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SPECIAL PURPOSE ELECTRIC MOTOR

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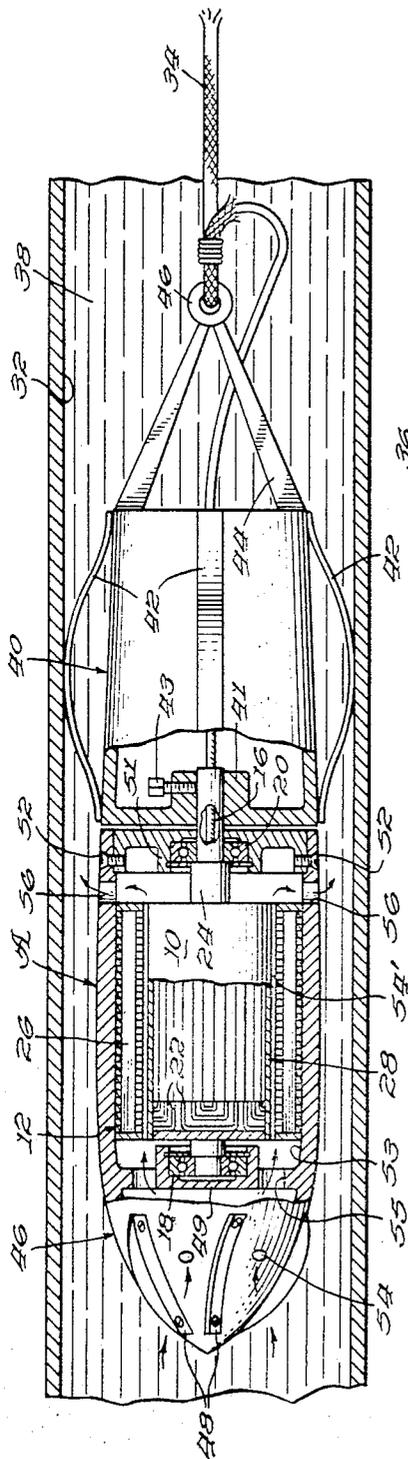


FIG. 1.

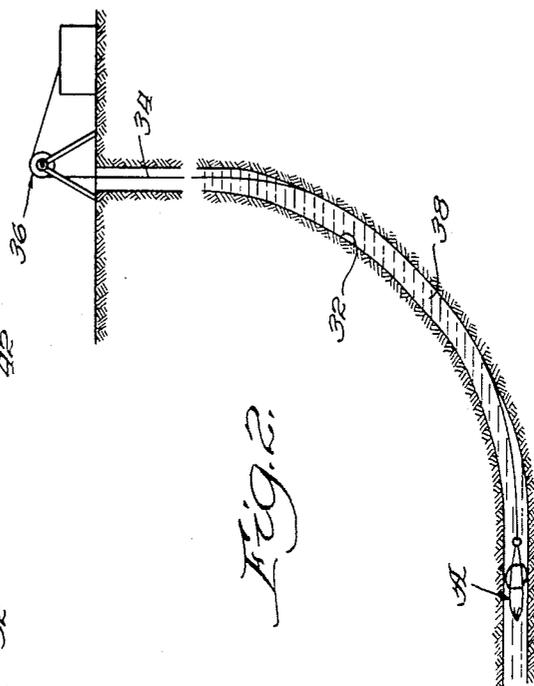


FIG. 2.

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# UNITED STATES PATENT OFFICE

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## SPECIAL PURPOSE ELECTRIC MOTOR

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1 Claim. (Cl. 310-67)

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The present invention relates to a special purpose electric motor especially adapted for use under extremely adverse operating conditions.

One example of such adverse operating conditions occurs in the art of oil or gas well drilling or servicing. In the drilling or servicing of oil and gas wells, it is frequently necessary to lower into the well bore certain instruments or tools, as for example, surveying instruments. Such an operation is normally not especially difficult where the well bore is substantially vertical. When, however, the well bore is of the whipstocked or directional type, it may include extreme vertical discontinuities; some portions of such wells actually approaching or exceeding the horizontal. Accordingly, it commonly occurs that considerable difficulty is encountered when lowering tools into a whipstocked well bore.

The usual manner of lowering a tool into a well bore is by means of a cable. Where, however, the bore is of the whipstocked type, having portions which veer far from the vertical, it becomes necessary to force the tool down the well bore by means of a string of tubing. Since such string must necessarily be made up of a great number of individual lengths of tubing, considerable time and effort is required for this operation. Accordingly, it is far more desirable to be able to lower the tool by means of a cable.

It has been suggested therefore, that in order to make it possible to utilize a cable for lowering a well tool into a whipstocked well bore, the tool be coupled to a source of traction adapted to pull the tool through the well bore. The source of traction may take the form of an electric motor, which motor receives its power from the same cable utilized to support the tool. This motor is adapted to rotate a propeller whereby the motor and tool may be pulled downwardly through the fluid in the well bore. When the tool is to be removed, the direction of rotation of the motor and propeller may be reversed.

The use of a conventional electric motor for the above-described purpose is not practical in view of the problems involved in providing an effective seal for the motor windings, and also because of the difficulty involved in cooling the motor and its bearings. In this regard, the conventional electric motor must be sealed from the well fluids, and accordingly a seal must be provided for its shaft. Such sealing of its shaft is extremely difficult, however, inasmuch as the pressure differential may exceed 1700 pounds per square inch, while the temperature may exceed 120° Fahrenheit. These pressure and tempera-

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ture conditions result in rapid wearing of the shaft seal as well as considerable power loss as the shaft is rotated. Such conditions of heat likewise results in a short service life for the motor windings and bearings.

It is a major object of the present invention to provide an electric motor which may be used under conditions of extreme pressure and temperature without the use of a shaft seal.

Another object of the present invention is to provide an electric motor which may be utilized under conditions of extreme pressure and temperature, and yet which will have a long service life.

It is a more particular object of the present invention to provide an electric motor which may be effectively utilized in a well bore containing fluid existing at a high pressure and temperature.

These and other objects and advantages of the present invention will become apparent from the following description of a preferred embodiment thereof, taken in conjunction with the appended drawings, wherein:

Figure 1 is a longitudinal side view, partly broken away in section, showing the novel special purpose electric motor of the present invention as embodied in a special well bore apparatus; and,

Figure 2 is a view showing the manner of operation of the well bore apparatus of Figure 1.

Referring to the drawings, the novel special purpose motor of the present invention is shown incorporated in a well bore apparatus designated A. This motor broadly comprises a generally cylindrical primary 10 and a generally tubular secondary 12 coaxial with and concentric to the primary. The secondary 12 is adapted for rotation relative to the primary 10 about their common axis. Front and rear ball bearings, 18 and 22, respectively, are shown interposed between the primary 10 and the secondary 12 whereby such rotation may take place. The primary 10 is connectible to a source of electric power (not shown) by conduit means 16.

More particularly, the primary 10 includes windings 22 disposed in a generally cylindrical configuration about a longitudinal axis, which windings are supported upon a fixed shaft 24 coinciding with the longitudinal axis. The secondary 12 includes a plurality of longitudinally extending conductor bars 26 disposed in a generally tubular configuration coaxial with and concentric to the windings 22. Preferably, the rear portion of the shaft 24 is hollow whereby to

house the conduit means 16. A non-magnetic and fluid-tight shield 28 is shown enclosing the windings 22 of the primary 10 for a purpose to be set forth hereinafter. From this description it will be apparent that upon connection of the conduit means 16 with a source of electric power there will take place relative rotation between the primary 10 and the secondary 12.

As mentioned previously hereinbefore, the special purpose motor of the present invention is especially adapted for use with a well bore apparatus A. Referring to Figure 2, this apparatus is shown disposed in a whip-stocked well bore 32. The slope of this well bore is seen to be of such a nature as to prevent the efficient use of a cable as lowering means for the apparatus A. It should be understood that this slope is exaggerated in Figure 2 in the interest of clarity.

The apparatus A is supported by a cable 34, which cable in turn is connected to a surface-located manipulating device 36. This cable is preferably of the type having integral electric conducting wires. In Figure 2 the apparatus A is shown in the process of being lowered through the well bore 32, which well bore is seen to contain fluid 38. As mentioned previously hereinbefore, such fluid commonly exists at a high pressure and temperature.

Referring again to Figure 1, the apparatus A may comprise a stationary member 40 wherein is located any desired instruments or tools, such as for example, a well surveying instrument. If such instrument is of the electrically operated type, it may readily receive current from the cable 34. Stationary member 40 is shown as mounting outwardly-bowed springs 42 for centralizing the apparatus A relative to the well bore 32, as well as for restraining rotation of the stationary member relative to such bore. A bracket 44 secured to the rear of the stationary member 40 supports a mounting loop 46 for the cable 34. The stationary member 40 mounts at its forward portion, a rotatable member 46 having blades 48, which blades are seen to be curved whereby rotation of the rotatable member will cause the apparatus to be pulled through the well bore fluid 38. Preferably, these blades 48 will be removable relative to the rotatable member 46 whereby their replacement is facilitated.

The primary 10 is shown rigidly connected to the stationary member 40 by means of the shaft 24, which shaft is in turn rigidly affixed to a boss 41 formed on the stationary member, as by a stud bolt 43. Preferably, the shaft 24 will extend beyond the front end of the primary windings 22 whereby it may rotatably support the front portion of the rotatable member 46. To this end the inner race of the bearing 18 is seen to be rigidly affixed to the front of the shaft, while its outer race is shown positioned within a spider 49, which spider is formed upon the rotatable member. Similarly, the inner race of the bearing 20 is shown rigidly affixed to the rear portion of the shaft, while its outer race is positioned within a spider 51. Preferably, this spider 51 will be removably secured within the stationary member, as by bolts 52. The two spiders 49 and 51 define between them an annular motor compartment 53 wherein is rigidly mounted the secondary 12.

Preferably, the nose of the stationary member will be formed with apertures 54, the spider 49 with bores 55, and the side walls with apertures

56. With this arrangement, upon rotation of the primary 10, fluid may pass through the annular gap 54' separating the primary and the secondary, as indicated by the arrows in Figure 1. The fluid passing through this annular gap will have a heat-transferring relationship with both the primary and the secondary whereby to reduce the temperature thereof.

In operation, the apparatus A will be lowered into the well bore 32 by means of the manipulating device 36. When the fluid-containing portion of the well bore is reached, electric current will be transmitted to the primary windings 22 through the cable 34. At this point the secondary 12, and hence the rotatable member 46, will commence rotation relative to the stationary member 40. Such rotation will cause the blades 48 to pull the apparatus A downwardly through the well bore. During this time, the primary windings 22 and the bearings 18 and 20 will be cooled by the well bore fluid passing through the annular gap 54'. This fluid will be prevented from contact with the primary windings 22 by the non-magnetic fluid-tight shield 28, which shield may preferably be formed of copper. When it is desired to retrieve the apparatus A, either the direction of rotation of the secondary 12 may be reversed whereby the blade 48 will tend to push the tool out of the well bore, or alternately, the cable 34 alone may be used to pull the apparatus upwardly out of the well bore.

It will be apparent to those skilled in the art that the novel electric motor of the present invention may be utilized for many other special purposes apart from the apparatus A described hereinabove. For example, this motor may prove very well adapted for use with pumps and blowers, especially where such devices must operate under extremely adverse pressure and temperature conditions. Accordingly, we do not wish to be limited to the specific structural details described hereinbefore, but solely by the scope of the following claim.

We claim:

Apparatus for pulling a tool into a well bore comprising: a cylindrical base member which is adapted to be lowered into a fluid-containing well bore and to house said tool; a plurality of outwardly-bowed flexible, longitudinally extending spring elements for engaging the walls of said well bore to restrain rotation of said base member relative to the longitudinal axis of the well bore; an electric current-carrying cable secured to the rear of said base member for lowering said apparatus into said well bore; a rotatable cylindrical member disposed forwardly of said base member, said rotatable member having a motor compartment; a coaxial hollow shaft rigidly mounted at its rear end to the front of said base member and extending forwardly therefrom; blade means removably attached to the front portion of said rotatable member, said blade means being adapted to pull said apparatus through said well bore upon rotation of said rotatable member; bearing means interposed between said shaft and said rotatable member at the front and at the rear of said windings whereby said rotatable member may rotate upon said shaft; a coaxial primary formed of windings disposed in a generally cylindrical configuration about said shaft within said motor compartment; conduit means extending rearwardly through said shaft from said primary for connection to said cable in order that elec-

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tric current may be supplied to said primary; a non-magnetic fluid-tight shield enclosing said primary windings; a secondary including a plurality of longitudinally extending conductor bars arranged in a generally tubular configuration coaxial with and concentric to said primary windings, said secondary being rigidly mounted within said motor compartment; intake apertures formed in the front portion of said rotatable member in communication with the front of the annular gap separating said primary and said secondary; and, outlet apertures formed in the rear portion of said rotatable member in communication with the rear of said annular gap whereby said fluid may pass through said annular gap in heat-transferring relationship during rotation of said rotatable member.

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