

SUBMERSIBLE PUMP ASSEMBLY AND METHOD OF INSTALLATION AND OPERATION THEREOF

BACKGROUND

5 Technical Field

Embodiments of the invention relate to submersible pumps of the type used in offshore and marine industry, including the type used during installation of jack-up rigs.

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Description of Related Art

Submersible pumps are used during installation of jack-up rigs to extract sea water for various purposes including, but not limited to, fire main assembly, equipment cooling, preloading, mud pit filling, and mud pump testing.

15 An existing pump installation method includes the following steps: assembling pipe spools and submersible pump at quayside to form a tower pump assembly, lifting the tower pump assembly to an installation position at the rig or vessel by crane, installing the tower pump assembly thereon, and connecting pipe spools and elbow to the pump assembly.

20 If quayside space is not available for assembling pipe spools, another existing pump installation method is employed which includes the following steps: lifting pipe spools to the vessel or rig by crane, assembling the pipe spools on the vessel to form a tower pump assembly, lifting the tower pump to an installation position at the vessel, installing the tower pump assembly thereon, and connecting pipe spools and elbow to the pump assembly.

25 During operation, if the height of the tower pump assembly needs to be adjusted (lengthened or shortened) due to adjustment in height of the vessel, the tower pump assembly has to be uninstalled, disassembled at the quayside or on the vessel and reassembled to the adjusted height. This is needed as pipe spools are commercially available only at certain fixed lengths.

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Due to complexity of the above-described procedures, many man hours and crane time are needed to assemble, install, modify and dismantle the pump tower assembly. Also, due to size and weight of pipe spools and other materials, a large storage space is required. Further, the above-described procedures pose several hazards, such as exposing personnel to overboard dangers and equipment damage. One of the most critical hazards is overboard falling hazard as personnel installing the submersible pump are required to access far-reaching areas to tighten bolts and nuts, and secure electrical cables. Although staging would assist personnel in accessing far-reaching areas, staging is both costly and time consuming and yet does not fully eliminate overboard falling hazards as the personnel are still working on a staging that is hanging outboard.

Summary

A submersible pump assembly is provided. According to one embodiment, a submersible pump assembly comprises:

- a frame;
- at least one first floatable device attached to the frame;
- a rigid pipe attached to the frame and having a first end and a second end;
- a submersible pump attached to the first end of the rigid pipe;
- a flexible hose having a first end and a second end, the first end of the flexible hose is connected in fluid communication with the second end of the rigid pipe;
- a curve pipe connected in fluid communication with the second end of the flexible hose; and
- a mounting support attached to the curve pipe for mounting the curve pipe onto a vessel.

The submersible pump assembly may further comprise at least one wire sling connected between the mounting support and the frame to provide lifting support to the frame, the at least one floatable device, the rigid pipe, and the submersible pump.

The submersible pump assembly may further comprise at least one second floatable device attached to the flexible hose at an intermediate location along the flexible hose.

The curve pipe of the submersible pump assembly may be provided with a constricted opening to throttle fluid flow therethrough. The curve pipe may include a swivel connection to allow rotational movement of the curve pipe. The curve pipe may be a goose neck pipe.

The mounting support may be a U-shaped bracket.

A method of installation and/or operating a submersible pump assembly is provided. According to one embodiment of the invention, the method comprises:

having a submersible pump assembly which comprises:

a frame,

at least one first floatable device attached to the frame,

a rigid pipe attached to the frame and having a first end and a second end;

a submersible pump attached to the first end of the rigid pipe,

a flexible hose having a first end and a second end, the first end of the flexible hose is connected in fluid communication with the second end of the rigid pipe,

a curve pipe connected in fluid communication with the second end of the flexible hose, and

a mounting support attached to the curve pipe for mounting the curve pipe onto a vessel; and

installing the submersible pump assembly in an operational position by transferring, in assembled form, the frame, the at least one first floatable device, the rigid pipe and the submersible pump into water, transferring the mounting support to a vessel, and coupling the mounting support onto the vessel to install the curve pipe at the vessel.

The method may further comprise: while a height of the vessel is being adjusted, maintaining the submersible pump assembly in the operational position by

utilizing a slack in the flexible hose to accommodate the height adjustment of the vessel.

An apparatus for storing a submersible pump assembly as described above is provided. The apparatus comprising:

- a base platform;
- a storage duct; and
- an upper platform;

wherein the storage duct includes a first end attached to the base platform and a second end attached to the upper platform, wherein the storage duct is arranged to house the submersible pump in a storage position, the second end of the storage duct arranged in fluid communication with an opening on the upper platform which is configured to support the at least one floatation device, and the base platform is configured to support the flexible hose being coiled around the storage duct.

The base platform may include a plurality of entryways for receiving prongs of a forklift truck. The base platform may include at least one guide member removably attached to a plurality of corners of the base platform.

The upper platform may include at least one lifting pad-eye. The upper platform may include a railing which is configured to allow coupling of the mounting support.

The storage duct may be provided with at least an opening for accessing the submersible pump in the storage position. A plurality of rings may be arranged external of the storage duct at an elevation from the base platform.

Brief Description of the Drawings

Embodiments of the invention are disclosed hereinafter with reference to the drawings, in which:

FIG. 1A shows a submersible pump assembly installed in an operational position;

FIG. 1B shows a close-up view of the installed submersible pump assembly of FIG. 1A;

FIG. 2A is a top view of a frame of the submersible pump assembly of FIG. 1A;

FIG. 2B is a profile view of the submersible pump assembly of FIG. 1A;

FIG. 2C is a partial sectional view taken along line A-A in FIG. 2A;

FIG. 3A shows a schematic representation of the submersible pump assembly;

FIG. 3B shows a constricting opening (orifice) at the curve pipe;

FIG. 4 shows a flow sequence for method of installing and operating the submersible pump assembly;

FIG. 5 shows the submersible pump assembly of FIG. 1A disposed in a storage position;

FIG. 6A is a side view of the storage apparatus of FIG. 5;

FIG. 6B is a top view of the storage apparatus of FIG. 6A along line B-B;

FIG. 6C is a sectional view of the storage apparatus of FIG. 6A taken along line C-C in FIG. 6A;

FIG. 6D is a sectional view of the storage duct taken along line D-D in FIGs. 6A and 6C.

Detailed Description

In the following description, numerous specific details are set forth in order to provide a thorough understanding of various illustrative embodiments of the invention. It will be understood, however, to one skilled in the art, that embodiments of the invention may be practiced without some or all of these specific details. In other instances, well known process operations have not been described in detail in order not to unnecessarily obscure pertinent aspects of embodiments being described. In the drawings, like reference numerals refer to same or similar functionalities or features throughout the several views.

Embodiments of the invention provide a submersible pump assembly, method of installing and operating the submersible pump assembly, and a storage apparatus for storing and/or transporting the submersible pump assembly.

5 Submersible Pump Assembly

Reference is made to FIGs. 1A and 1B which show a submersible pump assembly 100 installed in an operational position, and FIGs. 2A, 2B and 2C which show various views of the submersible pump assembly 100 according to one
10 embodiment of the invention. The submersible pump assembly 100 at least comprises the following components: a frame 110, at least one first floatable device 120, a rigid pipe 130, a submersible pump 140, a flexible hose 150, a curve pipe 160, and a mounting support 170. A detailed description of the aforementioned and other components is set out in the following paragraphs.

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The frame 110 provides a structural support for the submersible pump assembly 100. The frame 110 may include suitable structures, e.g. retainer, housing, to support the at least one first floatable device 120 which is attached to the frame 110 to provide buoyancy to the submersible pump assembly 100. The rigid pipe 130
20 is attached to the frame 110. The rigid pipe 130 includes a first end and a second distal end.

In one embodiment as illustrated in FIGs. 1A, 1B, 2A, 2B and 2C, the frame 110 includes radially-extending arms attached to the rigid pipe 130. At each arm, the end which is distal from the rigid pipe 130 is attached with an extension member. At
25 both ends of each extension member, the first floatable device(s) 120 are attached thereto. The first floatable devices 120 as illustrated are provided as recycled plastic drums containing hardened foam. The floatable devices 120 are evenly spaced from one another for uniform weight distribution. It is to be appreciated that other frame
30 configurations, number of floatable devices and type of buoyant design / materials may be envisaged in other embodiments of the invention.

At the first end of the rigid pipe 130, the submersible pump 140 is attached thereto. At a second distal end of the rigid pipe 130, a first end of the flexible hose 150 is connected in fluid communication therewith. The second distal end of the flexible hose 150 and the curve pipe 160 are both attached to the mounting support 170. The curve pipe 160 is provided with a swivel connection or victualic coupling 162 to allow swivel movement of the curve pipe 160, so that the curve pipe 160 outlet may be oriented to a desired output direction. The curve pipe 160 may be provided with a constricted opening 164 or orifice having a smaller diameter than the curve pipe 160 (see FIG. 3B) to throttle fluid flow through an outlet of the curve pipe 160. The curve pipe 160 may be provided with a pressure gauge 166 for measuring fluid pressure through the curve pipe 160.

The mounting support 170 is attached to the curve pipe 160. The mounting support 170, which may be provided as a latch or hook, is configured to be coupled to a vessel 10 or rig during installation of the submersible pump assembly 100 so that the curve pipe 160 is suitably positioned on the vessel 10. When the submersible pump assembly 100 is installed and operating, water extracted by the submersible pump 140 would be transferred through the rigid pipe 130, the flexible hose 150 and the curve pipe 160. Water output from the curve pipe 160 may be appropriately oriented for utilization or transferred through a further hose 12 or pipe.

At least one wire sling 180 is connected between the mounting support 170 and the frame 110 to provide lifting support to the frame 110, the at least one first floatable device 120, the rigid pipe 130, and the submersible pump 140 (see FIGs. 1A, 1B and 3A). Suitable securing structures, e.g. pad-eyes 172, may be provided at the mounting support 170 and the frame 110 for allowing the wire sling(s) 180 to be secured thereto. Further, at intermediate positions along each wire sling 180, wire guide clamps 182, cable ties 184 or other coupling devices may be provided to couple the wire sling(s) 180 and electrical cables 186 (for providing electrical power supply to the submersible pump 140) to the flexible hose 150. This will prevent displacement of the flexible hose 150 from the wire sling(s) 180 especially during transfer and lifting of the submersible pump assembly 100. To provide lifting support, the wire sling(s) 180 are suitably dimensioned and arranged such that when the

mounting support 170 is being lifted, due to weight of the attached components thereunder (i.e. frame 110, at least one first floatable device 120, rigid pipe 130, and submersible pump 140), the wire sling 180 would be rendered in taut condition while the flexible hose 150 would be rendered in slack condition. This follows that the flexible hose 150 would not support the weight of the frame 110, first floatable device 120, rigid pipe 130, and submersible pump 140. Particularly, the wire sling(s) 180 may have a shorter length than the flexible hose 150.

At an intermediate location along the flexible hose 150, at least one second floatable device 190 is attached thereto. The second floatable device 190 is to provide buoyancy to the flexible hose 150, so that when the submersible pump assembly 100 is installed, at least a portion of the flexible hose 150 is buoyant on the water surface and is therefore visible to approaching boats or barges.

Various modifications that may be envisaged by a person skilled in the art may be made to the aforementioned assembly, including but not limited to the following:

Each of the rigid pipe 130, flexible hose 150 and curve pipe 160 may be provided as a single pipe or hose, or may be joined from a plurality of pipes or hoses. To connect pipes or hoses, victaulic coupling 162 may be employed.

The curve pipe 160 may be provided as a goose neck pipe as illustrated in the FIGs. or as other pipe shapes.

The mounting support 170 may be provided as a U-shaped bracket as illustrated in the FIGs. or as other suitable shapes.

The wire sling(s) 180 may be detachable from the mounting support 170 and frame 110 and re-attachable as and when required. In certain embodiments, the wire sling(s) 180 may be provided with the flexible hose 150 as a single unit. In certain other embodiments, the wire sling(s) 180 may not be included in the submersible pump assembly 100 and, accordingly, during transfer and installation of the

submersible pump assembly 100, care is to be taken to ensure that the flexible hose 150 does not bear weight of other assembly components to avoid damaging the flexible hose 150.

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Method of Installing and Operating the Submersible Pump Assembly

A method of installing and operating the submersible pump assembly 100 is described with reference to flow sequence 400 in Figure 4.

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In block 402, a submersible pump assembly 100 as described in the present disclosure is provided in the vicinity of an installation site.

In block 404, the submersible pump assembly 100 is installed in an operational position. Particularly, an installation procedure includes transferring, in assembled form, the frame 110, the at least one floatable device 120, the rigid pipe 130, and the submersible pump 140 into water. The transfer may be performed by lifting crane. After the transfer into water, the frame 110, the at least one floatable device 120, the rigid pipe 130 would be rendered buoyant. The submersible pump 140 is submerged in water, by virtue of its arrangement relative to the rigid pipe 130, at a depth determined by the length of the rigid pipe 130. The installation procedure further includes transferring the mounting support 170 and the curve pipe 160 to the vessel, and coupling the mounting support 170 and the curve pipe 160 to the vessel. Particularly, in the embodiment where the mounting support 170 is a U-shaped bracket, the mounting support 170 is latched or hung onto a railing or other mountable surface of the vessel. Upon installation, the curve pipe 160 outlet can be oriented to a desired direction. Also, the flexible hose 150 would be disposed in a slack condition in water and space between the vessel and the submerged pump.

In block 406, the submersible pump assembly 100 may be operated according to its intended purpose, e.g. extracting sea water through the submersible pump 140 and transferring the sea water through the rigid pipe 130 and the flexible hose 150 to be discharged from the outlet of the curve pipe 160.

In block 408, a height of the vessel 10 may be adjusted due to vessel installation or jack-up procedure. While the height of the vessel 10 is adjusting, the installed submersible pump assembly 100 is maintained in the operational position by utilizing a slack in the flexible hose 150 to accommodate the height adjustment of the vessel. Accordingly, the installed submersible pump assembly 100 according to the invention does not require disassembly and re-installation due to jack-up procedure and therefore saves time and reduces likelihood of accidents.

Various modifications that may be envisaged by a person skilled in the art may be made to the aforementioned method. For example, in the installation procedure of block 404, the mounting support 170 and the curve pipe 160 may be transferred to the vessel and coupled thereto before transferring, in assembled form, the frame 110, the at least one floatable device 120, the rigid pipe 130, and the submersible pump into water.

Apparatus for Storing and/or Transporting the Submersible Pump assembly

Reference is made to FIG. 5 which shows a submersible pump assembly 100 disposed in a storage or stowed position in which the submersible pump assembly 100 may be stored and/or transported, and to FIGs. 6A to 6D which show various views of an apparatus for storing the submersible pump assembly 100.

A storage apparatus 500 at least comprises a base platform 510, an upper platform 520, and a storage duct 530 connected therebetween. The storage duct 530 includes a first end attached to the base platform 510, and a second end attached to the upper platform 520. The second end of the storage pipe is arranged or joined in fluid communication with (to lead to) an opening on the upper platform 520. The opening (see FIGs. 6B, 6C and 6D) is configured to receive the submersible pump 140 into the storage duct 530 to house the submersible pump 140 therein in a storage position. The upper platform 520 is configured to support the at least one floatation device in the storage position. The base platform 510 is

configured to support the flexible hose 150 of the submersible pump assembly 100 in the storage position wherein the flexible hose 150 is coiled around the storage duct 530 and the coiled flexible hose 150 is supported on the base platform 510.

5 The base platform 510 includes a plurality of entryways 512 (see FIG. 5 and 6C). The entryways 512 are suitably dimensioned and arranged to receive therein prongs of a forklift truck for transporting the submersible pump assembly 100 in the storage position.

10 The upper platform 520 includes at least one lifting pad-eye disposed on the upper platform 520. The lifting pad-eye allows the storage apparatus to be secured to a lifting crane for transporting the submersible pump assembly 100 in the storage position.

15 The upper platform 520 further includes a railing 522 which is configured to allow coupling or latching of the mounting support 170 of the submersible pump assembly 100 thereon.

20 The base platform 510 further includes a plurality of guide members 514 removably attached thereto, which are to guide the flexible hose 150 into the space between the upper platform 520 and base platform 510 when the flexible hose 150 is being coiled around the storage duct 530. The guide members 514 may also provide a restraint to retain the coiled flexible hose 150 within the spatial boundary of the base platform 510.

25 A ladder 516 may be provided, connecting between the base platform 510 and the upper platform 520, to allow personnel access the upper platform 520 and the submersible pump assembly 100.

30 One or more openings 532 may be provided along the storage duct 530 to allow access to a submersible pump 140 housed within the storage duct 530. This allows the submersible pump 140 to be cleaned and maintained. A plurality of rings 534 may be arranged externally of the storage duct 530 and at an elevation from the

base platform 510 to allow personnel access the openings 532 and/or securing safety belt/harness (see FIG. 6A).

Brackets and/or reinforcement structures may be provided to increase the rigidity and strength of the storage apparatus. Particularly, the brackets may be installed at the base platform 510 and fixed to the storage duct 530; brackets may also be installed at the upper platform 520 and fixed to the storage duct 530.

Various modifications that may be envisaged by a person skilled in the art may be made to the aforementioned storage apparatus, including but not limited to the following:

While FIG. 6C shows entryways 512 provided on all sides of the base platform 510, it is to be appreciated that the entryways 512 may be provided at only some sides of the base platform 510 in certain embodiments.

While FIG. 6A and 6C show the guide members 514 being attached to corners of the base platform 510, it is to be appreciated that the guide members 514 may be attached at other locations along the base platform 510 in certain embodiments. It is also to be appreciated that the number, shape and location of guide members may be varied in certain other embodiments.

The storage duct 530 may be attached to the base platform 510 and the upper platform 520 by welding or mechanical coupling.

Embodiments of the invention provide several advantages, including but not limited to the following:

The flexible hose 150 of the submersible pump assembly 100 is provided with a slack which obviates the need to add or remove pipe spool when the vessel is jacked up or jacked down. In contradistinction with prior art system, the invention enables one-time installation of the submersible pump assembly during rig installation and,

accordingly, man-hours, equipment time, and accident rate would be greatly reduced.

5 The first floatable device 120(s) maintain the submersible pump 140 at a predetermined depth. This prevents the submersible pump 140 from being installed too low or insufficiently submerged.

10 The mounting support 170 allows the curve pipe 160 to be mounted onto a vessel by latching or slotting onto a railing or other mounting surface of the vessel. After installing the mounting support 170, the curve pipe 160 outlet may be oriented by personnel located in the inboard area. Since the need to access outboard space is obviated, safety of the installation procedure is greatly increased. This is in contradistinction with existing methods where personnel requires access to outboard space in order to mount and adjust the outlet of tower pump assembly and are
15 therefore highly prone to accidents.

The wire sling(s) 180 allow the submersible pump assembly to be lifted and transferred without requiring the flexible hose 150 to bear the weight of the system.

20 The storage apparatus 500 allows the submersible pump assembly to be stored and transported in an assembled form. This is in contradistinction with existing methods which require pipe spools to be disassembled prior to storage and transportation, and re-assembling prior to installation.

25 Other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the invention. Furthermore, certain terminology has been used for the purposes of descriptive clarity, and not to limit the disclosed embodiments of the invention. The embodiments and features described above should be considered exemplary, with the invention being defined by the
30 appended claims.

What is claimed is:

1. A submersible pump assembly comprising:

a frame;

5 at least one first floatable device attached to the frame;

a rigid pipe attached to the frame and having a first end and a second end;

a submersible pump attached to the first end of the rigid pipe;

a flexible hose having a first end and a second end, the first end of the flexible hose is connected in fluid communication with the second end of the rigid pipe;

10 a curve pipe connected in fluid communication with the second end of the flexible hose; and

a mounting support attached to the curve pipe for mounting the curve pipe onto a vessel.

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2. The submersible pump assembly of claim 1, further comprising: at least one wire sling connected between the mounting support and the frame to provide lifting support to the frame, the at least one floatable device, the rigid pipe, and the submersible pump.

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3. The submersible pump assembly of any of claims 1 and 2, further comprising: at least one second floatable device attached to the flexible hose at an intermediate location along the flexible hose.

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4. The submersible pump assembly of any of claims 1 to 3, wherein the curve pipe is provided with a constricted opening to throttle fluid flow therethrough.

5. The submersible pump assembly of claim 4, wherein the curve pipe includes a swivel connection to allow rotational movement of the curve pipe.

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6. The submersible pump assembly of any of claims 1 to 5, wherein the mounting support is a U-shaped bracket.

7. The submersible pump assembly of any of claims 1 to 6, wherein the curve pipe is a goose neck pipe.

5 8. A method comprising:

having a submersible pump assembly which comprises:

a frame,

at least one first floatable device attached to the frame,

10 a rigid pipe attached to the frame and having a first end and a second end;

a submersible pump attached to the first end of the rigid pipe,

a flexible hose having a first end and a second end, the first end of the flexible hose is connected in fluid communication with the second end of the rigid pipe,

15 a curve pipe connected in fluid communication with the second end of the flexible hose, and

a mounting support attached to the curve pipe for mounting the curve pipe onto a vessel; and

20 installing the submersible pump assembly in an operational position by transferring, in assembled form, the frame, the at least one first floatable device, the rigid pipe and the submersible pump into water, transferring the mounting support and the curve pipe to a vessel, and coupling the mounting support and the curve pipe to the vessel.

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9. The method of claim 8, further comprising: while a height of the vessel is being adjusted, maintaining the submersible pump assembly in the operational position by utilizing a slack in the flexible hose to accommodate the height adjustment of the vessel.

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10. An apparatus for storing a submersible pump assembly wherein the submersible pump assembly comprises a frame, at least one first floatable device attached to the frame, a rigid pipe attached to the frame and having a first end and a second end; a submersible pump attached to the first end of the rigid pipe, a flexible hose having a first end and a second end, the first end of the flexible hose is connected in fluid communication with the second end of the rigid pipe, a curve pipe connected in fluid communication with the second end of the flexible hose, and a mounting support attached to the curve pipe for mounting the curve pipe onto a vessel, wherein the apparatus comprising:

- a base platform;
- a storage duct; and
- an upper platform;

wherein the storage duct includes a first end attached to the base platform and a second end attached to the upper platform, wherein the storage duct is arranged to house the submersible pump in a storage position, the second end of the storage duct arranged in fluid communication with an opening on the upper platform which is configured to support the at least one floatation device, and the base platform is configured to support the flexible hose being coiled around the storage duct.

11. The apparatus of claim 10, wherein the base platform includes a plurality of entryways for receiving prongs of a forklift truck.

12. The apparatus of any of claims 10 to 11, wherein the upper platform includes at least one lifting pad-eye.

13. The apparatus of any of claims 10 to 12, wherein the upper platform includes a railing which is configured to allow coupling of the mounting support.

14. The apparatus of any of claims 10 to 13, wherein the base platform includes at least one guide member removably attached to a plurality of corners of the base platform.

15. The apparatus of any of claims 10 to 14, wherein the storage duct is provided with at least an opening for accessing the submersible pump in the storage position.

5 16. The apparatus of any of claims 10 to 15, further comprising: a plurality of rings arranged external of the storage duct at an elevation from the base platform.

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