

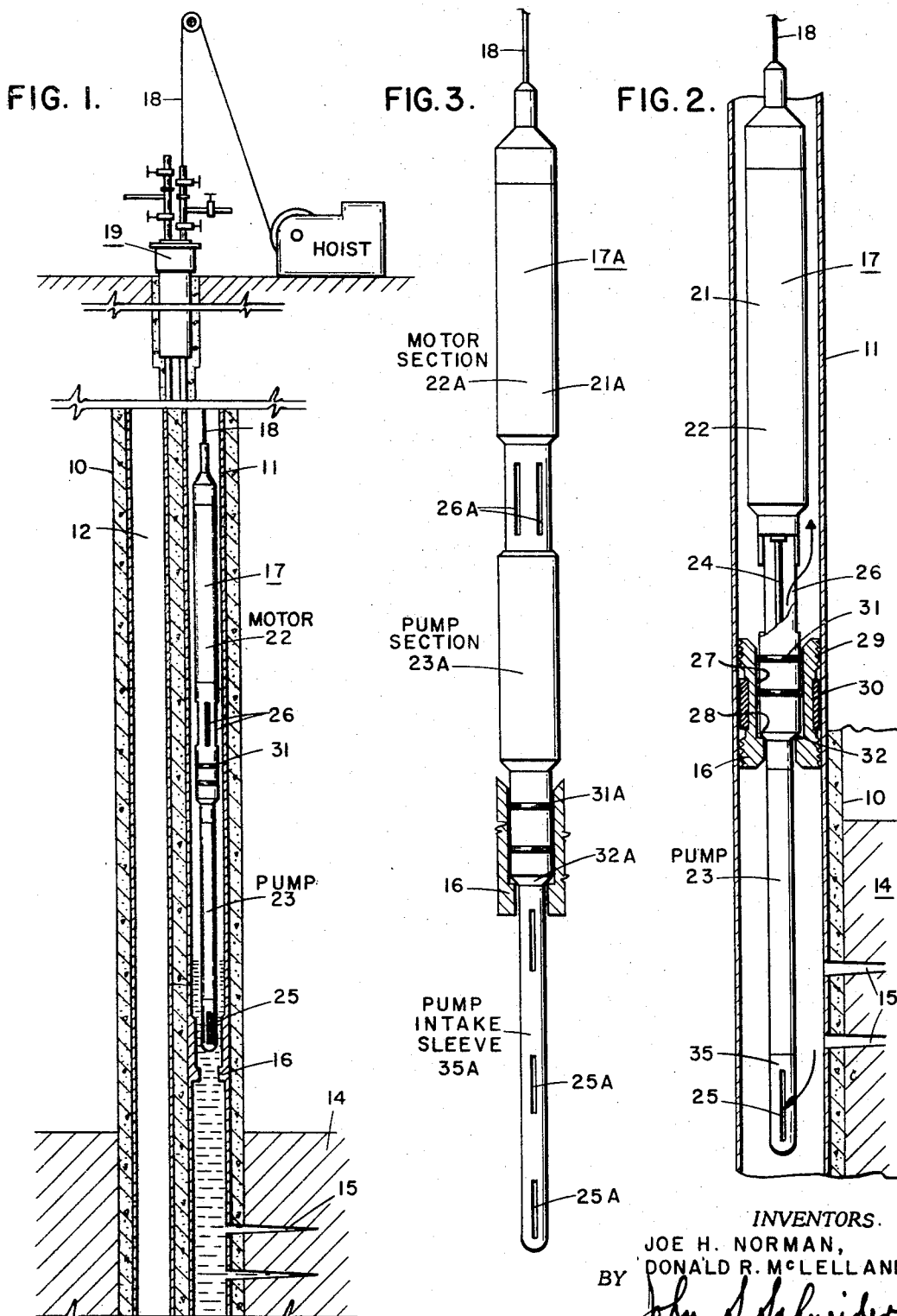
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SUBMERSIBLE ELECTRIC WELL PUMP OPERATION

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SUBMERSIBLE ELECTRIC WELL PUMP OPERATION

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ABSTRACT OF THE DISCLOSURE

A submersible electric well pump lowerable through well pipe on an electrical conductor cable onto a preset pump support arranged in the well pipe. The pump support, which may be set by wireline or may be a permanent installation in the well pipe, forms a restricted opening axially in the well pipe, and when the pump is lowered and seated thereon, an upper motor section of the pump is preferably located above the pump support. The pump is retrievable from the well pipe by the conductor cable, which also supplies power to the motor section to operate the pump.

BACKGROUND OF THE INVENTION

The present invention concerns well pump assemblies and method of operation thereof, and particularly electrically powered well pump assemblies adapted to be lowered to and raised from operating levels in well pipes by means of an electrical conductor cable which also functions to supply electrical power from the earth's surface to operate the pump assembly. No known well pump operation utilizes, as in the present invention, a preset pump support to provide a seat in a well pipe for an electrically operated pump which is run in the pipe on an electrical conductor cable, seated in the pump support, and operated and retrieved by means of the electrical power cable. No tubing or pipe is used to position or suspend the pump in the well. Further, no known well pump is specifically designed for operation in small diameter pipe strings such as those used in multiple tubing-less completions. One important feature of the invention is the preferred location of the motor section above the pump section when the pump is in operating position in the well pipe. Such an arrangement permits a maximum outside diameter for the motor section, which is especially desirable in small diameter pipe in order for the motor unit to supply adequate operating power to the pump section. The pump is very adaptable for use in low gas-liquid ratio oil and water wells.

SUMMARY OF THE INVENTION

A submersible pump assembly suspendible on an electrical conductor cable in well pipe in which is arranged a pump assembly support means having an axial bore therethrough which restricts the opening through the well pipe to the opening of the bore comprising:

A housing having arranged therein a motor section, a pump section, and means operatively connecting said motor section and said pump section for driving said pump section; and

Seating means arranged on said housing adapted to seat on said pump assembly support means and sealingly engage said bore;

Said housing having pump-intake ports arranged below said seating means, and pump discharge ports arranged above said seating means when said pump assembly is seated on said pump assembly support.

The invention also concerns a method for operating in wells which comprises the steps of:

Arranging in a well pipe a pump support which forms a

restricted opening extending axially in said well pipe and provides a pump seating means therein;

Lowering into said well pipe on an electrical conductor cable a pump having a motor section and means adapted to engage said pump seating means and close off the space between the exterior of said pump and the interior surface of said opening;

Seating said pump onto said pump seating means;

Creating a hydrostatic head in said well pipe above said pump support; and

Then operating said pump to pump hydrocarbons from below to above said pump support and thence from said well pipe.

The hydrostatic head may be created by initially operating said pump to pump liquid from below to above said pump support.

A primary object of the present invention is to provide an improved electrically operated pump capable of use in all sizes of well pipe. Another important object of the present invention is to provide a well pump assembly which can be easily lowered to and removed from its operating level in well pipe.

These objects and other objects and advantages of the invention will be apparent from the following description of the invention when taken with the drawings, wherein:

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic illustration of a well bore containing a plurality of pipe strings, in one of which a pump assembly made in accordance with the present invention is being lowered;

FIG. 2 is a vertical, partly sectional view of the pump assembly shown in FIG. 1 seated in the well pipe in operating position; and

FIG. 3 is a vertical view of a modified pump assembly in its operational position.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in FIG. 1, a well bore 10 contains a plurality of pipe strings 11 and 12, run and cemented in place in accordance with conventional well completion practices. At the level of a hydrocarbon-bearing zone 14 it is desired to produce, tubing string 11 and zone 14 are perforated as at 15. A pump seat 16 is preset in tubing string 11 adjacent zone 14. A pump assembly or unit 17 is being lowered through tubing string 11 on an electrical conductor cable 18 which passes upwardly through well head 19 to a suitable source of electrical power, not shown.

In FIG. 2, pump assembly 17 is shown seated on pump seat 16 in operating position. Pump assembly 17 is composed of a housing 21 which encloses an enlarged diameter upper electric motor section 22 and a lower, smaller diameter pump section 23 operably connected together by a rotatable steel drive shaft 24. A plurality of pump-intake openings or slots 25 are located in a pump-intake sleeve or nipple 35 near zone 14. Pump-discharge perforations 26 are located in housing 21 below motor section 22 but above pump seat 16.

Pump seat 16 is a preset packer-support provided with a bore 27 therethrough and having a seating nipple 28 formed therein. A wireline set packer, which includes pipe gripping elements 29 and seals 30 for sealing off the space between pump seat 16 and the interior wall of tubing string 11, may be utilized. Such a preset packer may be one of the many types currently manufactured, e.g., (1) Baker Oil Tools, Inc. Model "FA" wireline set packers illustrated on page 530 of the 1966-67 Composite Catalog of Oil Field Equipment & Services, or (2) Otis Engineering Corporation's Model "WA" wireline set packer illustrated on page 3792 of the 1966-67 Composite

Catalog of Oil Field Equipment & Services. Alternatively, pump seat 16 could be a seating shoe such as illustrated on page 3824 or a landing nipple such as shown on page 3816 of the Composite Catalog, where the seating shoe or landing nipple is permanently installed in the pipe string.

Housing 21 is provided with seals 31 for sealing off the space between the exterior surface of housing 21 and the wall of bore 27 when seating shoulder 32 formed on housing 21 is seated on landing nipple 28.

Once pump assembly 17 is properly seated on pump seat 16 in pipe string 11, the surface end of cable 18 is connected to a suitable power source and the pump is operated to pump hydrocarbons from tubing string 11 through a flowline on well head 19.

In operation, pump seating unit 16 is run in pipe string 11 to a desired depth in accordance with procedures well known in the art. Alternatively, pump seating unit 16 could be prefabricated in tubing string 11 as a permanent part thereof and run into the well to the desired depth when tubing string 11 is run in the well. In either case, a narrow opening is formed in tubing string 11 sufficiently large for pump section 23 to pass through but not motor section 22. Also, a seat for pump assembly 17 is provided by the pump seating unit. Pump assembly 17 is then lowered in tubing string 11 and landed in seating nipple 28 on seating unit 16 by means of electrical conductor cable 18. Pump assembly or tool 17 is seated by its own weight. The weight of pump assembly 17 forces it down into seating nipple 28. Cable 18 is then connected to a source of electrical power at the earth's surface, and motor section 22 is operated to drive pump section 23 through shaft 24 to raise well fluid in tubing string 11 from below to above pump seating unit 16 via the flow path indicated by the arrows, i.e., through pump-intake openings 25 and pump discharge openings 26. Hydrostatic pressure in tubing string 11 above pump seating unit 16 resulting from the hydrostatic head of the liquid pumped into the upper end of tubing string 11 in this manner assures seating of pump assembly 17. The presence of the hydrostatic head above pump seating unit 16 and the upper end of pump assembly 17 resulting from such pump action will tend to force pump assembly 17 down and thereby seat it firmly in the seating nipple 28 of pump seating unit 16. Alternatively, liquid could be pumped down tubing string 11 from the earth's surface to create a similar hydrostatic head above pump seating unit 16 and pump assembly 17 to aid in seating the pump assembly. In either event, the only force holding pump assembly 17 in the pump seating unit 16 is the weight of the pump assembly and the hydrostatic head above it.

Once pump assembly 17 is firmly seated, motor section 22 is supplied power from the surface through cable 18 to drive pump section 23 and pump hydrocarbons from zone 14 through pump-intake openings 25 and out pump discharge openings 26 and through flowline 33 at the earth's surface.

At any time it is desired to remove pump assembly 17 for repair or replacement, power from the surface is shut off and the pump assembly is stopped and remains inoperative, preferably for one or two days prior to pulling it from tubing string 11 in order to allow the liquid above the pump assembly to drain back through pump discharge openings 26 and pump-intake openings 25 into formation or zone 14. The differential pressure across pump assembly 17 being therefore equalized, it is unseated and pulled out of tubing string 11 by electrical cable 18.

Details of the pump section have not been shown, however, any conventional well pumping unit might be used.

For example, vanes rotated by drive shaft 24 would make suitable pumping elements.

A modified pump assembly 17A is illustrated in FIG. 3, composed of a pump section 23A located along with a motor section 22A above seals 31A and seating shoulder 32A formed on housing 21A. A sleeve or nipple 35A, provided with pump-intake perforations 25A, extends below seating shoulder 32A and fluidly communicates with pump section 23A. Pump discharge perforations 26A are provided in housing 21A between pump section 23A and motor section 22A. The pump section can be made as large as the motor section in this embodiment of the invention.

The operation of pump assembly 17A, including the steps of setting, removing, and operating it, are the same as those operations described above with respect to pump assembly 17.

The invention described herein is not to be considered limited to the specific embodiment shown and described, or to the specific arrangement of parts shown and described. Rather, various modifications and changes may be made without departing from the spirit or scope of the invention.

Having fully described the objects, advantages, apparatus, method, and operation of our invention, we claim:

1. A method for operating in wells comprising the steps of:

arranging in a well pipe a pump support which forms a restricted opening extending axially in said well pipe and which provides a pump support means therein;

lowering into said well pipe on an electrical conductor cable a pump having a motor section, a pump section, and seating means, said seating means being adapted to seat on and engage said pump support means and close off the space between the exterior of said pump and the interior of said opening;

seating said pump seating means onto said pump support means;

creating a hydrostatic head above said pump support means to assure firm seating of said pump seating means in said pump support means;

operating said pump to pump well fluids from said well pipe;

shutting down operation of said pump;

waiting a sufficient time until liquid above said pump drains back through said pump to below said pump support means; and

then removing said pump from its seat on said pump support means and from said well pipe by means of said conductor cable.

2. A method as recited in claim 1 in which said hydrostatic head is created by operating said pump to pump fluid from below to above said pump support means.

3. A method as recited in claim 1 in which said hydrostatic head is created by pumping liquid down the well pipe from the surface.

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