "approximately" the indicated value, and take into account experimental error and variations that would be expected by a person having ordinary skill in the art.

[0069] Various terms have been defined above. To the extent a term used in a claim can be not defined above, it should be given the broadest definition persons in the pertinent art have given that term as reflected in at least one printed publication or issued patent. Furthermore, all patents, test procedures, and other documents cited in this application are fully incorporated by reference to the extent such disclosure can be not inconsistent with this application and for all jurisdictions in which such incorporation can be permitted.

[0070] While certain preferred embodiments of the present invention have been illustrated and described in detail above, it can be apparent that modifications and adaptations thereof will occur to those having ordinary skill in the art. It should be, therefore, expressly understood

that such modifications and adaptations may be devised without departing from the basic scope thereof, and the scope thereof can be determined by the claims that follow.

Claims:

What is claimed is:

1. A system for mooring a vessel, comprising:
 - a buoy comprising a fixed part rotatively coupled to a rotating part;
 - a first swivel disposed on the buoy comprising a fixed part rotatively coupled to a rotating part, wherein the fixed part of the first swivel is coupled to the fixed part of the buoy, and wherein the rotating part of the first swivel is configured to rotate with the rotating part of the buoy;
 - a second swivel disposed on the buoy comprising a fixed part rotatively coupled to a rotating part, wherein the fixed part of the second swivel is coupled to the rotating part of the buoy; and
 - a spool coupled to and configured to rotate with the rotating part of the second swivel, wherein a central longitudinal axis of the first swivel is oriented vertically with respect to the buoy and a central longitudinal axis of the second swivel is oriented substantially horizontally with respect to the buoy.
2. The system of claim 1, wherein:
 - the first swivel is a first slip ring,
 - the second swivel is a second slip ring, and
 - the first and second slip rings are each configured to conduct electricity therethrough while the rotating part of the first and second slip rings rotate relative to the fixed part of the first and second slip rings, respectively.
3. The system of claim 2, further comprising:
 - a first electrical conduit having a first end connected to the rotating part of the first swivel and a second end connected to the fixed part of the second swivel; and
 - a second electrical conduit having a first end connected to the rotating part of the second swivel and a second end configured to be connected to the vessel when the vessel is moored to the buoy.

4. The system of claim 3, wherein the fixed part of the first swivel is configured to connect to a first end of a subsea electrical conduit, and wherein a second end of the subsea electrical conduit is configured to connect to an electrical power source.
5. The system of claim 4, wherein the electrical power source comprises one or more wind turbine generators.
6. The system of claim 4, further comprising an electrical motor disposed on the rotating part of the buoy, wherein the electrical motor is configured to rotate the spool in a payout direction and in a retrieval direction.
7. The system of claim 6, wherein the first electrical conduit is configured to provide electrical power to the electrical motor.
8. The system of claim 6, further comprising a battery disposed on the rotating part of the buoy, wherein the battery is configured to provide electrical power to the electrical motor.
9. The system of claim 8, wherein the battery is configured to be charged via a solar panel disposed on the rotating part of the buoy or via the subsea electrical conduit.
10. The system of claim 2, wherein the central longitudinal axis of the first swivel and the central longitudinal axis of the second swivel are substantially perpendicular or substantially orthogonal with respect to one another.
11. The system of claim 2, wherein the central longitudinal axis of the first swivel and the central longitudinal axis of the second swivel intersect and are perpendicular with respect to one another.
12. The system of claim 4, further comprising a switch and a remote telemetry system, wherein:
the switch is disposed on the buoy and configured to electrically isolate the second electrical conduit from the electrical power source, and

the remote telemetry system is configured to control the electric motor and the switch from a remote location.

13. The system of claim 1, wherein the buoy is a turret buoy or a turntable buoy.
14. The system of claim 1, wherein:
 - the first swivel is a first fluid swivel,
 - the second swivel is a second fluid swivel, and
 - the first and second fluid swivels each define at least one flow path therethrough configured to convey a fluid therethrough while the rotating part of the first and second fluid swivels rotates relative to the fixed part of the first and second fluid swivels.
15. The system of claim 14, further comprising:
 - a first fluid conduit having a first end connected to the rotating part of the first fluid swivel and a second end connected to the fixed part of the second fluid swivel; and
 - a second fluid conduit having a first end connected to the rotating part of the second fluid swivel and a second end configured to be connected to the vessel when the vessel is moored to the buoy, wherein the fixed part of the first fluid swivel is configured to connect to a first end of a subsea fluid conduit, and wherein a second end of the subsea fluid conduit is configured to connect to a fluid source.
16. The system of claim 1, further comprising a drive system disposed on the buoy, wherein the drive system is configured to rotate the rotating part of the buoy with respect to the fixed part of the buoy.
17. A process for mooring a vessel, comprising:
 - positioning the vessel near an offshore mooring system, wherein the offshore mooring system comprises:
 - a buoy comprising a fixed part rotatively coupled to a rotating part;
 - a first swivel disposed on the buoy comprising a fixed part rotatively coupled to a rotating part, wherein the fixed part of the first swivel is coupled to the fixed part of the buoy, and wherein the rotating part of the first swivel is configured to rotate with the rotating part of the buoy;

a second swivel disposed on the buoy comprising a fixed part rotatively coupled to a rotating part, wherein the fixed part of the second swivel is coupled to the rotating part of the buoy; and

a spool coupled to and configured to rotate with the rotating part of the second swivel, wherein a central longitudinal axis of the first swivel is oriented vertically with respect to the buoy and a central longitudinal axis of the second swivel is oriented substantially horizontally with respect to the buoy; and
connecting the vessel to the rotating part of the buoy via a hawser.

18. The process of claim 17, wherein the first swivel and the second swivel are each slip rings configured to conduct electricity therethrough while the rotating part of the first and second slip rings rotate relative to the fixed part of the first and second slip rings, wherein the second electrical conduit is at least partially coiled about the spool, and wherein the system further comprises:

a first electrical conduit having a first end connected to the rotating part of the first swivel and a second end connected to the fixed part of the second swivel;

a second electrical conduit having a first end connected to the rotating part of the second swivel and a second end configured to be connected to the vessel when the vessel is connected to the rotating part of the buoy; and

a subsea electrical conduit having a first end connected to the fixed part of the first swivel and a second end connected to an electrical power source, and wherein the process further comprises:

operating the spool in a payout direction to cause the second end of the second electrical conduit to deploy from the spool; and

connecting the second end of the second electrical conduit to the vessel to provide electrical power thereto.

19. The process of claim 18, wherein the buoy further comprises a drive system disposed on the buoy, the process further comprising rotating the rotating part of the buoy with respect to the fixed part of the buoy via the drive system prior to or during connection of the vessel to the buoy.

20. The process of claim 18, wherein the buoy further comprises a drive system disposed on the buoy, the process further comprising rotating the rotating part of the buoy with respect to the fixed part of the buoy via the drive system prior to or during connection of the second end of the second electrical conduit to the vessel.