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(54) **WORK-OVER RIG ASSEMBLY AND METHODS THEREOF**

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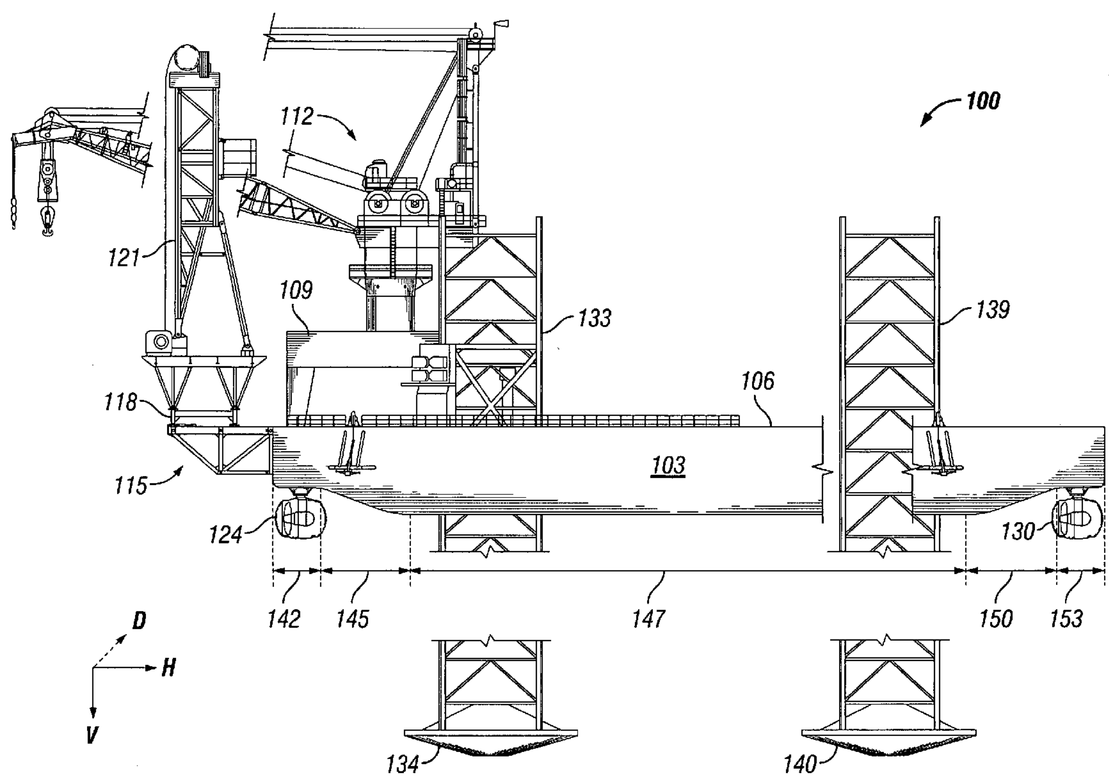
(57) **ABSTRACT**

A vessel is provided that is an improvement over previously disclosed jack-up rigs and lift boats. The vessel has at least three thrusters and is self-propelled. The vessel additionally has a raised and hollow crane support on which a crane may be mounted. The crane support is affixed to tracks, which permit the crane to slide along the deck of the vessel. The raised and hollowed feature of the crane support permits the storage of equipment and things beneath the crane support without hindering the movement of the crane along the tracks. Optionally, the vessel further comprises a sub-base structure removably affixed to the transom of the vessel; a base structure removably affixed to the sub-base structure; and a work-over rig removably affixed to the base structure. Also provided herein are methods of using the crane and affixing the sub-base structure, base structure, and work-over rig to the vessel's transom.



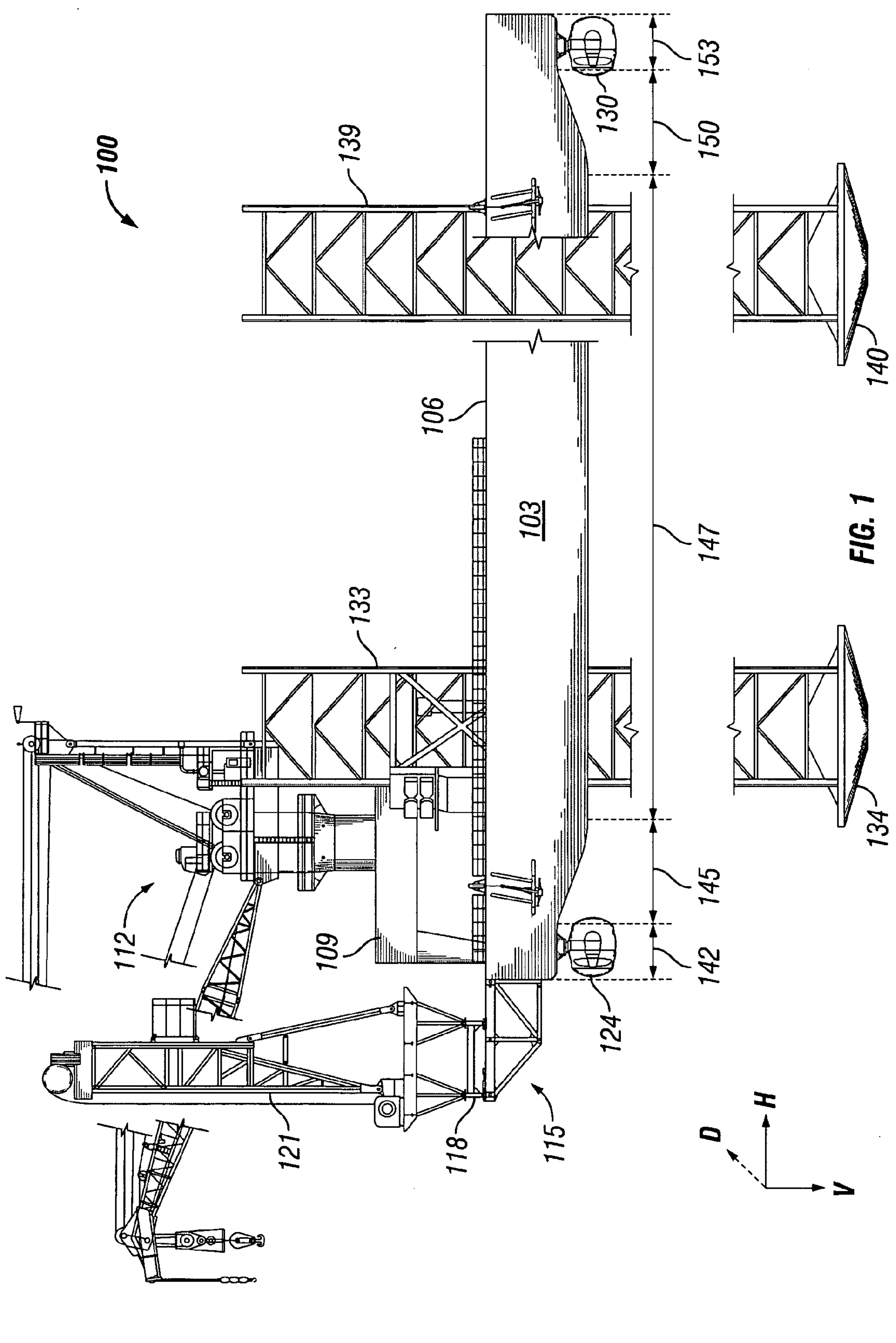

100
139
106
103
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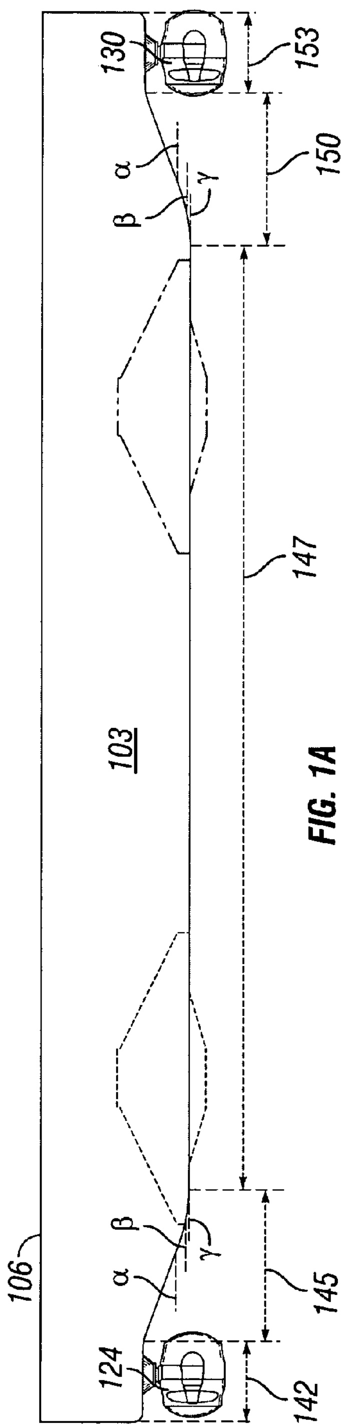
FIG. 1


106
103
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α
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FIG. 1A

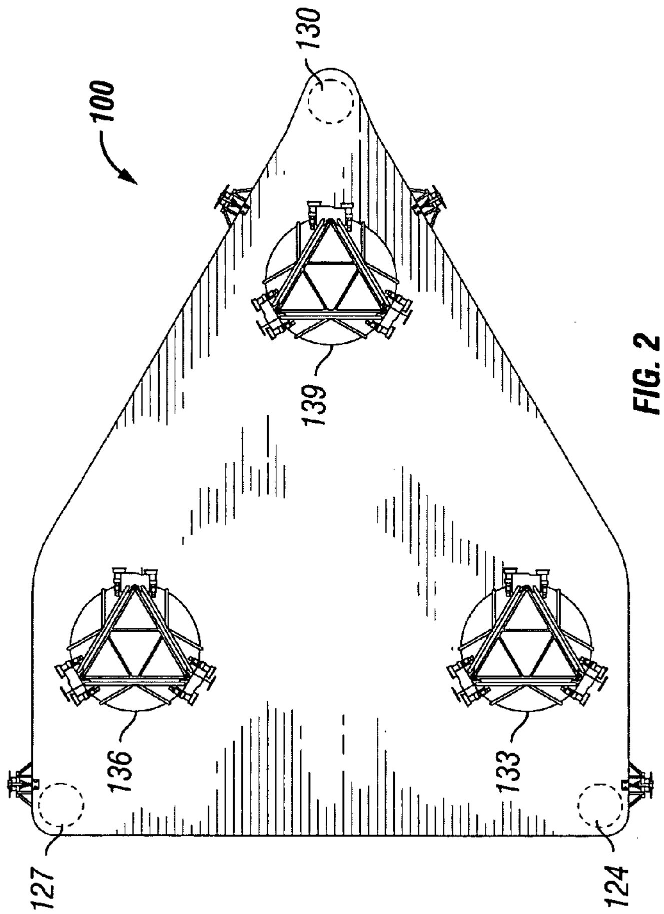
100
124
127
130
133
136
139

FIG. 2

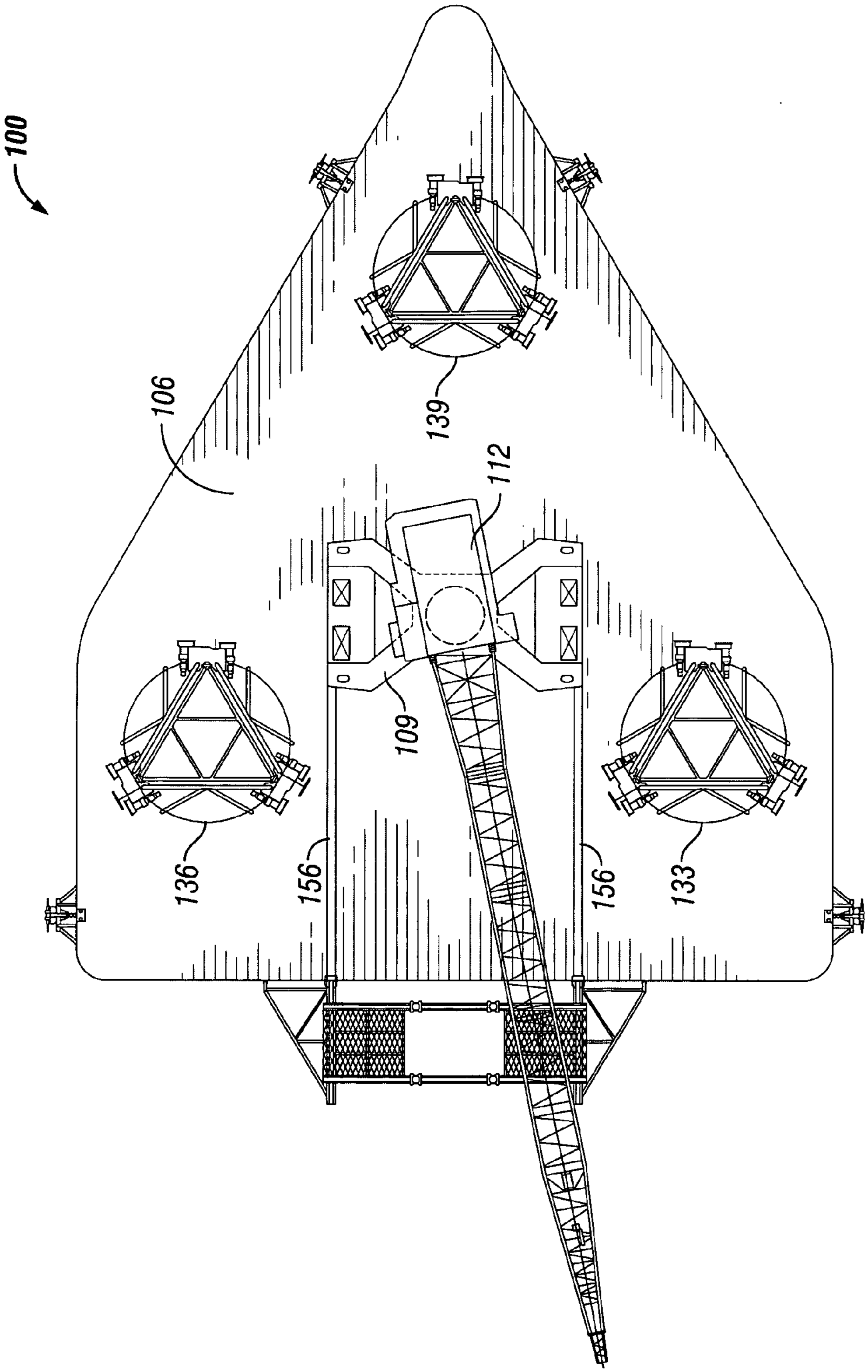

FIG. 3

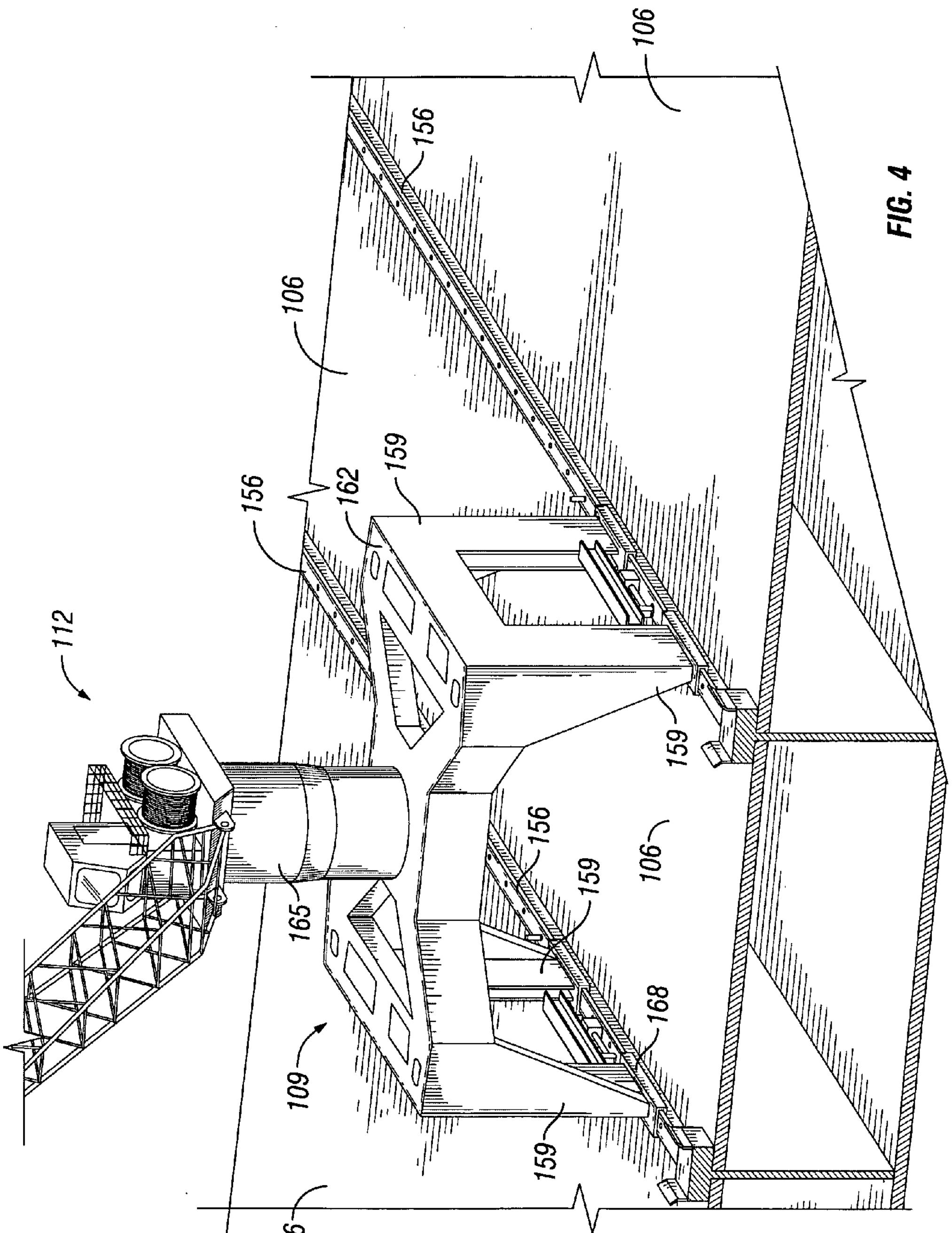

FIG. 4

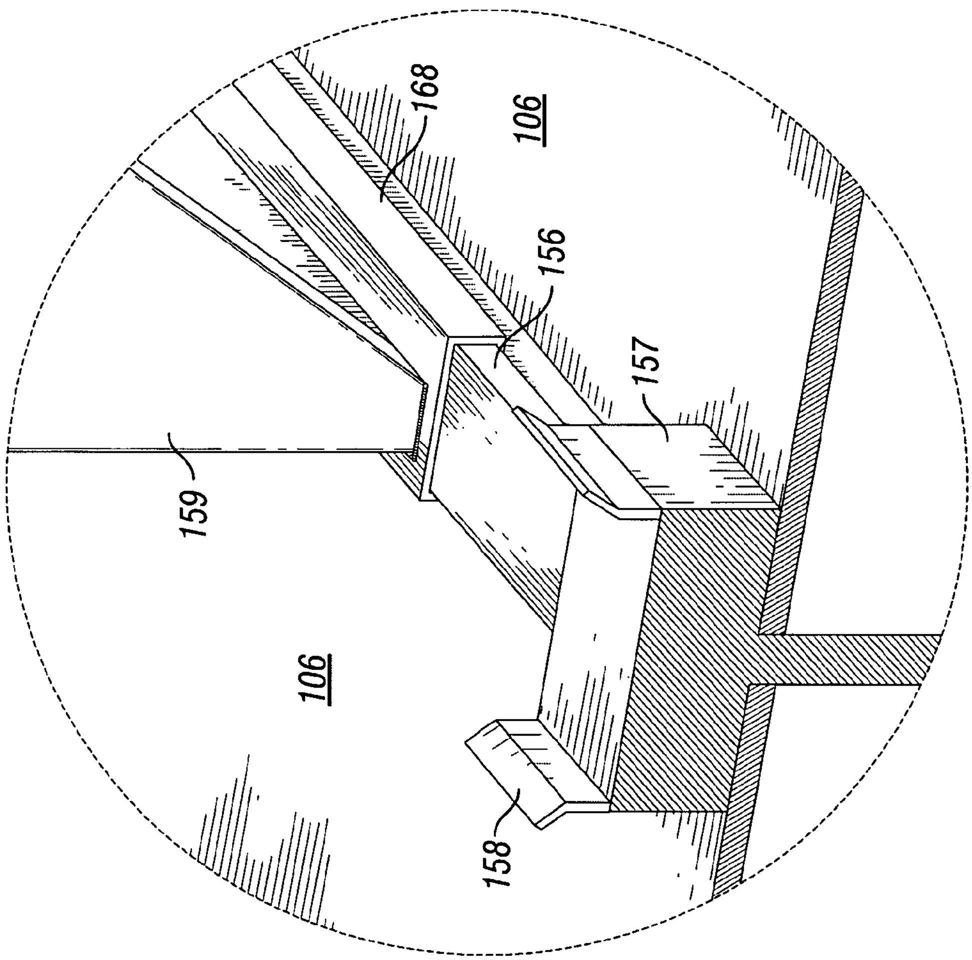

FIG. 5

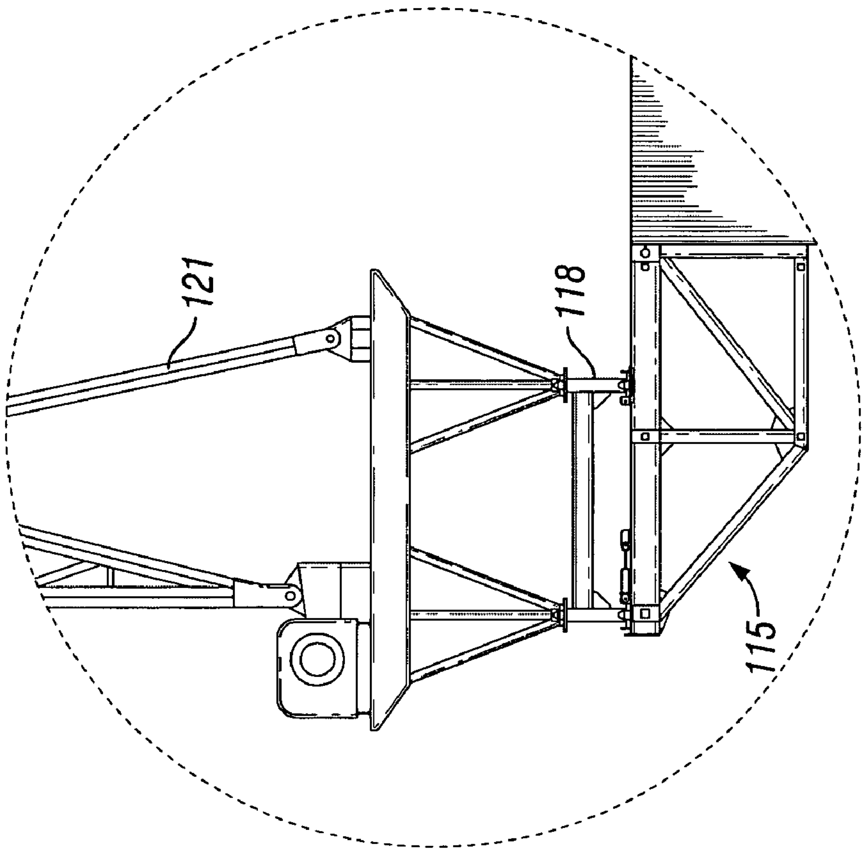

FIG. 6

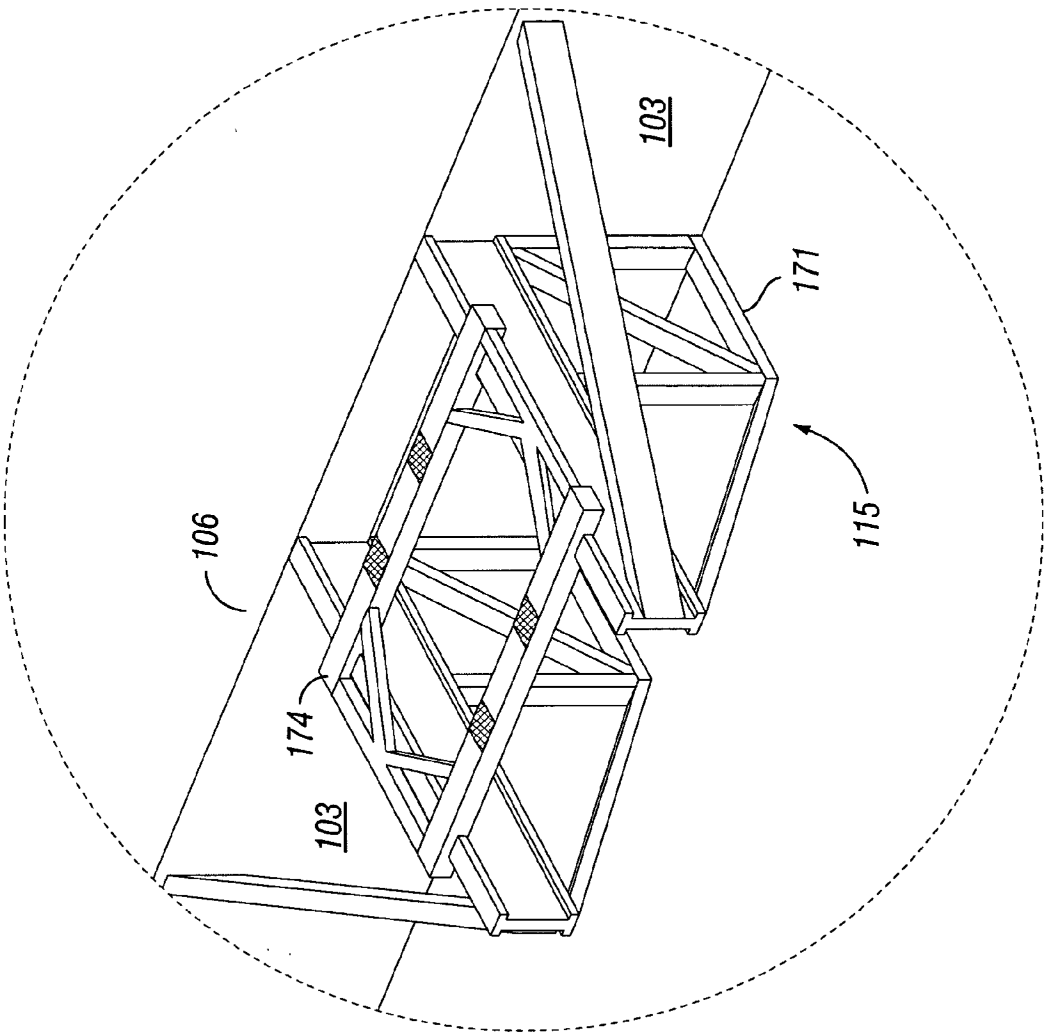

FIG. 7

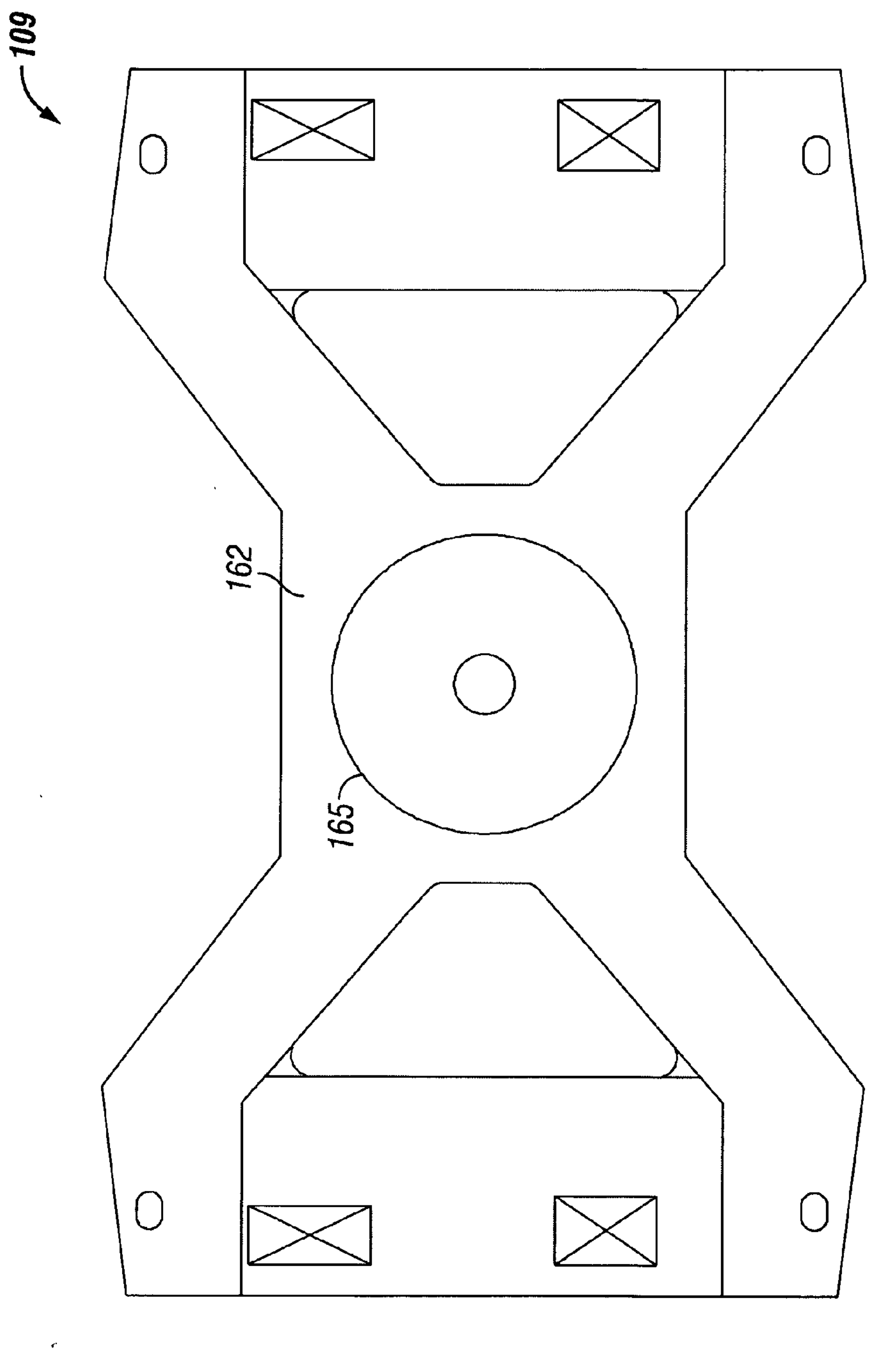

FIG. 8

WORK-OVER RIG ASSEMBLY AND METHODS THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 60/920,923 filed Mar. 30, 2007 and U.S. Provisional Application No. 61/030,815, filed Feb. 22, 2008.

FIELD OF THE INVENTION

[0002] This invention relates to improved work-over rig assembly, and methods of assembling the work-over rig assembly on improved marine vessels, or on satellite structures, for use in oil or gas field operations.

BACKGROUND OF THE INVENTION

[0003] Jack-up drilling rigs are typically employed for offshore energy exploration and development of offshore oil and gas fields. These drilling rigs generally float on a hull and have three or four extendable legs. In the typical situation, the drilling rig is pulled or towed to a location by one or more tug vessels. At the desired location, the drilling rig's legs are then extended to the ocean/sea floor, and the deck of the drilling rig is raised—or jacked up—out of the water. Preferably, the deck of the drilling rig is raised high enough to avoid any sea swells. The jacked-up deck of the drilling rig provides a stable structure in an environment from which a crew may perform drilling operations. These drilling rigs can withstand harsh weather conditions and may be deployed for long periods of time. Due to the nature of the work, deck space is limited and valuable.

[0004] Drilling rigs may have a cantilever system, atop which sits a fixed rig. In operation, a drilling rig is moved to a location near an oil or gas platform, a free-standing conductor, or a fixed conductor and jacked up. Then, the cantilever system is skidded out from the transom of the drilling rig and over the desired well. These cantilever systems, however, are stowed on the deck as a single unit, and take up a large portion of the limited space available.

[0005] Another type of vessel used in the oil and gas field is the derrick barge. Derrick barges are typically fitted with one or more cranes. Such cranes are typically mounted atop fixed and solid pedestals. The derrick barges, like jack-up drilling rigs, are typically pulled or towed to location. Unlike jack-up drilling rigs, however, derrick barges typically do not jack-up. Accordingly, derrick barges are subject to the pitch and roll of the sea/ocean. Thus, the derrick barge's ability to work offshore is limited by the environment in which they serve.

[0006] Yet another type of vessel used to facilitate offshore operations is a lift boat. Lift boats, like jack-up rigs, typically have three or four jack-up legs and may be elevated out of the water. Lift boats are considerably smaller than jack-up rigs, and are intended for short term deployment. These smaller vessels cannot withstand harsh weather conditions and are typically designed to move, under their own power and without the need for a tug boat, out of the way of bad weather. Accordingly, a lift boat is limited in its size and ability, and cannot function as a jack-up rig.

[0007] Additional features of the three above-identified vessels are illustrated in the following patents:

[0008] U.S. Pat. No. 4,483,644 to Johnson describes a cantilever mobile marine rig with hydraulic load equalizers. The rig includes a deck structure and a cantilever assembly skiddingly mounted on the deck structure. The hydraulic load equalizers distribute the stresses between the cantilever assembly and the structure.

[0009] U.S. Pat. No. 5,388,930 to McNease describes a method and apparatus for transporting and using a drilling apparatus or a construction crane apparatus from a single moveable vessel. In the McNease disclosure, a drilling apparatus of a construction crane apparatus is skidded onto the deck of a jack-up rig which is then floated to a remote location for use.

[0010] U.S. Pat. No. 6,257,165 to Danos, Jr. et al. describes a vessel with a movable deck. The vessel comprises a first and second pontoon, a first catamaran hull attached thereto, and a platform. The pontoons and catamaran hull float on the waters' surface, and cannot be raised. The platform is connected to the catamaran hull using jack-up legs. In this manner, the platform may be raised and lowered relative to the catamaran hull using a jacking mechanism. Danos, Jr. et al. further describes a first thruster nozzle attached to the first pontoon, the first thruster nozzle is attached in a 360 degree phase and a second thruster nozzle attached to the second pontoon, with the second thruster nozzle being movable in a 360 degree phase.

[0011] U.S. Pat. No. 6,200,069 to Miller describes a jack-up work platform. The work platform of Miller comprises a hovercraft vessel outfitted with several jack up legs. Miller states that the hovercraft can traverse environmentally sensitive terrain such as brackish and freshwater marshes without the need to dig canals that may cause or exacerbate salt water instruction. Once the drilling or exploration site is reached, the jack up legs may be lowered, lifting the work platform above the surface.

[0012] U.S. Pat. No. 6,607,331 to Sanders et al. describes a support structure for a lift crane, and in particular, to a lift crane jack-up structure, wherein the lift crane is positioned about a leg of the jack-up structure without relying upon the leg for structural support. The structure includes an above deck portion and a substructure situated below deck such that the jack-house is structurally integrated into the vessel.

[0013] U.S. Pat. No. 6,926,097 to Blake describes an offshore jack-up workover rig, which is detachably mounted on an extensible cantilevered frame. The cantilevered frame comprises a pair of parallel support beams mounted to the vessel. A pair of cantilever skid beams rests on the support beam. And, at least one hydraulic ram and cylinder is provided to drive the cantilever skid beam over the support beam.

[0014] U.S. Pat. No. 7,131,388 to Moise, II et al. describes a lift boat having recesses in the hull that receive the pads of the legs when the boat is underway. Moise, II et al. states that preferably, the total bottom surface area of the pads is preferably at least 30% of the surface area of the deck of the lift boat. Moreover, Moise describes that the total bottom surface area of the pad is large enough such that, when the boat is loaded and jacked up, the pads exert less than 7 psi on the sea floor. Moise further describes propelling the boat using two rear propellers and rudders.

[0015] Accordingly, what is needed is a modified vessel, which incorporates the beneficial features of a jack-up drilling rig, a derrick barge, and a lift boat to meet the demanding requirements of offshore construction, maintenance, and demolition of oil and gas platforms, free-standing conductors, and/or fixed conductors. Preferably, the modified vessel has the stature of a jack-up rig with enhanced maneuverability. Further, a modified vessel having an improved crane support system which optimizes the use of deck space is needed. What is also needed is a modified vessel, which allows a work-over rig to be extended off of the transom of the modified vessel, or placed directly onto an offshore platform or structure, without taking up valuable deck space. There is also a need for an improved method of selecting a location to jack-up a vessel in proximity to a platform, and a method of handing off a single well conductor from a jack-up rig to a modified vessel.

SUMMARY OF THE INVENTION

[0016] In accordance with one important aspect of the present invention a work-over rig assembly is provided that includes at least two braces, wherein each of the braces are adaptably mounted to a transom of an Elevating Support Vessel; a sub-base support structure adaptably mounted to each of the braces, wherein the sub-base support structure defines an aperture; a base structure adaptably mounted to the sub-base support structure; and a work-over rig adaptably mounted to the base structure, wherein the base structure and work-over rig are disposed over the aperture defined by the sub-base support structure. In accordance with another important aspect of the invention, a crane is used to assembly the work-over rig assembly to the transom of the Elevating Support Vessel, and the crane is then used to affix a work-over rig atop the assembled work-over rig assembly.

[0017] Those skilled in the art will further appreciate the above-mentioned advantages and superior features of the invention together with other important aspect thereof upon reading the detailed description which follows in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] For a further understanding of the nature and objects of the present inventions, reference should be made to the following detailed disclosure, taken in conjunction with the accompanying drawings, in which like parts are given like reference numerals, and wherein:

[0019] FIG. **1** is a side, partially cut-away, view of an exemplary Elevating Support Vessel having a crane disposed on a crane support of the present invention, three thrusters of the present invention, and a workover rig disposed on a sub-base structure of the present invention;

[0020] FIG. **1**A is a side, partially cut-away, view of an alternative Elevating Support Vessel;

[0021] FIG. **2** is a top-down, partially cut away, view of the exemplary Elevating Support Vessel showing the location of the three thrusters of the present invention;

[0022] FIG. **3** is a top-down view of the exemplary Elevating Support Vessel having the crane disposed on the crane support of the present invention and showing the tracks along which the crane support moves;

[0023] FIG. **4** is a front view of the crane disposed on the crane support of the present invention.

[0024] FIG. **5** is a front view of the T connection connecting the leg of the crane support with the track;

[0025] FIG. **6** is a side view of the workover rig disposed on the sub-base structure of the present invention;

[0026] FIG. **7** is a side view of the sub-base structure; and

[0027] FIG. **8** is a top-down view of the crane support.

DISCLOSURE OF THE INVENTIONS

DEFINITIONS

[0028] In an embodiment, the terms "horizontal axis" or "horizontal" mean a direction along the length of a vessel from the transom of the vessel to the bow of the vessel.

[0029] In an embodiment, the terms "vertical axis" or "vertical" mean a direction along the width of a vessel from the port of the vessel to the starboard of the vessel.

[0030] In an embodiment, the terms "depth axis", "depth", or "deep" mean a direction along the depth of a vessel from the bottom of the vessel to the top of the vessel.

[0031] In an embodiment, the term "still water line" means the level of the water without wind or other disturbances which artificially impacts the level of the water, such as the wake from another vessel.

[0032] In an embodiment, the term "air gap" means the distance from the lowest portion of the hull of a vessel to the still water line.

[0033] In an embodiment, the term "self propelled" or "self propelled vessel" means a vessel that is capable of navigating open waters without the assistance of any other vessel, such as a tug boat.

[0034] In an embodiment, the term "hold station" or the term "holding a vessel in station" means that the vessel has the ability to remain within a **3** meter radius of its position during flotation.

[0035] In an embodiment, the term "Elevating Support Vessel" is defined as any vessel having at least a hull and deck, at least three jack-up legs capable of extending through the hull and deck, and at least three azimuthing thrusters, wherein the vessel is self propelled.

[0036] In an embodiment, the term "light ship" means the weight of the ship including its fixed components such as cranes, engines, and the like apparatus permanently affixed to the vessel.

[0037] In an embodiment, the term "full displacement" means the light ship weight plus the weight of variable loads and consumables such as fuel, water, deck cargo, personnel and the like objects.

[0038] For the purposes of this disclosure, wherein a measurement of distance, length, or thickness is discussed the mean distance, length, or thickness is implied, unless otherwise indicated or unless would be otherwise understood by one of ordinary skill in the art. For example, wherein thickness of a section is discussed the mean thickness across the section is implied.

[0039] FIG. **1** illustrates one embodiment of an Elevating Support Vessel **100**. The Elevating Support Vessel **100** has a hull **103**, a deck **106**, a crane support **109**, a crane **112**, a sub-base structure **115**, a base structure **118**, a work-over rig **121**, three thrusters **124**, **127**, and **130**, three jack-up legs **133**, **136**, and **139**, and three spud cans **134**, **137**, and **140**; however, due to the position of the Elevating Support Vessel **100** only two thrusters **124** and **130**, two jack-up legs **133** and **139**, and two spud cans **134** and **140**, are shown. For clarity of understand, FIG. **1** also illustrates the above-defined orientations, wherein H is the horizontal axis, V is the vertical axis, and D is the depth axis. FIG. **2** is a top-down view of the

Elevating Support Vessel **100**, and illustrates the locations of the three thrusters **124**, **127**, and **130** and the three jack-up legs **133**, **136**, and **142**.

Vessel Hull and Dimensions

[0040] The hull **103** of the Elevating Support Vessel **100** may be thought of as subdivided into five sections: a transom section **142**, a sloped transom section **145**, a center section **147**, a sloped bow section **150**, and a bow section **153**. Preferably, at least a portion of the lower side of the transom section **142** is flat. Likewise, preferably at least a portion of the lower side of the bow section **153** is flat. In this manner, thrusters **124**, **127**, and **130** may be mounted, respectively, to the flat lower sides of the transom section **142** and bow section **153**. The transom section **142** and the bow section **153** are of a relatively thinner depth than the center section **147**. In one embodiment of the Elevating Support Vessel **100**, the transom section **142** and the bow section **153** are at least half as deep as the center section **147**. The center section **147** may be of a uniform curvature or generally flat. Preferably, the center section **147** has additional slopes (not shown) to accommodate the spud cans **134**, **137**, and **140**.

[0041] The sloped transom section **145** and the sloped bow section **150** are of a length along the depth and horizontal axes and angle sufficient such that the thrusters **124**, **127**, and **130** may be mounted with the necessary. Preferably, the angle of the sloped transom section **145** and the sloped bow section **150** with respect to the bottom of the hull is sufficient to allow efficient flow of water through the thrusters. In one embodiment, the angle of the sloped transom section **145** and the sloped bow section **150** with respect to the bottom of the hull will vary depending on the requirements of the thrusters. For example, the angle of the sloped transom section **145** and the sloped bow section **150** with respect to the bottom of the hull is preferably between about 15 and about 30 degrees, alternatively between about 17 and about 25 degrees, alternatively between 18 and 22 degrees, and alternatively about 20 degrees.

[0042] With respect to FIG. **1**A, and in an alternative embodiment, the sloped transom section **145** and the sloped bow section **150** comprise a series of graduated slopes. In a preferred embodiment, the sloped transom section **145** and the sloped bow section **150** each comprise an alpha slope, a beta slope, and a gamma slope. The alpha slope is preferably of such an angle to allow sufficient water flow into the thrusters **124**, **127**, (not shown) and **130**. The alpha slope will have an angle generally dependent upon the size of the thrusters **124**, **127**, (not shown) and **130** and the length of the hull. In an embodiment, the alpha slope is between about 15 and about 25 degrees, preferably about 20 degrees. The beta slope is preferably of an angle lesser than the alpha slope. In this manner, the beta slope acts as a transition slope between the alpha slope and gamma slope, and reduces the stress on the hull. In an embodiment, the beta slope is between about 10 and about 15 degrees, and preferably about **13** degrees. The gamma slope is preferably of an angle lesser than the beta slope. In this manner, the gamma slope acts as a transition slope between the beta slope and the center section **147**, and reduces the stress on the hull. In an embodiment, the gamma slope is between about 5 and about 10 degrees, and preferably about 6 or about 7 degrees.

[0043] Continuing with reference to FIG. **1**A, all edges and/or corners of the hull **103** are radial, or rounded. Without wishing to be bound by the theory, it is generally thought that the hull having radial edges reduces drag and is more hydrodynamic.

[0044] The hull **103** of the Elevating Support Vessel **100** is preferably made of 355 MPa steel. In an embodiment, the hull **103** of the Elevating Support Vessel **100** is from about 5 to about 15 meters deep, and preferably about 7.5 meters deep from the lowest point until the deck **106** of the Elevating Support Vessel **100**. At full displacement the air gap is preferably about 11 meters, alternatively about 12.5 meters, alternatively about 13.5 meters, and alternatively about 15.5 meters.

[0045] In an embodiment, the Elevating Support Vessel **100** weighs about 6,800 metric tons at light ship. In this embodiment, the Elevating Support Vessel exerts a minimum of about 345 kilopascals per leg on the sea floor. The Elevating Support Vessel **100** may vary in weight from about 4,500 metric tons to about 11,000 metric tons at light ship. Alternatively, the Elevating Support Vessel **100** may vary in weight from about 6,800 metric tons to about 15,500 metric tons at full ship, and preferably from about 9,000 metric tons to about 13,500 metric tons.

Jack-Up Legs

[0046] The three jack-up legs **133**, **136**, and **139** may have a lattice, truss, or tubular configuration. Preferably, the jack-up legs **133**, **136**, and **139** may withstand greater than about 5 meter waves, alternatively greater than about 10 meter waves, and more preferably, greater than about 15 meter waves. The jack-up legs **133**, **136**, and **139** may withstand greater than about 50 knot winds, preferably greater than about 75 knot winds, and most preferably greater than about 100 knot winds. The jack-up legs **133**, **136**, and **139** may be able to withstand a wave period of about 13.5 seconds. The dimensions of the jack-up legs **133**, **136**, and **139** may vary depending on many factors, including the location of the platform or wells to be serviced. In an embodiment, the jack-up legs **133**, **136**, and **139** have an overall leg length of at least 100 meters, alternatively about 127 meters, an about 2.7 meter safety zone, a 7.5 meter leg tower, and an estimated sea bed penetration of about 3 to about 8.3 meters. This embodiment may yield a working water depth of from about 60 meters to about 90 meters, and alternatively a working water depth of from about 60 meters to about 75 meters.

Azimuthing Thrusters

[0047] With reference to FIG. **1**, FIG. **1**A, and FIG. **2**, two of the azimuthing thrusters **124** and **127** are mounted to the underside of the transom section **142** and along the horizontal axis behind the two rear jack-up legs **133** and **136**. The two rear azimuthing thrusters **124** and **127** may be mounted along the vertical axis of the transom section **142** in a position to avoid the turbulence created by the drag of the rear jack-up legs **133** and **136**, and give the greatest maneuverability to the Elevating Support Vessel **100**. To increase maneuverability, it is preferred that the two rear azimuthing thrusters **124** and **127** are placed as far apart along the vertical axis as possible, however, in an embodiment, the two rear azimuthing thrusters **124** and **127** may be placed along the vertical axis of the transom between the two rear jack-up legs **133** and **136**. It is also preferred that the two rear azimuthing thrusters **124** and **127** are mounted in a location such that at least a portion of the two rear azimuthing thrusters **124** and **127** extend below the hull **103** of the Elevating Support Vessel **100**. In this manner, there is a greater chance that the water flow through the thrusters **124** and **127** is laminar as opposed to turbulent.

[0048] Continuing with reference to FIG. **1**, FIG. **1**A, and FIG. **2**, the front azimuthing thruster **130** is preferably mounted to the underside of the bow section **153**. Preferably, the front azimuthing thruster **130** is mounted ahead of the front jack-up leg **139** along the horizontal axis. In this manner, the front azimuthing thruster **130** avoids the turbulence created by the front jack-up leg **139**. However, in an alternative embodiment, the front azimuthing thruster **130** may be mounted behind the front jack-up leg **139** along the horizontal axis. The front azimuthing thruster **130** is preferably mounted in a location to provide the Elevating Support Vessel **100** the greatest maneuverability. In an embodiment, the front thruster **130** is mounted in a location along the center of the bow section **153** along the vertical axis and toward the front-most portion of the Elevating Support Vessel **100** along the horizontal axis. The front azimuthing thruster **130** is also preferably mounted in a location such that at least a portion of the front azimuthing thruster **130** extends beyond the hull **103** of the Elevating Support Vessel **100**. In this manner, there is a greater chance that the water flow through the front thruster **130** is laminar as opposed to turbulent.

[0049] In an alternative embodiment (not shown), there are two front azimuthing thrusters. In this embodiment, the bow of the Elevating Support Vessel **100** is widened—with respect to the configuration shown in FIG. **2**—along the vertical axis to such that two front azimuthing thrusters may be mounted parallel along the vertical axis. The bow is also widened such that each of the front azimuthing thrusters may be mounted to the bow of the Elevating Support Vessel **100**, along the vertical axis, such that their exhaust straddles the front jack-up leg **139**. The two front azimuthing thrusters are preferably mounted to the bow of the Elevating Support Vessel **100**, along the horizontal, at a generally front-most location.

[0050] The azimuthing thrusters **124**, **127**, and **130** may be any commercially available azimuthing thruster, which may be affixed to the Elevating Support Vessel **100** and provide sufficient horsepower and maneuverability such that the Elevating Support Vessel **100** is self-propelled. Preferably the azimuthing thrusters **124**, **127**, and **130** are capable of producing between 500 and 4,000 kilo-watts of power, alternatively about 2,500 kilo-watts of power. For example, the thrusters may be SP 35 azimuthing thrusters having a ducted propeller, available from Steerporp Ltd., located in Rauma, Finland. The Elevating Support Vessel **100** may have a maximum speed of from about 5 knots to about 10 knots, or greater than about 7 knots.

Crane Support and Crane

[0051] FIGS. **3**, **4**, and **8** illustrate a crane support **109**, a crane **112**, and tracks **156** disposed on the deck **106** of an Elevating Support Vessel **100**. The crane support **109** must be of a size and strength to support the crane **112**. The crane support **109** is a table-like structure having at least two crane-support legs **159**, preferably four crane-support legs **159**, and a crane-support platform **162**. The crane-support legs **159** are attached to the crane-support platform **162** at one end. Preferably, the crane-support legs **159** are welded to the crane-support platform **162**. At the other end, the crane-support legs **159** are attached to the tracks **156**, alternatively the crane-support legs **159** are attached to crane-leg shoes **168**. The connection between the crane-support legs **159**, crane-leg shoes **168**, and the tracks **156** is discussed in more detail below. The crane-support legs **159** are of a length such that the lower side of the crane-support platform **162** is at least about 2 meters for example about 3 meters, from the deck **106**. Alternatively, the crane-support legs **159** are of a length such that the lower side of the crane-support platform **162** is at least about 6 meters from the deck **106**. In yet another embodiment, the crane-support legs **159** are of a length such that the lower side of the crane-support platform **162** is at least about 9 meters from the deck **106**.

[0052] The crane-support legs **159** may be triangular shaped with the top end of the leg being thicker than the bottom end of the leg. The crane-support legs **159** may be made of double girder steel, alternatively an I shaped steel beam may be used. The crane-support platform **162** may be generally rectangular or square shape, and is preferably a lattice of support beams designed to be light-weight yet strong.

[0053] A crane-support column **165** is connected at one end to the crane-support platform **162**. Preferably, the crane-support column **165** is welded into the center of the crane-support platform **162**. In this manner, the weight of the crane **112** is distributed as evenly as possible across the crane-support structure **109**. The crane **112** is rotatably affixed to the other end of the crane-support column **165**. By rotatably affixed it is meant that the connection between the crane **112** and the crane-support column **165** permits the crane **112** to rotate about the radius of the crane-support column **165** from a first location to a second location.

[0054] The crane support **109**, and its components, may weigh from about 150 metric tons to about 300 metric tons, and more preferably about 170 metric tons. The crane support **109**, and its components, are preferably made of steel, and are more preferably 355 MPa medium strength steel.

[0055] The crane **112** may vary generally in size, and preferably has a 280 metric ton capacity at 20 meters. Alternatively, the crane has at least a 50 metric ton capacity at 20 meters, alternatively at least a 100 metric ton capacity at 20 meters, alternatively at least a 200 metric ton capacity at 20 meters, alternatively at least a 300 metric ton capacity at 20 meters, alternatively at least a 350 metric ton capacity at 20 meters, and alternatively at least a 500 metric ton capacity at 20 meters. A suitable crane **112** is a PC 250HD crane, which is commercially available from Australia Favelle Favco Cranes Pty. Ltd., located in Australia.

Crane Support Tracks

[0056] The tracks **156** may vary in length, but preferably run along the horizontal axis from the rear of the transom to a location generally behind the rear jack-up legs **124** and **127**. In an embodiment, the tracks run along the horizontal axis from the rear of the transom to a length of about 20 meters, alternatively about 15 meters, alternatively about 10 meters. The tracks **156** are spaced apart from one another, along the vertical axis, at a distance such that the crane-support platform **162** may be large enough to evenly and safely distribute the weight of the crane **112** under load. Additionally, the tracks **156** are spaced apart from one another, along the vertical axis, at a distance such that there is room to store a variety of equipment and things beneath the crane-support platform **162** and between the tracks **156**. The tracks **156** may be about 10 meters apart, along the vertical axis, alternatively about 15 meters apart, alternatively about 20 meters apart, alternatively about 25 meters apart. The tracks **156** must be sturdy to carry the weight of the crane-support **109**, crane **112**, and load. Accordingly, the tracks **156** preferably extend through the entire depth of the transom and are integral with the Elevating Support Vessel **100**. Applicants believe, without wishing to be bound by the theory, that the tracks **156** absorb little to no dynamic moments or forces. Instead, the connection between the crane-support legs **159** and the track **156** permits the forces to be distributed in simple static directions.

[0057] The connection between the track **156** and the crane-support legs **159** is described with reference to FIG. **5**. The crane-support legs **159** may be secured to crane-leg shoes **168**. The track **156** may be of a general T-shape, wherein the post of the T extends through the transom **142** of the deck **106**. The top of the T-shaped track **156** is in communication with the crane-leg shoe **168**, which is of a female shape designed to fit about the top of the T-shaped track **156**. There must be enough space between the top of the T-shaped track **156** and the crane-leg shoe **168** such that the crane support **109** may slide along the track. In a preferred embodiment, there is about a **3** millimeter gap between the top of the T-shaped track **156** and the crane-leg shoe **168**. The T-shaped portion of the track **156** may be between about 30 centimeters and about 60 centimeters in width, and preferably about 40 centimeters.

[0058] In an embodiment, the track **156** includes at one end, alternatively at either end, a stop **157**. The stop **157** prevents the crane-leg shoe **168** from sliding off the track **156**. The stop **157** is preferably from about two to three times as wide as the track **156**, and in an embodiment about 1 meter. Preferably the stop **157** is from about 40 centimeters to about 80 centimeters in length, and preferably about 60 centimeters. The stop **157** may run the depth from the deck **106** to the top of the T-shaped portion of the track **156**, alternatively the stop **157** may extend below the deck **106**, or be shallower than the depth from the deck **106** to the top of the T-shaped portion of the track **156**. The stop **157** may have protrusions **158** extending in the depth axis about eight to about 20 centimeters, preferably about 10 centimeters. The protrusions **158** preferably extend straight up along the depth axis, may be sloped away from each other, or extend up some distance and then slope away from each other.

[0059] In this manner, the crane **112** may be used in a number of ways. The crane **112** may be moved by skidding the crane support **109** across the tracks **159**. The crane **112** may pick up a load from any point along the track **159**. Thus, the crane **112** may pick up a load of the deck **106** of the Elevating Support Vessel **100**, or from a location outside of the Elevating Support Vessel **100**. The crane **112** may also be rotated 360° about the crane-support column **165** while under full load. The crane **112** may also be skidded along the tracks **159** while under load. Accordingly, the crane **112** may transport load or erect load in a self-contained manner, without need for any additional support vessels. The crane **112** has the additional benefit of allowing for the storage of equipment and things beneath the crane support **109**. Because of the high clearance of the crane-support platform **162**, the storage of equipment and things will not obstruct the movement of the crane **112**. Additional uses of the crane **112** are discussed below.

Work-Over Rig Assembly

[0060] The sub-base structure **115**, base structure **118**, and work-over rig **121** are described with reference to FIGS. **6** and **7**. The sub-base structure **115** has at least one brace **171**, preferably two braces, and a sub-base support structure **174**. The braces **171** are preferably designed to be pinned on the transom in vertical alignment with the tracks **156**. In this manner, the braces **171** are pinned to the most reinforced section of the Elevating Support Vessel's **100** transom. Likewise, the rear of the transom of the Elevating Support Vessel **100** is designed to engage the pins of the brace **171**. Preferably, the braces **171** are secured along a point on the depth axis which allows the top of the brace **171** to be flush with the deck **106**.

[0061] The sub-base support structure **174** is a matrix of beams that are secured to the braces **171** and define an aperture. The sub-base support structure **174** may be secured to the braces **171** either by a weld, or preferably by pins in such a manner that allows the sub-base support structure **174** to be removably secured to the braces **171**.

[0062] The base structure **118** may be secured over the aperture defined by the sub-base support structure **174**. Preferably, the base structure **118** and the sub-base support structure **174** are connected by pins, however, they may be welded together. The work-over rig **121** may be secured to the base structure **118**. Thus, the aperture defined by the sub-base support structure **174** must be of a size and shape to permit work to be done using the work-over rig **121**. Preferably the work-over rig **121** is secured to the base structure **118** by pins; however, the work-over rig **121** may be welded to the base structure **118**. Preferably, the work-over rig **121** can slide or skid in the vertical direction along the sub-base support structure **174**. In this manner, the work-over rig **121** may be secured at any vertical point along the sub-base support structure **174**, and preferably may be skidded plus or minus about **3** meters from the center of the Elevating Support Vessel **100**.

[0063] The vertical length of the sub-base support structure **174** is preferably defined by the width of the tracks **156** because the brace **171** is preferably designed to be pinned in vertical alignment with the tracks **156**. Additionally, the work-over rig **121** is preferably skidable in the horizontal direction along the braces **171**. In this manner, the work-over rig **121** may be secured at any point along the horizontal axis of the sub-base support structure **174** within about 1 to about 3 meters, alternatively within about 1 to about 2 meters, from the transom. Advantageously, the work-over rig **121** is deployed without the need for a cantilever or outrigger system, which takes up valuable space on the deck **106**.

[0064] The work-over rig **121** may be any standard rig adapted to be connected to the base structure **118**, and is preferably designed with the capability of racking drill-pipe, work string, completion strings in singles, doubles, or triples configuration having a total capacity of at least about 50, alternatively at least about 100 metric tons, alternatively about 200 metric tons, and alternatively up to about 250 metric tons. In an embodiment, the work-over rig comprises a vertically telescoping mast and drawworks with a capacity of at least about 50, alternatively between about 30 and 350, alternatively about 250 metric tons. In an embodiment, the maximum height of the telescoping mast is about 33 meters, alternatively about 36.5 meters, alternatively about 46 meters. In an embodiment, the maximum vertical length of the telescoping mast is about 7 meters, and the maximum horizontal length of the telescoping mast is about 7 meters. A preferred work-over rig may be obtained from National Oilwell Varco (NOV) located in Houston, Tex. In an embodiment, the work-over rig **121** may have a v-door hinged to one of its sides to allow personnel and equipment to pass to and from it. The v-door preferably folds up when the work-over rig **121** is stowed during transport and lift-up.

[0065] In an embodiment, the crane **112** is used to assemble the sub-base structure **115**, base structure **118**, and work-over rig **121** on the transom of the Elevating Support Vessel **100**. First, the crane **112** is used to lift the sub-base structure **115**, and used in the assembly of the sub-base structure **115** to the rear of the transom. The crane **112** is then used to lift the base structure **118**, and used in the assembly of the base structure **118** to the sub-base structure **115**. The crane **112** is then used to lift the work-over rig **121** and used in the assembly of the work-over rig **121** to the base structure **118**. The crane **112** also preferably assembles the sub-base structure **115**, base structure **118**, and work-over rig **121** in less than about 15 lifts, preferably less than about 10 lifts, and alternatively less than about 5 lifts. The crane **112** may be employed to disassemble the sub-base structure **115**, base structure **118**, and work-over rig **121** by the reverse process as just described. The crane **112** also preferably disassembles the sub-base structure **115**, base structure **118**, and work-over rig **121** in less than about 15 lifts, preferably less than about 10 lifts, and alternatively less than about 5 lifts.

[0066] Alternatively, the sub-base structure **115** may be secured on a satellite structure outside of the Elevating Support Vessel **100**. Preferably, the satellite structure is an oil or gas platform. The satellite structure preferably has tracks which the sub-base structure **115** may be fitted to engage, and an opening through which the work-over rig **121** may work. In an embodiment, the sub-base structure **115** and the tracks of the satellite structure engage each other in a manner similar to the engagement between the crane tracks **156** and the crane-support legs **159**, as described above with reference to FIG. **5**. In an embodiment, the crane **112** is used to assemble the sub-base structure **115**, base structure **118**, and work-over rig **121** on the transom of the Elevating Support Vessel **100**. First, the Elevating Support Vessel **100** is aligned with the satellite at a distance such that crane **112** may be used to safely lift objects from the deck **106** of the Elevating Support Vessel **100** onto the satellite. Preferably, this distance is less than about 23 meters. Once in the desired location, the Elevating Support Vessel **100** is jacked-up at least 3 meters out of the water. The crane **112** is then used to lift the sub-base structure **115** from the deck of the Elevating Support Vessel **100**, and used in the assembly of the sub-base structure **115** to tracks of the satellite. The crane **112** is then used to lift the base structure **118** from the deck of the Elevating Support Vessel **100**, and used in the assembly of the base structure **118** to the sub-base structure **115**. The crane **112** is then used to lift the work-over rig **121**, from the deck of the Elevating Support Vessel **100**, and used in the assembly of the work-over rig **121** to the base structure **118**. Alternatively, a bridge is laid between the Elevating Support Vessel **100** and the satellite so that equipment and personnel may move easily between the two structures. The Elevating Support Vessel **100** preferably supplies all of the support and function, such as electrical power, necessary for the work-over rig **121** to work. The crane **112** also preferably assembles the sub-base structure **115**, base structure **118**, and work-over rig **121** in less than about 15 lifts, preferably less than about 10 lifts, and alternatively less than about 5 lifts. The crane **112** may be employed to disassemble the sub-base structure **115**, base structure **118**, and work-over rig **121** by the reverse process as just described. The crane **112** also preferably disassembles the sub-base structure **115**, base structure **118**, and work-over rig **121** in less than about 15 lifts, preferably less than about 10 lifts, and alternatively less than about 5 lifts.

Methods of Holding Station

[0067] The Elevating Support Vessel **100** preferably has the ability to hold station. In an embodiment, the Elevating Support Vessel **100** holds station using the azimuthing thrusters. In this embodiment, a set point is determined. A GPS device, preferably in combination with a gyroscope and other attitude measuring devices, provide digital signals to a computer informing the computer how far off from the set point the Elevating Support Vessel **100** has traveled. The computer sends a signal to the azimuthing thrusters, which engages the azimuthing thrusters to correct for the error. Thus, in an embodiment, the azimuthing thrusters of the Elevating Support Vessel **100** are in signal communication with a computer. In an alternative embodiment, any number of the azimuthing thrusters may be in signal communication with a computer, and any number of the azimuthing thrusters may be in signal communication with each other and/or the computer. In these embodiments, the Elevating Support Vessel **100** may remain within about a three meter radius from the set point. The ability to hold station is especially important while the legs are being lowered to the sea/ocean floor until the Elevating Support Vessel **100** is supported by its jack-up legs. Preferably, the Elevating Support Vessel **100** can hold station, using only the azimuthing thrusters, in a current of between 0 to about 3 knots. In the embodiment wherein the Elevating Support Vessel **100** holds station during deployment of the jack-up legs, there may be forces acting on the jack-up legs, such as undercurrents. In such situations, the net forces acting on the Elevating Support Vessel **100** is called the effective current, and the Elevating Support Vessel **100** can preferably hold station in an effective current of between 0 to about 3 knots. In these embodiments, the surface current may or may not be above about 3 knots.

[0068] In another embodiment, the Elevating Support Vessel **100** may hold station using the azimuthing thrusters in combination with a mooring system. This embodiment is especially preferable if the current, or effective current, is greater than about 3 knots. The mooring system is preferably either a two or four-point mooring system, and a four-point mooring system is preferred in effective currents over about 3 knots.

[0069] In a two-point mooring system, a first anchor is connected to one end of the Elevating Support Vessel's **100** transom, and a second anchor is connected to the opposite end of the Elevating Support Vessel's **100** transom. In an alternative two-point mooring system, a first anchor is connected to one end of the Elevating Support Vessel's **100** bow, and a second anchor is connected to the opposite end of the Elevating Support Vessel's **100** bow. In a four-point mooring system, a first anchor is connected to one end of the Elevating Support Vessel's **100** bow, a second anchor is connected to the opposite end of the Elevating Support Vessel's **100** bow, a third anchor is connected to one end of the Elevating Support Vessel's **100** transom, and a fourth anchor is connected to the opposite end of the Elevating Support Vessel's **100** transom. Preferably, the azimuthing thrusters are used to correct for any deviation should the Elevating Support Vessel **100** deviate from its set point. The azimuthing thrusters are put to greater use in a two-point mooring system than in a four-point mooring system. The use of one, three, and greater than four anchors is also contemplated.

[0070] In an embodiment, the anchors each weight from about 4.5 megagrams to about 9 megagrams, and preferably about 6.8 megagrams. The anchors are preferably connected to the Elevating Support Vessel **100** by an about 3.8 centimeter thick wire rope, which is from about 760 meter to about 915 meters in length. Alternatively the anchors are connected to the Elevating Support Vessel **100** by a chain, or a combination of a wire rope and chain, which is from about 760 meter to about 915 meters in length.

[0071] In an embodiment, the crane **112** is used to retract the anchor. In this embodiment, once the first anchor is released from the sea/ocean floor the azimuthing thrusters will be used to correct for the deviation that the Elevating Support Vessel **100** undergoes from the set point. The azimuthing thrusters continue to correct for any deviation from the set point as the additional anchor(s) are retracted. Alternatively, after the first anchor is released from the sea/ocean floor, the azimuthing thrusters serve to hold tension against the other anchors such that the vessel holds station.

Method of Selecting A Jack-Up Location

[0072] A method of selecting a location to jack-up an Elevating Support Vessel **100** is now described. In an embodiment of the method, an Elevating Support Vessel **100** is moved within proximity to an offshore structure, preferably, an oil and gas facility. The Elevating Support Vessel is preferably moved within about 30 meters from the edge of the platform, alternatively within about 20 meters, alternatively within about 10 meters. The Elevating Support Vessel **100** is moved around the platform to obtain a map of the sea floor. Alternatively, or in addition to the map obtained by the Elevating Support Vessel **100**, a remote operated vehicle ("ROV") is deployed from the Elevating Support Vessel **100**, and images the sea floor. The map of the sea floor is then used to determine a suitable location to lower the jack-up legs. Preferably, the location selected does not contain pits caused by previous jack-up vessels, commonly referred to as "can holes", debris, pipe ties, or other obstructions. Once in location, the legs of the Elevating Support Vessel **100** are jacked-up, and the Elevating Support Vessel **100** is raised out of the water.

[0073] The ROV may be an unmanned submersible. Preferably, the ROV can dive below the surface of the water and obtain detailed images of the sea floor using a side acoustic scanner and/or bottom contour sonar, and the like equipment. The ROV may have a range of from about 30 meters to about 300 meters, or more, which may permit the Elevating Support Vessel **100** to remain at a distance further away from the platform such as at least about 30 meters, alternatively at least about 50 meters, alternatively at least about 100 meters. In an embodiment, the ROV has an umbilical cord that carries power to it, as well as electrical signals and data to and from the Elevating Support Vessel **100**. Alternatively, the ROV can be remotely controlled.

[0074] The sea floor may be mapped using any depth finding device and method, and is preferably mapped using side acoustic scanning and/or multi-beam echo scanning. Side acoustic scanning is similar to sonar, in that sound waves are transmitted out to a target area, i.e., the sea floor. The time for the sound waves to travel out to the target area and back to receiver of the side acoustic scanning device is used to determine the range to the target. The distance that the Elevating Support Vessel **100** is from the platform when mapping the sea floor will depend on the optimum range of the mapping device, i.e., side acoustic scanner. The Elevating Support Vessel **100** is preferably far enough from the platform's edge to ensure safe movement, yet close enough to the platform's edge to obtain a map of the sea floor. A preferred depth finding device and method is the use of a SeaBeam 1185 in conjunction with HYPACK™ software. Such a system is available from L-3 Communications Corporation located in New York, N.Y. HYPACK™ is a registered trademark of Coastal Oceanographics, Inc., located in Middlefield, Conn.

[0075] The reach of the Elevating Support Vessel's **100** onboard skiddable crane permits the Elevating Support Vessel **100** to select a position further away from the platform than previously possible. In an embodiment, the Elevating Support Vessel **100** is located and jacked-up between about 7 and about 14 meters from the edge of the platform, alternatively from about 15 meters to about 20 meters, and alternative at most about 23 meters from the edge of the platform.

Single Well Conductor Pipe Hand-Off

[0076] In an embodiment, the Elevating Support Vessel **100** may be used to relieve a jack-up drilling rig from its duty of securing a single well conductor pipe. In this embodiment, the jack-up drilling rig has been used to drill case and cement the single well conductor pipe; however, the pipe has not yet been perforated. The Elevating Support Vessel **100** is outfitted with an arm suitable to hold the single well conductor pipe.

[0077] The Elevating Support Vessel **100** is moved to a location such that its arm is within reaching distance from the single well conductor pipe. Preferably the reaching distance is less than about 6 meters. The jack-up legs of the Elevating Support Vessel **100** are lowered until they are pinned, i.e., just touching the sea/ocean floor. During this operation, the methods of holding station, as described above, may be implemented. Once the jack-up legs of the Elevating Support Vessel **100** are pinned, the arm of the Elevating Support Vessel **100** extends to hold the single well conductor pipe. The jack-up drilling rig releases the single well conductor pipe and is tugged away from location. With the single well conductor pipe in hand, the Elevating Support Vessel **100** is jacked-up to a height sufficient to avoid the crests of the waves. The Elevating Support Vessel **100** may use its crane to assemble the work-over rig to its transom, as described above, such that work may be done on the single well conductor pipe.

[0078] While specific alternatives to steps of the invention have been described herein, additional alternatives not specifically disclosed but known in the art are intended to fall within the scope of the invention. Thus, it is understood that other applications of the present invention will be apparent to those skilled in the art upon reading the described embodiment and after consideration of the appended claims and drawings.

1) A work-over rig assembly comprising:

a. at least two braces, wherein each of the braces are adaptably mounted to a transom of an Elevating Support Vessel;

b. a sub-base support structure adaptably mounted to each of the braces, wherein the sub-base support structure defines an aperture;

c. a base structure adaptably mounted to the sub-base support structure; and

d. a work-over rig adaptably mounted to the base structure, wherein the base structure and work-over rig are disposed over the aperture defined by the sub-base support structure.

2) The work-over rig assembly of claim 1, wherein the at least two braces are pinned to the transom of the Elevating Support Vessel, the sub-base support structure is pinned to each of the braces, the base structure is pinned to the sub-base support structure, and the work-over rig is pinned to the base structure.

3) The work-over rig assembly of claim 1, wherein the transom of the Elevating Support Vessel comprises two tracks that are disposed through the depth of the Elevating Support Vessel and each of the braces are pinned in vertical aligned with each of the tracks.

4) The work-over rig assembly of claim 1, wherein the base structure is skiddable along at least a portion of an vertical axis of the sub-base support structure.

5) The work-over rig assembly of claim 4, wherein the base structure is skiddable along about 6 meters in the vertical axis.

6) The work-over rig assembly of claim 1, wherein the base structure is skiddable along at least a portion of a horizontal axis of the sub-base support structure.

7) The work-over rig assembly of claim 6, wherein the base structure is skiddable along about 3 meters in the horizontal axis.

8) The work-over rig assembly of claim 1, wherein the work-over rig comprises the ability to rack drill-pipe doubles having a total capacity of 200 metric tons.

9) A method of assembling a work-over rig assembly on a transom of an Elevating Support Vessel comprising:

a. using a crane disposed on a crane support apparatus to lift a sub-base structure, wherein the crane support apparatus comprises:

i. at least two vertical members with each vertical member having a first and second end, the first end of the first vertical member is affixed to a first track, the first end of the second vertical member is affixed to a second track, the first and second tracks are affixed to a deck of the Elevating Support Vessel, the second end of the first vertical member is affixed to a first side of a platform, the second end of the second vertical member is affixed to a second side of the platform; and

ii. a column having a proximate and distal end, the proximate end is affixed to the platform, and the crane is rotatably affixed to the distal end of the column, the platform has a lower side disposed at least about 2 meters above the deck, the crane support apparatus is movable along the track;

b. using the crane to assemble the sub-base structure to a distal end of the transom of the Elevating Support Vessel;

c. using the crane to lift a base structure;

d. using the crane to assemble the base structure to the sub-base structure;

e. using the crane to lift a work-over rig; and

f. using the crane to assemble the work-over rig to the base structure.

10) The method of claim 9, wherein the sub-base structure comprises at least one brace and a sub-base support structure, and the at least one brace is adaptably pinned to the transom of the Elevating Support Vessel and the sub-base support structure is adapatably mounted to the brace.

11) The method of claim 9, wherein the brace has a top portion which is flush with the deck of the Elevating Support Vessel.

12) The method of claim 9, wherein the sub-base support structure defines an aperture over which the base structure and work-over rig are mounted.

13) The method of claim 9, wherein the crane assembles the work-over rig in less than 15 lifts.

14) The method of claim 13, wherein the crane assembles the work-over rig in less than 10 lifts.

15) A method assembling a work-over rig assembly on a satellite structure comprising:

a. placing an Elevating Support Vessel within about 23 meters of a satellite structure, wherein the satellite structure comprises at least two T-tracks;

b. jacking-up the Elevating Support Vessel at least 3 meters out of the water;

c. using a crane disposed on a crane support apparatus to lift a sub-base structure, wherein the sub-base structure comprises at least two shoes adaptable to be skiddably disposed about the least two T-tracks, the crane support apparatus comprises:

i. at least two vertical members with each vertical member having a first and second end, the first end of the first vertical member is affixed to a first track, the first end of the second vertical member is affixed to a second track, the first and second tracks are affixed to a deck of the Elevating Support Vessel, the second end of the first vertical member is affixed to a first side of a platform, the second end of the second vertical member is affixed to a second side of the platform; and

ii. a column having a proximate and distal end, the proximate end is affixed to the platform, and the crane is rotatably affixed to the distal end of the column, the platform has a lower side disposed at least about 2 meters above the deck, the crane support apparatus is movable along the track.;

d. using the crane to skiddably mount the at least two shoes of the sub-base support structure to the at least two T-tracks of the satellite structure;

e. using the crane to lift a base structure;

f. using the crane to assemble the base structure to the sub-base structure;

g. using the crane to lift a work-over rig; and

h. using the crane to assemble the work-over rig to the base structure.

16) The Elevating Support Vessel of claim 15, wherein the Elevating Support Vessel is jacked-up at least 10 meters above the still water line.

17) The method of claim 15, further comprising:

a. using the crane to lift a bridge;

b. using the crane to assemble the bridge between the Elevating Support Vessel and the satellite structure.

18) The method of claim 15, wherein the Elevating Support Vessel provides electrical power to the work-over rig.

19) The method of claim 15, wherein the crane assembles the work-over rig in less than 15 lifts.

20) The method of claim 19, wherein the crane assembles the work-over rig in less than 10 lifts.

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