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METHOD OF UNDERWATER MOUNTING OF PROPULSION DRIVE SYSTEM FOR A FLOATING STRUCTURE

BACKGROUND OF THE INVENTION

The present invention relates to the field of floating offshore structures for the drilling and production of offshore deposits of petroleum and natural gas. More particularly, the present invention relates to a system for securing under water, a drive means for propelling a floating body.

Mobile offshore rigs, especially at present, are designed both as, so-called semi-submersible drilling platforms and so-called jack-up drilling rigs, the latter being provided with legs or columns drivable in a vertical direction with respect to the frame structure of a drilling rig for steadying the drilling rig on the seabed in operating condition. Semi-submersible offshore rigs include an underwater section for supporting the drilling and production facilities on decks of the vessel. This type of drilling rig is not secured to the seabed at all in a drilling condition, and therefore, such a drilling rig must be provided with articulation and motion compensating mechanisms between a ground drilling mechanism and an offshore rig in order to enable drilling on rough seas.

To this end, the offshore structures in the form of semi-submersible rigs are often installed with thrusters, which are of azimuthing type and are used for propulsion, steering and positioning of the vessel. The process of mounting and dismounting these thrusters is strenuous, laborious and dangerous.

One of the methods for mounting and dismounting a thruster propeller unit is disclosed in the United States Patent No. 4,586,907 according to the method of the '907 patent, the process of mounting and dismounting the thruster is facilitated with lifting wires connected to the thruster through two tubular members located below the bottom plating of the floating body and by means of some lifting equipment located above the pontoon deck and from within the pontoon. However, the process is strenuous as it requires the lifting operators and the underwater divers to have precise coordination in positioning the thruster. The pontoon hull is exposed to potential abrasion when it comes into contact with the lifting wires. The method as described in the US Patent No. 4,586,907 has limitation as the lifting equipment located above the pontoon deck may not



be necessarily have sufficient outreach to cater for installation of the forward and aft thrusters.

The present invention overcomes shortcomings of the prior art by providing a method of installing a mountable thruster using a self propelled submersible body, which is a safer and faster way to install a thruster.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method of underwater mounting of propulsion drive system on a floating structure, such as for instance a semi-submersible vessel.

It is another object of the present invention to provide a method of mounting dynamic positioning thrusters on a pontoon bottom of a semi-submersible vessel.

It is still another object of the present invention to provide a method of mounting propulsion units on a semi-submersible vessel that allows reducing the use divers' work hours when securing the propulsion units on the semi-submersible structure.

These and other objects of the invention are achieved through a provision of a method that utilizes a submersible self-propelled unit that delivers a thruster directly to the semi-submersible vessel and positions the thruster in a submerged position under the pontoons. The thruster is loaded onto the self-propelled submersible unit using a floating crane or rigboard crane. At least one thruster which will then be positioned below the thruster housing of the pontoon is secured on the cradle of the self-propelled submersible unit for installation.

The thruster which is to be installed is loaded from a workboat to the self-propelled submersible floating unit. This self-propelled submersible body can float and move freely underwater and can be deployed to submerge at certain water depth within an uncontrolled environment. The self-propelled submersible unit is designed to assist in the mounting and dismounting of a thruster. The floating unit when submerged has propulsion capabilities to permit horizontal movements.

At least one thruster is loaded and secured on the self-propelled submersible body. The thruster is secured onto a built-in cradle which forms a part of the self-propelled submersible unit. The self-propelled submersible unit is connected to a ballast control system which is separately stored on a workboat. The control system is connected

to the unit by an umbilical cable. The self-propelled submersible unit is then pushed towards the pontoon of the semi-submersible structure. When it is near the semi-submersible structure, ballast water is injected into the ballast tanks of the self-propelled submersible unit to submerge it at a depth below the pontoon of the semi-submersible structure.

An independent propulsion system of the submersible unit is activated to propel the submerged body towards the pontoon. Water is de-ballasted from the body using compressed air to float the self-propelled submersible body upwards until all fenders are in contact with the surface of the pontoon. The propulsion system of the submersible unit is subsequently shut down when the unit is fully attached to the pontoon. Divers will be deployed to mount the thruster using lifting wires passed through the pontoon and subsequently release the thruster from the cradle.

When the lifting wires attached to the thruster are in tension, more ballast water is injected into the ballast tanks to sink the body slightly below the original position. The thrusters are activated again to move out the submersible unit away from the pontoon. Compressed air is then injected in to de-ballast the tanks of the submersible unit to float up the self-propelled submersible unit above water. The same process is repeated for installation of all other thrusters required for the offshore vessel.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will below be described with reference to the accompanying drawing, in which:

Figure 1 is a schematic view illustrating a semi-submersible structure during the thruster installation process.

Figures 2a through 2e are schematic views illustrating steps in the method of positioning thruster units on a bottom of a pontoon of a semi-submersible vessel using a self-propelled unit.

Figure 3 is a schematic view illustrating tank arrangement of the self-propelled unit.

Figure 4 is a cross-sectional view taken along lines A-A of Figure 3.

Figure 5 is a schematic end view of the self-propelled unit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to Figure 1, there is illustrated a floating semi-submersible vessel 10 that can be employed for drilling and production operations at sea. It should be understood that the method of installing thruster units can be used with various other types of vessels and floating bodies, and the offshore vessel 10 shown in Figure 1 is one example of a possible use.

The vessel 10 is shown to comprise a superstructure 12 mounted on a working platform 16. The platform 16 is supported by supporting columns 18, 20 and buoyant pontoons 22, 24, respectively. There may be more than two supporting columns and pontoons. The columns 18, 20 may be connected by braces 19. A derrick 26 is erected on the platform 16, and a pair of cranes 30, 32 is positioned on the port and starboard sides of the platform 16, respectively.

The propulsion drive system comprises a plurality of individual thruster units 36, of which units 36a, 36b, 36c, and 36d are shown in Figure 1. The thruster units 36a – 36d are shown attached to the bottom of the pontoons 22, 24. In the practice of the present invention, any suitable type of thruster may be utilized as the choice for the thruster units is largely dictated by the parameters of the vessel 10. The azimuthing thrusters are desirable because they can provide a force in any direction. Other types of thrusters, such as fixed-direction thrusters may also be mounted on a vessel using the method of the instant invention.

Turning now to the method steps of the invention schematically illustrated in Figures 2a through 2e, the column 20 is seen in Figure 2e extending from a body of water 50, while the pontoon 24 is almost entirely submerged below a waterline WL. The thruster 36c has been mounted on the bottom of the pontoon 24, while the thruster 36 is in the process of being mounted. The method of the present invention provides for the use of a remotely-controlled self-propelled submersible unit 52, which is provided with remotely-controlled drive means in the form of thruster/propellers. The self-propelled unit 52 comprises a main hull 54 and upwardly extending columns 56, 58 secured to the main hull 54. The main hull 54 and the columns 56, 58 are comprised of ballast tanks that can be selectively ballasted to submerge or float the unit 10.

Shown in plan view in Figure 3, the main hull 54 comprises central ballast tanks 60, 62, while column 56 is seen comprising a pair of port ballast tanks 64, 66, and the column 58 is seen comprising starboard ballast tanks 68, 70. The columns 56, 58 may comprise one or more vertical ballast tanks. In Figure 4, the column 58 is seen comprising a bottom ballast tank 70 and an upper ballast tank 72. A top surface 55 of the central hull 54 serves as a support for a thruster cradle 74.

The self-propelled unit 52 is provided with a pair of protectors, or fenders that protect the pontoons and the unit 52 during contact. One of the fenders 76 is mounted on a vertical wall 73 of the column 58. The second fender/protector 65 is mounted on top of the column 56 and is designed to protect the bottom of the pontoons and the column 56 upper surface during the propulsion device mounting process.

The self-propelled unit 52 is provided with a plurality, for instance five, thruster-propellers 80 secured at the bottom of the self-propelled submersible unit 52 to allow movement of the unit 52 in water. Only two of the propellers 80 can be seen in Figures 2a – 2e. The other propellers 80 are mounted on the bottom of the central portion 54 of the unit 52.

The thruster mounting process starts with partially submerging the unit 52 (Figure 2a) by injecting ballast water into the central ballast tanks 60 and 62. All ballasting and de-ballasting operations are controlled onboard a workboat usually positioned alongside the unit 52. At least one thruster unit 82 is loaded and secured on the cradle 74 when the central ballast tanks 60, 62 are fully filled (Figure 2b). The thruster can be loaded to the cradle 74 by means of a floating lifting equipment, while the locking mechanism can be made by means of a clamp or pin.

Ballasting of the tanks will continue from the position shown in Figure 2a when the ballast tanks 60, 62 are slightly filled and to the position shown in Figure 2b when the tanks 60, 62 are fully filled, and then to a position shown in Figure 2c when the ballast tanks 68, 70, 60 and 62 are semi-filled and the thruster 82 becomes partially submerged.

The next step (Figure 2d) comprises injecting ballast water into the starboard tanks 68, 70 and the central tanks 60, 62 until these ballast tanks are fully filled. The port tanks 64, 66 remain partially filled. In that position, ballasting is stopped, and the submersible unit 52 is slowly propelled towards the pontoon 24. The movement of the

self-propelled submersible unit 52 from the position in Figure 2a to the position in Figure 2e is maintained in an even keel condition. The propulsion of the unit 52 is controlled remotely from a workboat (not shown) tagging along with the submersible unit 52.

The movement of the submersible unit 52 is terminated when the vertical fender 76 comes into contact with the side 25 of the pontoon hull 24. De-ballasting of water from the port ballast tanks 60, 62 then begins in order to float up the submersible unit 52 from the position in Figure 2d to the position in Figure 2e until the top fender 65 and the vertical side fender 76 are pressing against the hull of the pontoon 24. De-ballasting is facilitated by the use of compressed air.

At this juncture, all thrusters 80 of the unit 52 are shut down and divers will be deployed to attach lifting wires 84 to the thruster 82. Upon securing the wires on the thruster 82, the divers will release the thruster 82 by detaching a locking mechanism 86 from the cradle 74. The thruster 82 is then lifted slightly by means of a plurality of lifting equipment from within the pontoon until the lifting wires 84 attached to the thruster 82 are in tension. The thruster 82 remains suspended below a thruster housing positioned on the bottom of the pontoon 24, while the divers secure the thruster/propeller in the thruster housing.

De-ballasting then commences to submerge the submersible unit 52 slightly until it reaches the level of submergence shown in Figure 2d. Divers are required to stay away when de-ballasting is in process. Thruster propellers 80 are activated again to propel the submersible unit 52 away from the pontoon 24; along the forward or aft direction of the semi-submersible structure 10. De-ballasting continues until the submersible body reaches the position shown in Figure 2a. The same process applies to either side of the offshore vessel i.e. portside or starboard.

The same process, except in reverse can be employed when dismounting the propulsion devices 82 from the vessel 10. The instant invention eliminates the use of lifting wires, and thus there is no potential damage caused by abrasion of lifting wires to the pontoon hull. With the use of the remotely-controlled self propelled ballastible submersible unit 52 it becomes possible to reduce the time required by the divers to stay underwater to mount and dismount the thruster on a floating structure, such as a semi-submersible vessel. Thus, it is safer for the divers to work underwater as compared to

convention methods or to that described in the US Patent No. 4,586,907. The invention provides for a more efficient means to move and position a dynamic positioning thruster in place for installation with minimal support of lifting equipment. Of course, the instant method can be used for securing propulsion devices for other floating structures, such as spars, boats and the like.

Many changes and modifications can be made in the method of the present invention without departing from its scope. I therefore pray that my rights to the invention be limited only by the scope of the appended claims.

CLAIMS

We Claim:

1. A method of mounting propulsion units on a floating structure provided with propulsion unit housing on a bottom thereof, the method comprising the steps:

- (a) providing a submersible ballastible unit;
- (b) positioning and securing at least one propulsion unit on said submersible ballastible unit;
- (c) partially submerging the submersible ballastible unit;
- (d) transporting the partially submerged submersible ballastible unit to a position adjacent to said floating structure and moving said submersible ballastible unit such that said at least one propulsion unit is located adjacent to the propulsion unit housing;
- (e) removing said at least one propulsion unit from said submersible ballastible unit and mounting said at least one propulsion unit to the propulsion unit housing; and
- (f) maneuvering the partially submerged submersible ballastible unit away from the floating structure.

2. The method of Claim 1, further comprising a step of de-ballasting the submersible ballastible unit a distance away from the floating structure.

3. The method of Claim 1, further comprising a step of regulating submergence depth of the submersible ballastible unit to facilitate orientation of said at least one propulsion unit in close proximity to the propulsion unit housing.

4. The method of Claim 1, further comprising a step of suspending said at least one propulsion unit adjacent to the propulsion unit housing prior to mounting said at least one propulsion unit to the propulsion unit housing.

5. The method of Claim 1, wherein said submersible ballastible unit comprises a central portion with a top surface and a plurality of upwardly extending columns on a starboard of the central portion.

6. The method of Claim 5, further comprising a step of providing said submersible ballastible unit with a plurality of separate ballast tanks capable of receiving a ballast

mass for submerging the submersible ballastible unit and capable of receiving a de-ballasting medium for floating submerged submersible ballastible unit to the surface.

7. The method of Claim 5, further comprising a step of providing a contact surface protection means on said submersible ballastible unit for protecting contact surfaces of the submersible ballastible unit and the floating structure.

8. The method of Claim 7, wherein said contact surface protection means comprises a first protection fender secured on vertical walls of upwardly extending columns for protecting vertical contact surfaces of the floating structure and the submersible ballastible unit.

9. The method of Claim 8, further comprising a step of attaching a second protection fender to upper surfaces of opposing upwardly extending columns for protecting bottom surface of the floating structure during contact with the submersible ballastible unit.

10. The method of Claim 9, further comprising a step of providing ballast tanks in the center portion of the submersible ballastible unit, in the starboard columns and in the port columns.

11. The method of Claim 10, wherein said central portion ballast tanks and said columns are ballasted such that the first protection fender and said second protection fender are in contact with the floating structure to facilitate maneuvering of the submersible ballastible unit underwater and placing said at least one propulsion unit generally below the floating structure.

12. The method of Claim 1, wherein said submersible ballastible unit is provided with a remotely controlled drive means.

13. The method of Claim 13, wherein said remotely controlled drive means comprises propellers.

14. The method of Claim 13, wherein said submersible ballastible unit is capable of maneuvering in horizontal direction underwater.

15. The method of Claim 1, further comprising a means for detachably securing said at least one propulsion unit on said submersible ballastible unit.

16. The method of Claim 15, wherein said securing means comprises a cradle with a locking device mounted on said submersible ballastible unit.

17. The method of Claim 6, wherein the steps of ballasting and de-ballasting of the ballast tanks are conducted with the submersible ballastible unit remaining in a generally upright even keel condition.

18. A method of mounting propulsion units on a pontoon of a semi-submersible vessel, said pontoon being provided with a vertical sidewall and propulsion unit housing on a bottom thereof, the method comprising the steps:

- (a) providing a remotely-controlled submersible ballastible unit having a body with a plurality of ballast tanks positioned in a central portion of the body and in opposing starboard and port vertical columns;
- (b) providing a propulsion unit cradle in the central portion of the body;
- (c) positioning and detachably securing at least one propulsion unit on said cradle;
- (d) partially submerging the submersible ballastible unit by partially ballasting the ballast tanks in the central portion and in the starboard and port columns;
- (e) maneuvering the partially submerged submersible ballastible unit to a position adjacent said floating structure;
- (f) adding ballast mass to the ballast tanks of the central portion and at least one vertical column and then maneuvering said submersible ballastible unit such that said at least one propulsion unit is oriented below a propulsion unit housing;
- (g) removing said at least one propulsion unit from said submersible ballastible unit and suspending said at least one propulsion unit by tension wires from the semi-submersible vessel;
- (h) mounting said at least one propulsion unit to the propulsion unit housing; and
- (i) maneuvering the partially submerged submersible ballastible unit away from the semi-submersible vessel.

19. The method of Claim 18, further comprising a step of providing protection fenders on exterior walls of said starboard and port columns to facilitate protection of contact surfaces during contact with the pontoon.

20. The method of Claim 18, wherein step (f) comprises a step of regulating ballasting of the submersible ballasting unit to facilitate maneuvering of said at least one propulsion unit into a position adjacent the propulsion unit housing.