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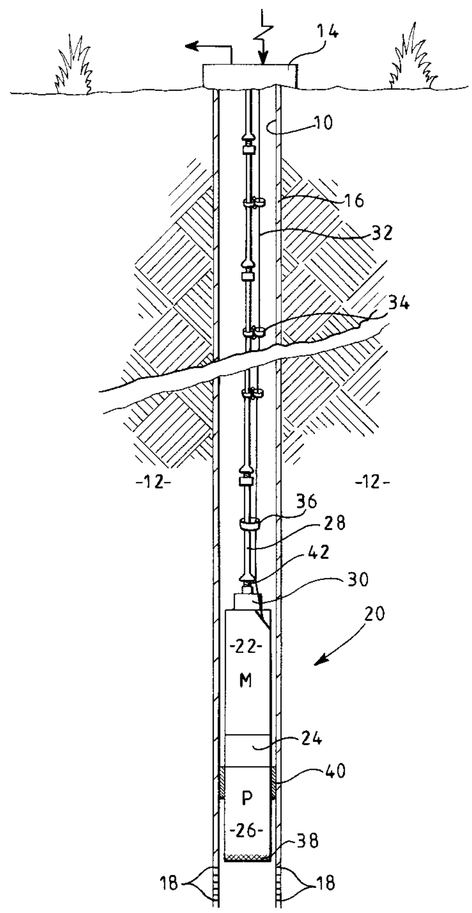
(54) **System for deploying an electrical submersible pump within a wellbore**

(57) A system and related method for deploying an electric submergible pumping system within a wellbore comprises an electric submergible pumping system (20) with an electrical cable (32) operatively connected thereto. A plurality of sucker rods (28) are connected together to form a sucker rod string, with one end of the sucker rod string connected to the electric submergible pumping system. The electrical cable (32) is attached to the sucker rod string (28) at a plurality of spaced locations by clamping (34) or banding (36). This deployment system permits the use of relatively inexpensive and manoeuvrable rigs/cranes for the installation, removal and repair of the electric submergible pumping system rather than having to use conventional relatively expensive and large workover rigs.



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Description

The present invention relates to electric submergible pumping systems (ESPs) used for recovering fluids from subterranean wellbores and, more particularly, systems and related methods for deploying such ESPs within wellbores.

Electric submergible pumping systems (ESPs) are widely used around the world for recovering fluids from subterranean wellbores because ESPs have the broadest performance capabilities of any artificial lift system. For example, ESPs are commercially available that are sized to efficiently lift from only about 100 bbl/day up to 95,000 bbl/day; from depths as great as 15,000 ft; and in wells with bottomhole temperatures ofup to 450 degrees F. Typical examples of an ESP suspended in a well on conventional production tubing are shown in US 3,83 5,929 and US 4,187,912. For all of their inherent benefits, ESPs have not been as widely used as desired because of the relatively high cost and/or lack of availability of suitable workover rigs and derrick structures to install and remove the ESPs. This situation is especially true for offshore wells where workover rigs are extremely expensive, as compared to their onshore equivalents.

To address the issue of the need to use a workover rig, several inventors have conceived of suspending an ESP from coiled tubing in a well to take advantage of the relatively low cost and ease of transportation of the units used to install and remove coiled tubing. Coiled tubing is a continuous length of tubing coiled onto a reel or drum. The drum is driven to the well site where a motorised injector unit is removably mounted on the wellhead to feed the tubing into the well. The same drum and injector unit is used to pull the tubing out of the well. Coiled tubing is widely used for logging deviated wellbores, well stimulation, cementing, perforating, drilling and well cleaning. With an ESP suspended on coiled tubing, the previously detrimental issues of relatively high cost and lack of availability of workover rigs are eliminated. Examples of ESPs suspended on coiled tubing are shown in US Patents 4,336,415; 4,345,784; 4,374,530; 4,476,923; 4,938,060; and 5,180,014; as well as GB Patent 2,252,777A.

While coiled tubing has many benefits as a means for suspending an ESP within a wellbore, the coiled tubing rig and injector equipment are often too large and/or too tall to fit on relatively small sites, such as on a small offshore platform or in Arctic rig enclosures. Therefore, there is a need for a yet more compact and lightweight system and related methods for deploying an ESP within a wellbore.

The inventors hereof have successfully tested an ESP suspended on coiled tubing in a well and have developed several novel features that meet the above needs and overcome the foregoing disadvantages. Specifically, the present invention is a system and related method for deploying an electric submergible pumping system within a wellbore. The electric submergible pumping system has an electrical cable operatively connected thereto. A plurality of sucker rods are connected together to form a sucker rod string, with one end of the sucker rod string connected to the electric submergible pumping system. The electrical cable is attached to the sucker rod string at a plurality of spaced locations by clamping or banding. This deployment system permits the use of relatively inexpensive and manoeuvrable rigs/cranes for the installation, removal and repair of the electric submergible pumping system rather than having to use conventional relatively expensive and larger workover rigs.

The single figure of the accompanying drawing is a side elevational view of an electric submergible pumping system deployed within a wellbore on a sucker rod string in accordance with one preferred embodiment of the present invention.

As briefly stated above, the present invention is a system and related method for deploying an ESP within a wellbore, utilising a sucker rod string in place of jointed tubing, coiled tubing and cable. This deployment system permits the use of relatively inexpensive and manoeuvrable rigs/cranes for the installation, removal and repair of the ESP rather than having to use conventional relatively expensive and larger workover rigs. In addition, sucker rods are relatively inexpensive as compared to joined tubing, coiled tubing and non-torque cable.

To aid in the understanding of the present invention, reference is made to the accompanying drawing. As shown in the drawing, a wellbore 10, used for recovering fluids such as water and/or hydrocarbons, penetrates one or more subterranean earthen formations 12. The wellbore 10 includes a wellhead 14 removably connected to an upper portion of a production tubing and/or casing string 16, as is well known to those skilled in the art. If the casing string 16 extends across a fluid producing subterranean formation 12, then the casing string 16 can include at least one opening or perforation 18 for permitting fluids to enter the interior thereof. An electric submergible pumping system (ESP) 20 is shown suspended within the casing string 16, and generally comprises an electric motor 22, an oil-filled motor protector 24, and a pump 26, such as a centrifugal, gear, vane, turbine or positive displacement pump. The ESP 20 is shown in an "up-side down" configuration, commonly known as a "bottom intake system", with the motor 22 above the pump 26, but it should be understood that a conventional configuration with the motor 22 connected below the pump 26 can be used, as desired.

The ESP 20 is operatively connected to a lower end of a length of conventional sucker rod 28 by way of a threaded connector 30. A string of connected sucker rods 28 acts as a strength member to fully support the weight of the ESP 20; however, as an alternative, the casing string 16 can include a casing shoe (not shown) whereupon a lower portion of the ESP 20, such as the pump 26 is landed to transfer the weight of the ESP 20 to the casing string 16. The sucker rods 28 can be of any commercially available size (i.e. diameter and length) and formed from any material suitable to the wellbore conditions, as all is well known in the art. For examples, sucker rods are made from ferrous metals, ceramics, carbon fibres, fibreglass, or combinations of these.

An electrical cable 32 is operatively connected to the ESP 20 to provide electrical power to the motor 22, and is operatively connected at the surface to surface electrical control equipment and a source of electrical power (both not shown), as are both well known in the art. Commercially available electrical cable 32 typically used with ESPs 20 does not have sufficient internal strength to support its own freely suspended weight; therefore, a plurality of bolt-on clamp devices 34 are used to attach the cable 32 to outside ofthe sucker rods 28. The clamp devices 34 are spaced about every 10 to about 200 feet apart, and are preferably spaced about every 20 to 100 feet apart. The clamp devices 34 can be used alone or in conjunction with one or more plastic or metallic bands or straps 36, as commonly used to band electrical cable to the outside of production tubing in a well. It should be understood that any form of wrap-around tape, string, band, or straps may be used in the practice of the present invention in conjunction with or apart from the clamp device 34. Further, if the cable 32 includes its own steel wire strength member or members then the clamp devices 34, straps, bands, etc. may not be necessary for a successful application of the present invention. In any event, some form of clamp device 34 is desired to prevent the cable 32 from being loose within the well where movement thereof may cause damage to it by rubbing against the interior surface of the casing string 16.

The annular production arrangement shown in the drawing has a pump intake 38 located adjacent a lower portion of the well 10 adjacent the perforations 18, as desired, or in any other location and configuration suitable to those skilled in the art. One or more sealing devices 40 are used to seal the annular space between the interior of the casing string 16 and the exterior of the ESP 20. The sealing devices 40 are preferably one or more retrievable or permanent elastomeric packing elements or "packers", and contact the exterior of the ESP 20 above the pump intake 38 but below the fluid discharge opening of the pump 26.

In one preferred method of the present invention, the ESP 20 is connected to one end of a first length of sucker rod 28 by way of a threaded male-female coupling 42, which type of coupling is also used to couple each of the sucker rods 28 together to form a sucker rod string, as is well known to those skilled in the art. The elevators on a typical workover rig (not shown) fasten to the coupling 42 to suspend the ESP 20, whereafter the cable 32 is banded or strapped or clamped to the sucker rods 28. The elevators lower the ESP 20 and the sucker rods 28 into the wellbore 10 as additional lengths of sucker rods 28 are connected thereto to form the sucker rod string that suspends the ESP 20. When the ESP 20 is to be retrieved, the workover rig is brought to the well site, the elevators connected to the topmost sucker rod 28, and then the elevators are used to raise the sucker rod string and the ESP, as is well known to those skilled in the art.

The use of sucker rods to deploy an ESP has many advantages over the use of conventional jointed tubing, coiled tubing and cable. Sucker rods are reusable, have almost indefinite life, and are far less expensive per unit length than jointed tubing, coiled tubing and cable. The use of sucker rods permits the use of relatively small, lightweight, and inexpensive workover rigs for installation and retrieval. This is especially important for small offshore platforms where space and weight considerations are very important. In addition, the time to install and retrieve an ESP by use of sucker rods is less than for other methods due to the ease of set up and rig down of the workover rig as compared to larger workover units needed for jointed tubing and coiled tubing units.

Wherein the present invention has been described in particular relation to the drawing attached hereto, it should be understood that other and further modifications, apart from those from those shown or suggested herein, may be made within the scope of the present invention as defined in the claims.

Claims

1. A system for deploying an electric submergible pumping system within a wellbore, comprising: an electric submergible pumping system; an electrical cable operatively connected to the electric submergible pumping system; a plurality of sucker rods connected together to form a sucker rod string, with one end of the sucker rod string connected to the electric submergible pumping system; and means for attaching the electrical cable to the sucker rod string at a plurality of spaced locations.

2. The system of Claim 1, wherein the sucker rods are formed from a material selected from the group consisting of ferrous metals, ceramics, carbon fibres, fibreglass, and combinations thereof.

3. The system of Claim 1 or Claim 2, wherein the electric submergible pumping system comprises an electric motor assembly, with the electrical cable operatively connected thereto, and a pump.

4. The system of Claim 3, wherein the sucker rod string is connected to one end of the pump.

5. The system of Claim 3, wherein the sucker rod string is connected to one end of the motor assembly.

6. The system of any of the preceding claims, wherein the means for attaching further comprises a plurality of bolt-on clamps.

7. The system of any of the preceding claims, wherein the means for attaching further comprises a plurality of bands.

8. A method of deploying an electric submergible pumping system within a subterranean wellbore, comprising:

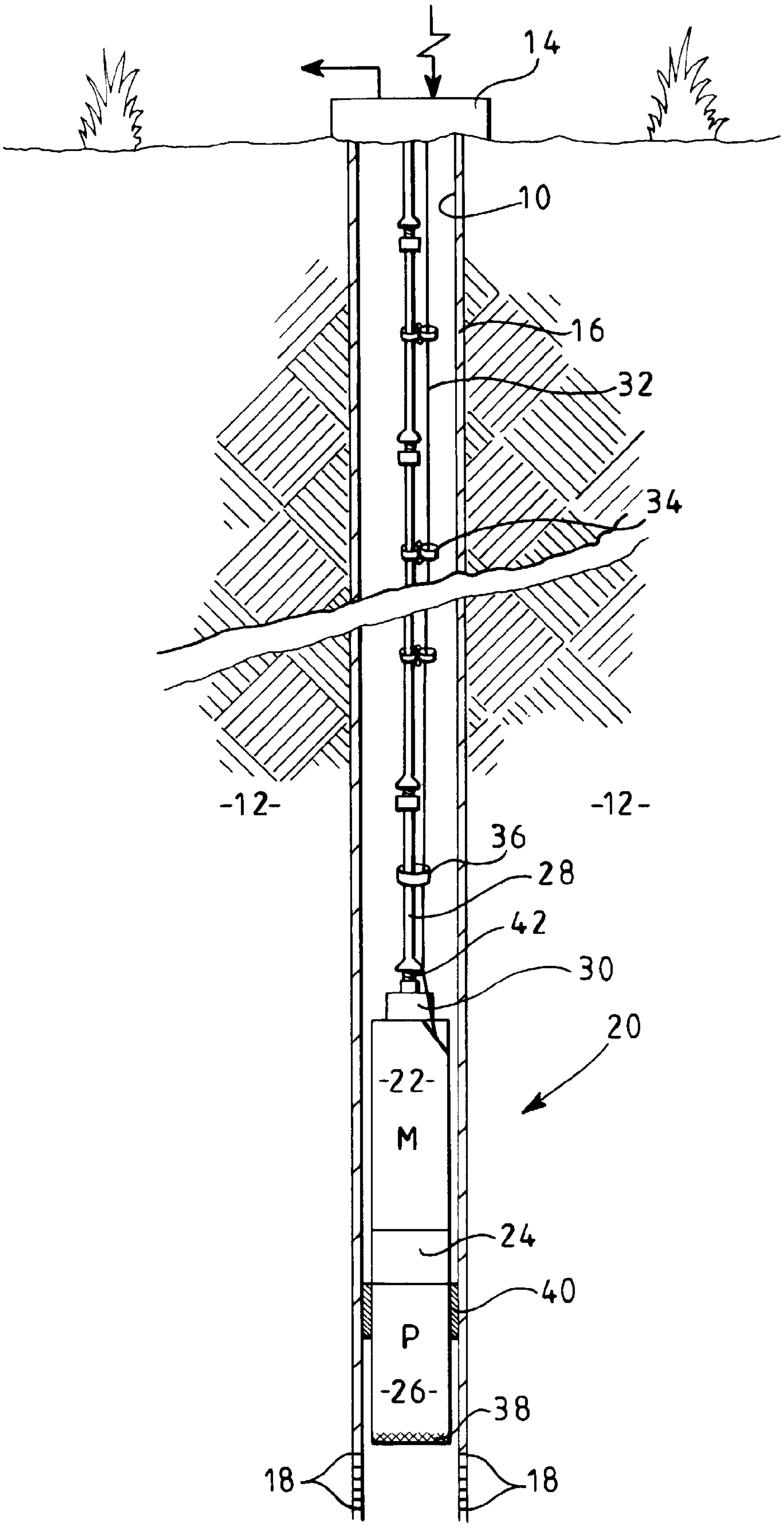
(a) operatively connecting one end of an electrical cable to an electric submergible pumping system;
(b) operatively connecting one end of a first length of sucker rod to the electric submergible pumping system;
(c) connecting additional lengths of sucker rod to the first length of sucker rod as the electric submergible pumping system is lowered into the wellbore; and
(d) attaching the electrical cable to the lengths of sucker rod as the electric submergible pumping system is lowered into the wellbore.

9. The method of Claim 8, wherein the first length of sucker rod is operatively connected to a motor assembly within the electric submergible pumping system.

10. The method of Claim 8, wherein the first length of sucker rod is operatively connected to a pump within the electric submergible pumping system.

11. The method of any of Claims 8 to 10, wherein the electrical cable is attached to the lengths of sucker rod by clamping.

12. The method of any of Claims 8 to 11, wherein the electrical cable is attached to the lengths of sucker rod by banding.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