



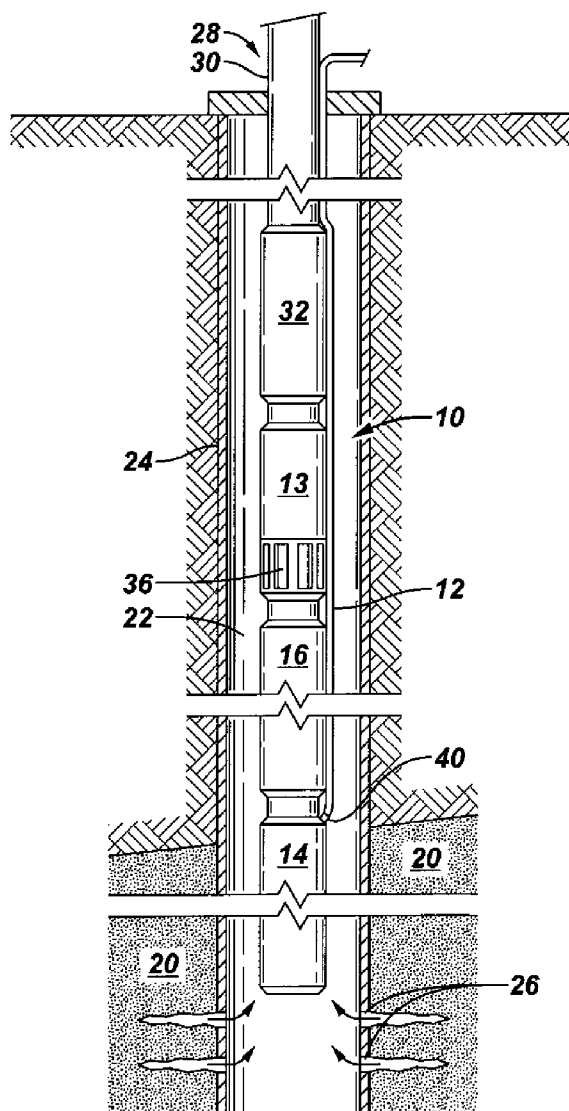
US 20090317264A1

(19) **United States**(12) **Patent Application Publication**  
**Manke et al.**(10) **Pub. No.: US 2009/0317264 A1**(43) **Pub. Date: Dec. 24, 2009**(54) **ESP MOTOR WINDINGS FOR HIGH TEMPERATURE ENVIRONMENTS**(21) Appl. No.: **12/141,514**(22) Filed: **Jun. 18, 2008**(75) Inventors: **Gregory H. Manke**, Overland Park, KS (US); **Mark Metzger**, Lawrence, KS (US); **Albert Kyin**, Missouri City, TX (US); **Aider Matarrita**, Olathe, KS (US)**Publication Classification**(51) **Int. Cl.**  
**F04B 45/067** (2006.01)(52) **U.S. Cl.** ..... **417/53; 417/423.3**

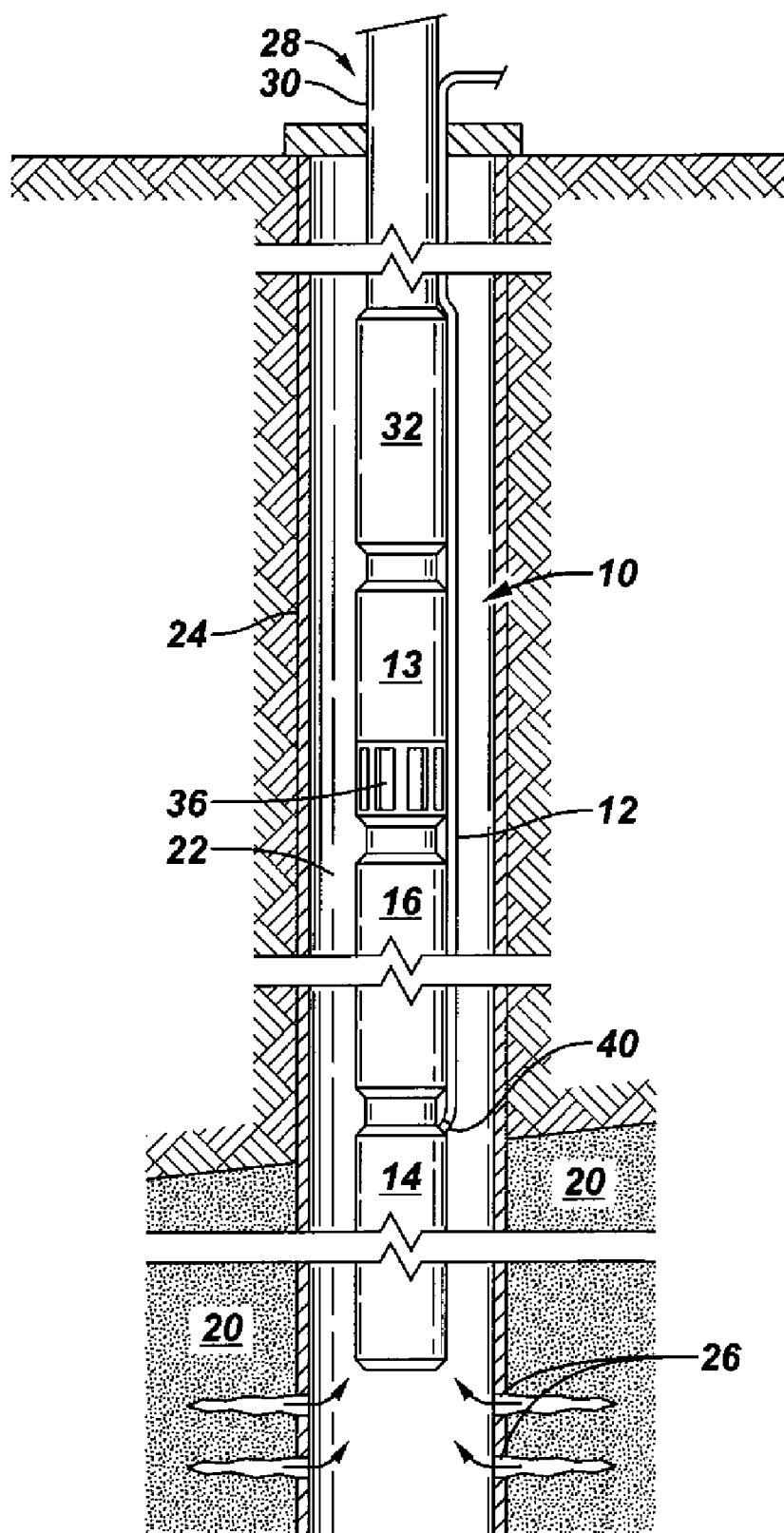
Correspondence Address:

**SCHLUMBERGER RESERVOIR COMPLETIONS****14910 AIRLINE ROAD**  
**ROSHARON, TX 77583 (US)**(57) **ABSTRACT**

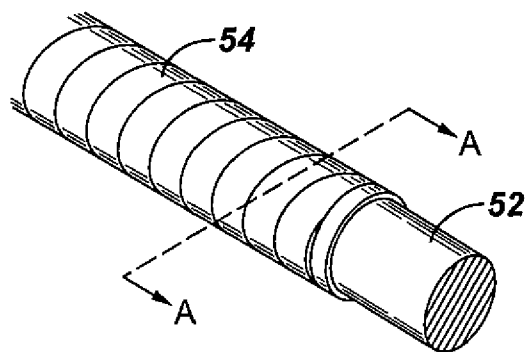
An electric submersible pump device, comprising: an electric motor having motor windings; a pump coupled with the motor; and high temperature polymeric insulation surrounding at least a portion of the motor windings, the high temperature polymeric insulation comprising HN polyimide film and a high temperature fluoropolymer adhesive coating at least one side of the HN polyimide film.

(73) Assignee: **SCHLUMBERGER TECHNOLOGY CORPORATION**, Sugar Land, TX (US)

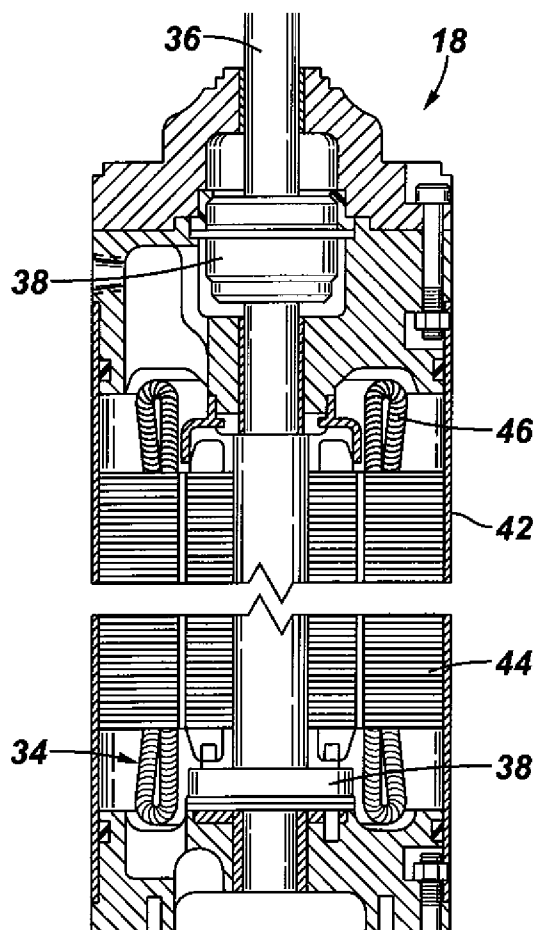
**FIG. 1**



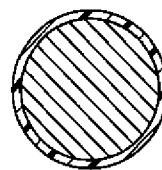
**FIG. 3A**



**FIG. 2**



**FIG. 3B**



## ESP MOTOR WINDINGS FOR HIGH TEMPERATURE ENVIRONMENTS

### TECHNICAL FIELD

[0001] The present application relates to an electric submersible motor, and more specifically, to motor windings of an electric submersible motor.

### BACKGROUND

[0002] Fluids are located underground. The fluids can include hydrocarbons (oil) and water, for example. Extraction of at least the oil for consumption is desirable. A hole is drilled into the ground to extract the fluids. The hole is called a wellbore and is oftentimes cased with a metal tubular structure referred to as a casing. A number of other features such as cementing between the casing and the wellbore can be added. The wellbore can be essentially vertical, and can even be drilled in various directions, e.g. upward or horizontal.

[0003] Once the wellbore is cased, the casing is perforated. Perforating involves creating holes in the casing thereby connecting the wellbore outside of the casing to the inside of the casing. Perforating involves lowering a perforating gun into the casing. The perforating gun has charges that detonate and propel matter through the casing thereby creating the holes in the casing and the surrounding formation and helping formation fluids flow from the formation and wellbore into the casing.

[0004] Sometimes the formation has enough pressure to drive well fluids uphole to surface. However, that situation is not always present and cannot necessarily be relied upon. An artificial lift device can therefore be needed to drive downhole well fluids uphole, e.g., to surface. The artificial lift device is placed downhole inside the casing.

### SUMMARY

[0005] According to an embodiment an electric submersible pump device comprises an electric motor having motor windings; a pump coupled with the motor; and high temperature polymeric insulation surrounding at least a portion of the motor windings, the high temperature polymeric insulation comprising HN polyimide film and a high temperature fluoropolymer adhesive coating at least one side of the HN polyimide film.

### BRIEF DESCRIPTION OF THE FIGURES

[0006] FIG. 1 is a view of an electric submersible pump within a wellbore according to embodiments.

[0007] FIG. 2 is a cut away longitudinal view of a submersible electric motor according to embodiments.

[0008] FIG. 3A is an isometric view of the magnet wire with the conductor and helically wrapped dielectric layers according to embodiments.

[0009] FIG. 3B is a sectional view of the magnet wire with the conductor and helically wrapped dielectric layers according to embodiments.

### DETAILED DESCRIPTION

[0010] In the following description, numerous details are set forth to provide an understanding of the present invention. However, it will be understood by those skilled in the art that the present invention may be practiced without many of these

details and that numerous variations or modifications from the described embodiments are possible.

[0011] As used here, the terms “above” and “below”; “up” and “down”; “upper” and “lower”; “upwardly” and “downwardly”; and other like terms indicating relative positions above or below a given point or element are used in this description to more clearly describe some embodiments of the invention. However, when applied to equipment and methods for use in wells that are deviated or horizontal, such terms may refer to a left to right, right to left, or diagonal relationship as appropriate.

[0012] Electrical submersible pumping systems (herein referred to as ESPs) are used in a wide variety of environments, including wellbore applications for pumping production fluids, such as water or petroleum. The submersible pumping system includes, among other components, an induction motor used to power a pump, lifting those fluids to the surface. At times, it is desirable to operate the ESP system in high temperature applications, such as steam flood conditions. Production fluid recovery in such applications can expose the ESP motor to temperatures of 500° F. or greater. Temperatures at or exceeding that level may lead to undesirable levels of degradation of materials used in current ESP motor designs, in particular, the dielectric insulation layer used on the motor windings. Incorporating new higher temperature materials for the dielectric layer of the motor windings can allow improved resilience and improved levels of degradation that can lead to continuous operation of the motor in temperature environments at or exceeding 500° F. for an extended period of time.

[0013] The present application features a submersible pumping system that is deployed in a wellbore to pump fluids disposed in a subterranean environment. The system includes a submersible motor and pump powered by the motor. The submersible electric motor comprises a motor housing having a plurality of laminations stacked there within, a drive shaft longitudinally extending through the motor housing, and a plurality of electrical windings extending through slots in the laminations. The electrical windings are formed from magnet wire comprising an electrical conductor and a polymeric dielectric insulation surrounding the electrical conductor. The polymeric insulation layer is comprised of single or multiple layers of thin, high dielectric, high temperature tape that is continuously helically wrapped around the electrical conductor and is bonded to the electrical conductor and to itself through the use of high temperature adhesive. The unique design permits the use of the motor and the overall ESP system in high temperature environments or applications where the system is exposed to high temperature conditions.

[0014] Referring generally to FIG. 1, an exemplary system 10 includes a wellbore environment with an ESP system installed. The wellbore typically is drilled into a geological formation 20 and is then lined with casing 24. The casing is then perforated to form perforations 26 to allow fluid to flow into the casing 24. For this example an electric submersible pump system 10 is then deployed into the wellbore 22. The deployment system 28 may be tubing or coiled tubing 30 connected to the submersible pump by a connector 32.

[0015] For this system 10, an electrical power cable 12 is coupled to an electrical submersible motor 14 in the wellbore environment 22 by an electrical connector 40. This electrical connector is commonly referred to as a “pothead”. The electrical power cable 12 provides typically the three phase power needed to power the electrical submersible motor 14 and may

have different configurations and sizes depending on the application. For this system **10** the electrical power cable **12** and connector **40** are designed to withstand the high-temperature wellbore environment **22**.

**[0016]** The electrical submersible pump system **10** may have a variety of configurations depending on the application. The system **10** typically comprises an electrical submersible motor **14**, motor protector **16**, pump intake **36**, and submersible pump **13**. The system is deployed into the wellbore **22** to extract fluids from within the wellbore **22** and to pump the fluids to surface. The well fluids **26** are extracted by the system **10** and delivered through the production tubing **30** from which the electrical submersible pump **13** is connected.

**[0017]** Internally, the electric motor **14** includes, as shown in FIG. 2, an elongated cylindrical motor housing **42** with a plurality of metallic laminations **44** stacked there within. To form the electrical phases a plurality of magnet wires **46** are wrapped around the laminations **44** to form what are called "windings" **34** of the motor **18**. A drive shaft **36** extends longitudinally through the laminations **44** and at least two bearings **38**, and extends out from the housing **42** for interconnection with the pump.

**[0018]** As shown in FIG. 3A, the magnet wire comprises an electrical conductor **52** and a polymeric insulation **54**. The electrical conductors **52** are single drawn wires of copper or copper alloys or a twist of several wires. For typical wellbore applications, the conductors **52** are single drawn copper wires having a diameter or gauge thickness of from about 0.162" (#6 AWG) to about 0.0050" (#16 AWG).

**[0019]** FIG. 3B is a sectional view of the magnet wire with the conductor **52** and the polymeric insulation **54**. The polymeric insulation **54** comprises one layer or multiple layers of a high temperature polymeric dielectric material selected from the material group polyimide. The polymeric insulating material **54** is in tape form and is applied by helically or longitudinally wrapping the polyimide tape onto the conductor in an overlap configuration. Multiple layers can be applied to the conductor all in the same direction or in opposite directions. The thickness of the polyimide film can vary from 0.0005 inch to 0.005 inch. The polyimide film is adhered to the conductor and to itself with the use of a fluoropolymer material that is coated on one or both sides of the polyimide film and is activated by short term exposure to extreme heat. These fluoropolymer materials can be FEP (fluorinated ethylene propylene), PTFE (polytetrafluoroethylene), PFA (perfluoroalkoxy) or a blend thereof. The use of this high temperature, high dielectric polyimide along with the high temperature fluoropolymer adhesive allows the magnet wire, and hence the ESP motor, to continuously operate in downhole environments at temperatures at or greater than 500° F. Continuous operation is considered to be a period longer than one hour and up to at least multiple years.

**[0020]** An example of the polymeric insulation **54** referred to herein is commercially available from DuPont™ under the identification 150PRN411. The 150 indicating 1.5 mils thick overall tape thickness, the PRN indicating an HN polyimide film with the high temperature fluoropolymer adhesive, the 4 indicating 0.0004 inch thick high temperature adhesive on the bottom side of the tape, the first 1 indicating the thickness of the polyimide film and the second 1 indicating 0.0001 inch thick high temperature adhesive on the top side of the tape.

**[0021]** Another polymeric insulation **54** available from DuPont™ is CR polyimide film (Corona Resistant Film),

identified as PRCR. The PRCR is used with the high temperature fluoropolymer adhesive referred to above.

**[0022]** The embodiments referred to above are meant to illustrate features of a number of embodiments of the inventive idea. The embodiments are in no way meant to limit the scope of the claims herein.

1. An electric submersible pump device, comprising:
  - an electric motor having motor windings, comprising an electrical conductor;
  - a pump coupled with the motor; and
  - high temperature polymeric insulation surrounding at least a portion of the motor windings,
    - the high temperature polymeric insulation comprising polyimide film and a high temperature fluoropolymer adhesive coating at least one side of the polyimide film; wherein the polyimide film is adhered to the conductor with the high temperature fluoropolymer adhesive.
2. The device of claim 1, comprising multiple layers of the high temperature polymeric insulation.
3. The device of claim 1, wherein the high temperature insulation is in tape form.
4. The device of claim 3, wherein the high temperature polymeric insulation is applied longitudinally.
5. The device of claim 3, wherein the high temperature polymeric insulation is wrapped onto the conductor in an overlap configuration.
6. The device of claim 1, wherein the thickness of the polyimide film is from 0.0005 inch to 0.005 inch.
7. The device of claim 1, wherein the polyimide film is adhered to itself with the fluoropolymer adhesive coating.
8. The device of claim 1, wherein the fluoropolymer adhesive coating is coated on the polyimide film and is activated by short term exposure to extreme heat.
9. The device of claim 1, wherein the fluoropolymer adhesive coating comprises a material selected from a group consisting of the following: fluorinated ethylene propylene, polytetrafluoroethylene, and perfluoroalkoxy.
10. The device of claim 1, wherein the high temperature polymeric insulation has material capabilities that allow operation of the electric submersible motor where conductor temperature within in the motor is at least 500 degrees Fahrenheit.
11. A method of pumping subterranean fluids, comprising:
  - lowering an electric submersible pump device downhole, the electric submersible pump device comprising
    - an electric motor having motor windings, comprising an electrical conductor;
    - a pump coupled with the motor; and
    - high temperature polymeric insulation surrounding at least a portion of the motor windings; wherein the high temperature polymeric insulation comprises polyimide film and a high temperature fluoropolymer adhesive coating at least one side of the polyimide film, wherein the polyimide film is adhered to the conductor with the high temperature fluoropolymer adhesive; and
  - operating the motor.
12. (canceled)
13. The method of claim 11, wherein the motor windings comprising multiple layers of the high temperature polymeric insulation.
14. The method of claim 11, wherein the high temperature insulation is in tape form.

**15.** The method of claim **11**, wherein the high temperature polymeric insulation is applied longitudinally.

**16.** The method of claim **11**, wherein the high temperature polymeric insulation is wrapped onto the conductor in an overlap configuration.

**17.** The method of claim **11**, wherein the thickness of the polyimide film is from 0.0005 inch to 0.005 inch.

**18.** The method of claim **11**, wherein the polyimide film is adhered to the conductor and to itself with the fluoropolymer adhesive coating.

**19.** The method of claim **18**, wherein the fluoropolymer adhesive coating is coated on the polyimide film and is activated by short term exposure to extreme heat.

**20.** The method of claim **18**, wherein the fluoropolymer adhesive coating comprises a material selected from a group consisting of the following: fluorinated ethylene propylene, polytetrafluoroethylene, and perfluoroalkoxy.

**21.** The device of claim **1**, wherein the polyimide film is HN polyimide film.

**22.** The device of claim **1**, wherein the polyimide film is CR polyimide film.

**23.** The method of claim **11**, wherein the polyimide film is HN polyimide film.

**24.** The method of claim **11**, wherein the polyimide film is CR polyimide film.

**25.** The method of claim **11**, further comprising operating the electric submersible pump while the motor conductor temperature is at least 500 degrees Fahrenheit continuously for at least one hour.

**26.** The device of claim **1**, wherein the electric submersible pump is configured to be capable of operating for at least one uninterrupted hour when the motor conductor temperature is at least 500 degrees Fahrenheit.

\* \* \* \* \*