



(51) International Patent Classification:

B05D 5/08 (2006.01) *B05D 3/02* (2006.01)
F04B 47/06 (2006.01) *C09D 129/12* (2006.01)
E21B 43/12 (2006.01) *C09D 129/10* (2006.01)

(21) International Application Number:

PCT/US2016/022745

(22) International Filing Date:

17 March 2016 (17.03.2016)

(25) Filing Language:

English

(26) Publication Language:

English

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(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,

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(54) Title: COATED DOWNHOLE COMPONENTS

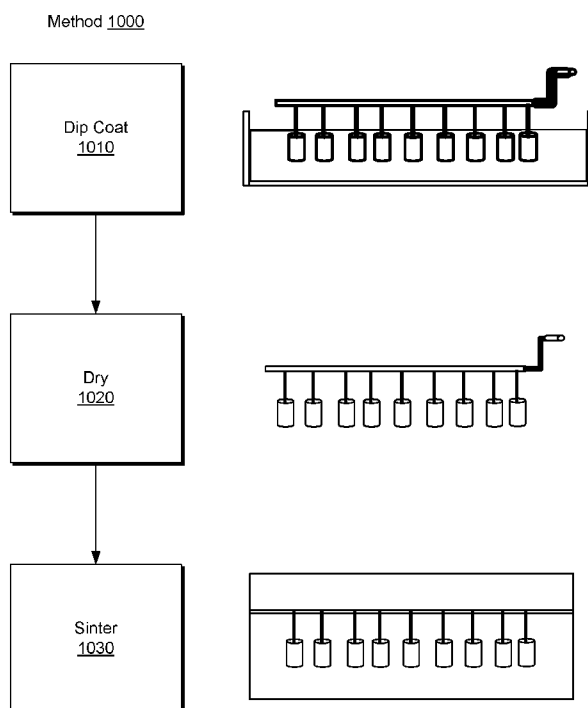


Fig. 10

(57) Abstract: A method can include coating a hydrophilic polymeric surface of a component of an electric submersible pump system with an aqueous polymer dispersion to form a coated component; and sintering the coated component to form a sintered, coated component that includes a less hydrophilic polymeric surface, which can be a hydrophobic polymeric surface.



DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH,

— *with international search report (Art. 21(3))*

COATED DOWNHOLE COMPONENTS

BACKGROUND

[0001] Polymeric materials include one or more polymers. A polymer may be considered to be a relatively large molecule or macromolecule composed of subunits. Polymers are created via polymerization of smaller molecules that can include molecules known as monomers. Polymers may be characterized by physical properties such as, for example, toughness, viscoelasticity, tendency to form glasses and semicrystalline structures, melting temperature, etc.

SUMMARY

[0002] A method can include coating a hydrophilic polymeric surface of a component with an aqueous polymer dispersion to form a coated component; and sintering the coated component to form a sintered, coated component that includes a less hydrophilic polymeric surface. An electrical connector can include a thermoplastic core that includes a sintered hydrophobic polymeric surface. An electric submersible pump pot head assembly can include a component that includes a thermoplastic core that includes a sintered hydrophobic polymeric surface. Various other apparatuses, systems, methods, etc., are also disclosed.

[0003] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Features and advantages of the described implementations can be more readily understood by reference to the following description taken in conjunction with the accompanying drawings.

[0005] Fig. 1 illustrates examples of equipment in geologic environments;

[0006] Fig. 2 illustrates an example of an electric submersible pump system;

[0007] Fig. 3 illustrates examples of equipment;

[0008] Fig. 4 illustrates an example of a system that includes a motor;

[0009] Fig. 5 illustrates an example of a cable;

[0010] Fig. 6 illustrates examples of cables;

- [0011]** Fig. 7 illustrates examples of equipment;
- [0012]** Fig. 8 illustrates examples of equipment;
- [0013]** Fig. 9 illustrates an example of a method;
- [0014]** Fig. 10 illustrates an example of a method;
- [0015]** Fig. 11 illustrates an example of equipment for a plasma process;
- [0016]** Fig. 12 shows photographs of examples of components;
- [0017]** Fig. 13 shows photographs of examples of coated and uncoated surfaces;
- [0018]** Fig. 14 shows photographs of examples of fluid in contact with examples of coated and uncoated surfaces;
- [0019]** Fig. 15 shows photographs of examples of an untreated wire and a treated wire;
- [0020]** Fig. 16 illustrates examples of plots of data;
- [0021]** Fig. 17 illustrates examples of plots of data; and
- [0022]** Fig. 18 illustrates example components of a system and a networked system.

DETAILED DESCRIPTION

[0023] The following description includes the best mode presently contemplated for practicing the described implementations. This description is not to be taken in a limiting sense, but rather is made merely for the purpose of describing the general principles of the implementations. The scope of the described implementations should be ascertained with reference to the issued claims.

[0024] As an example, polymeric coating materials may be formulated using one or more of fluorinated ethylene propylene (FEP), polytetrafluoroethylene (PTFE), perfluoroalkoxy copolymer (PFA), perfluoro-methyl-alkoxy copolymer (MFA), and hexafluoropropylene/vinylidene fluoride/tetrafluoroethylene (HFP/VDF/TFE terpolymer). As an example, a formulation can include one or more of the foregoing materials as a mixture.

[0025] As an example, a polymeric coating material may be utilized to coat high temperature dielectric materials, such as, for example, polyether ether ketone (PEEK) thermoplastic polymeric component and/or a PEEK composite component (e.g., glass filled PEEK, etc.) as well as, for example, polyimide (PI) components and PI composite components. In such an example, the polymeric coating material may

alter the surface properties of the component. As an example, a component can include a core with a polymeric layer of one or more high temperature dielectric materials that can be coated with one or more of the foregoing polymeric coating materials.

[0026] Various polymeric materials and/or polymeric composite materials may find use in the oil and gas industry. For example, such materials may be suitable for use in equipment that can be disposed at least in part in a downhole environment, which may be subject to chemicals, water, temperatures, pressures, etc. that can impact durability and performance of such equipment.

[0027] Fig. 1 shows examples of geologic environments 120 and 140. In Fig. 1, the geologic environment 120 may be a sedimentary basin that includes layers (e.g., stratification) that include a reservoir 121 and that may be, for example, intersected by a fault 123 (e.g., or faults). As an example, the geologic environment 120 may be outfitted with any of a variety of sensors, detectors, actuators, etc. For example, equipment 122 may include communication circuitry to receive and to transmit information with respect to one or more networks 125. Such information may include information associated with downhole equipment 124, which may be equipment to acquire information, to assist with resource recovery, etc. Other equipment 126 may be located remote from a well site and include sensing, detecting, emitting or other circuitry. Such equipment may include storage and communication circuitry to store and to communicate data, instructions, etc. As an example, one or more satellites may be provided for purposes of communications, data acquisition, etc. For example, Fig. 1 shows a satellite in communication with the network 125 that may be configured for communications, noting that the satellite may additionally or alternatively include circuitry for imagery (e.g., spatial, spectral, temporal, radiometric, etc.).

[0028] Fig. 1 also shows the geologic environment 120 as optionally including equipment 127 and 128 associated with a well that includes a substantially horizontal portion that may intersect with one or more fractures 129. For example, consider a well in a shale formation that may include natural fractures, artificial fractures (e.g., hydraulic fractures) or a combination of natural and artificial fractures. As an example, a well may be drilled for a reservoir that is laterally extensive. In such an example, lateral variations in properties, stresses, etc. may exist where an assessment of such variations may assist with planning, operations, etc. to develop

the reservoir (e.g., via fracturing, injecting, extracting, etc.). As an example, the equipment 127 and/or 128 may include components, a system, systems, etc. for fracturing, seismic sensing, analysis of seismic data, assessment of one or more fractures, etc.

[0029] As to the geologic environment 140, as shown in Fig. 1, it includes a well 141 (e.g., a bore) and equipment 147 for artificial lift, which may be an electric submersible pump (e.g., an ESP). In such an example, a cable or cables may extend from surface equipment to the equipment 147, for example, to provide power, to carry information, to sense information, etc.

[0030] Conditions in a geologic environment may be transient and/or persistent. Where equipment is placed within a geologic environment, longevity of the equipment can depend on characteristics of the environment and, for example, duration of use of the equipment as well as function of the equipment. Where equipment is to endure in an environment over an extended period of time, uncertainty may arise in one or more factors that could impact integrity or expected lifetime of the equipment. As an example, where a period of time may be of the order of decades, equipment that is intended to last for such a period of time may be constructed to endure conditions imposed thereon, whether imposed by an environment or environments and/or one or more functions of the equipment itself.

[0031] As an example, an environment may be a harsh environment, for example, an environment that may be classified as being a high-pressure and high-temperature environment (HPHT). A so-called HPHT environment may include pressures up to about 138 MPa (e.g., about 20,000 psi) and temperatures up to about 205 degrees C (e.g., about 400 degrees F and about 480 K), a so-called ultra-HPHT environment may include pressures up to about 241 MPa (e.g., about 35,000 psi) and temperatures up to about 260 degrees C (e.g., about 500 degrees F and about 530 K) and a so-called HPHT-hc environment may include pressures greater than about 241 MPa (e.g., about 35,000 psi) and temperatures greater than about 260 degrees C (e.g., about 500 degrees F and about 530 K). As an example, an environment may be classified based in one of the aforementioned classes based on pressure or temperature alone. As an example, an environment may have its pressure and/or temperature elevated, for example, through use of equipment, techniques, etc. For example, a SAGD operation may elevate temperature of an environment (e.g., by 100 degrees C or more; about 370 K or more).

[0032] Fig. 2 shows an example of an ESP system 200 that includes an ESP 210 as an example of equipment that may be placed in a geologic environment. As an example, an ESP may be expected to function in an environment over an extended period of time (e.g., optionally of the order of years).

[0033] In the example of Fig. 2, the ESP system 200 includes a network 201, a well 203 disposed in a geologic environment (e.g., with surface equipment, etc.), a power supply 205, the ESP 210, a controller 230, a motor controller 250 and a VSD unit 270. The power supply 205 may receive power from a power grid, an onsite generator (e.g., natural gas driven turbine), or other source. The power supply 205 may supply a voltage, for example, of about 4.16 kV.

[0034] As shown, the well 203 includes a wellhead that can include a choke (e.g., a choke valve). For example, the well 203 can include a choke valve to control various operations such as to reduce pressure of a fluid from high pressure in a closed wellbore to atmospheric pressure. A wellhead may include one or more sensors such as a temperature sensor, a pressure sensor, a solids sensor, etc.

[0035] As to the ESP 210, it is shown as including cables 211 (e.g., or a cable), a pump 212, gas handling features 213, a pump intake 214, a motor 215, one or more sensors 216 (e.g., temperature, pressure, strain, current leakage, vibration, etc.) and a protector 217.

[0036] As an example, an ESP may include a REDA™ HOTLINE™ high-temperature ESP motor. Such a motor may be suitable for implementation in a thermal recovery heavy oil production system, such as, for example, SAGD system or other steam-flooding system.

[0037] As an example, an ESP motor can include a three-phase squirrel cage with two-pole induction. As an example, an ESP motor may include steel stator laminations that can help focus magnetic forces on rotors, for example, to help reduce energy loss. As an example, stator windings can include copper and insulation.

[0038] As an example, the one or more sensors 216 of the ESP 210 may be part of a digital downhole monitoring system. For example, consider the commercially available PHOENIX™ MULTISENSOR XT150 system marketed by Schlumberger Limited (Houston, Texas). A monitoring system may include a base unit that operatively couples to an ESP motor (see, e.g., the motor 215), for example, directly, via a motor-base crossover, etc. As an example, such a base unit (e.g.,

base gauge) may measure intake pressure, intake temperature, motor oil temperature, motor winding temperature, vibration, currently leakage, etc. As explained with respect to Fig. 4, a base unit may transmit information via a power cable that provides power to an ESP motor and may receive power via such a cable as well.

[0039] As an example, a remote unit may be provided that may be located at a pump discharge (e.g., located at an end opposite the pump intake 214). As an example, a base unit and a remote unit may, in combination, measure intake and discharge pressures across a pump (see, e.g., the pump 212), for example, for analysis of a pump curve. As an example, alarms may be set for one or more parameters (e.g., measurements, parameters based on measurements, etc.).

[0040] Where a system includes a base unit and a remote unit, such as those of the PHOENIX™ MULTISENSOR XT150 system, the units may be linked via wires. Such an arrangement provide power from the base unit to the remote unit and allows for communication between the base unit and the remote unit (e.g., at least transmission of information from the remote unit to the base unit). As an example, a remote unit is powered via a wired interface to a base unit such that one or more sensors of the remote unit can sense physical phenomena. In such an example, the remote unit can then transmit sensed information to the base unit, which, in turn, may transmit such information to a surface unit via a power cable configured to provide power to an ESP motor.

[0041] In the example of Fig. 2, the well 203 may include one or more well sensors 220, for example, such as the commercially available OPTICLINE™ sensors or WELLWATCHER BRITEBLUE™ sensors marketed by Schlumberger Limited (Houston, Texas). Such sensors are fiber-optic based and can provide for real time sensing of temperature, for example, in SAGD or other operations. As shown in the example of Fig. 1, a well can include a relatively horizontal portion. Such a portion may collect heated heavy oil responsive to steam injection. Measurements of temperature along the length of the well can provide for feedback, for example, to understand conditions downhole of an ESP. Well sensors may extend a considerable distance into a well and possibly beyond a position of an ESP.

[0042] In the example of Fig. 2, the controller 230 can include one or more interfaces, for example, for receipt, transmission or receipt and transmission of information with the motor controller 250, a VSD unit 270, the power supply 205

(e.g., a gas fueled turbine generator, a power company, etc.), the network 201, equipment in the well 203, equipment in another well, etc.

[0043] As shown in Fig. 2, the controller 230 may include or provide access to one or more modules or frameworks. Further, the controller 230 may include features of an ESP motor controller and optionally supplant the ESP motor controller 250. For example, the controller 230 may include the UNICONN™ motor controller 282 marketed by Schlumberger Limited (Houston, Texas). In the example of Fig. 2, the controller 230 may access one or more of the PIPESIM™ framework 284, the ECLIPSE™ framework 286 marketed by Schlumberger Limited (Houston, Texas) and the PETREL™ framework 288 marketed by Schlumberger Limited (Houston, Texas) (e.g., and optionally the OCEAN™ framework marketed by Schlumberger Limited (Houston, Texas)).

[0044] In the example of Fig. 2, the motor controller 250 may be a commercially available motor controller such as the UNICONN™ motor controller. The UNICONN™ motor controller can connect to a SCADA system, the ESPWATCHER™ surveillance system, etc. The UNICONN™ motor controller can perform some control and data acquisition tasks for ESPs, surface pumps or other monitored wells. As an example, the UNICONN™ motor controller can interface with the aforementioned PHOENIX™ monitoring system, for example, to access pressure, temperature and vibration data and various protection parameters as well as to provide direct current power to downhole sensors. The UNICONN™ motor controller can interface with fixed speed drive (FSD) controllers or a VSD unit, for example, such as the VSD unit 270.

[0045] For FSD controllers, the UNICONN™ motor controller can monitor ESP system three-phase currents, three-phase surface voltage, supply voltage and frequency, ESP spinning frequency and leg ground, power factor and motor load.

[0046] For VSD units, the UNICONN™ motor controller can monitor VSD output current, ESP running current, VSD output voltage, supply voltage, VSD input and VSD output power, VSD output frequency, drive loading, motor load, three-phase ESP running current, three-phase VSD input or output voltage, ESP spinning frequency, and leg-ground.

[0047] In the example of Fig. 2, the ESP motor controller 250 includes various modules to handle, for example, backspin of an ESP, sanding of an ESP, flux of an

ESP and gas lock of an ESP. The motor controller 250 may include any of a variety of features, additionally, alternatively, etc.

[0048] In the example of Fig. 2, the VSD unit 270 may be a low voltage drive (LVD) unit, a medium voltage drive (MVD) unit or other type of unit (e.g., a high voltage drive, which may provide a voltage in excess of about 4.16 kV). As an example, the VSD unit 270 may receive power with a voltage of about 4.16 kV and control a motor as a load with a voltage from about 0 V to about 4.16 kV. The VSD unit 270 may include commercially available control circuitry such as the SPEEDSTAR™ MVD control circuitry marketed by Schlumberger Limited (Houston, Texas).

[0049] Fig. 3 shows cut-away views of examples of equipment such as, for example, a portion of a pump 320, a protector 370 and a motor 350 of an ESP. The pump 320, the protector 370 and the motor 350 are shown with respect to cylindrical coordinate systems (e.g., r , z , Θ). Various features of equipment may be described, defined, etc. with respect to a cylindrical coordinate system. As an example, a lower end of the pump 320 may be coupled to an upper end of the protector 370 and a lower end of the protector 370 may be coupled to an upper end of the motor 350. As shown in Fig. 3, a shaft segment of the pump 320 may be coupled via a connector to a shaft segment of the protector 370 and the shaft segment of the protector 370 may be coupled via a connector to a shaft segment of the motor 350. As an example, an ESP may be oriented in a desired direction, which may be vertical, horizontal or other angle. As shown in Fig. 3, the motor 350 is an electric motor that includes a connector 352, for example, to operatively couple the electric motor to a power cable, for example, optionally via one or more motor lead extensions (see, e.g., Fig. 4).

[0050] Fig. 4 shows a block diagram of an example of a system 400 that includes a power source 401 as well as data 402 (e.g., information). The power source 401 provides power to a VSD block 470 while the data 402 may be provided to a communication block 430. The data 402 may include instructions, for example, to instruct circuitry of the circuitry block 450, one or more sensors of the sensor block 460, etc. The data 402 may be or include data communicated, for example, from the circuitry block 450, the sensor block 460, etc. In the example of Fig. 4, a choke block 440 can provide for transmission of data signals via a power cable 411 (e.g.,

including motor lead extensions “MLEs”). A power cable may be provided in a format such as a round format or a flat format with multiple conductors. MLEs may be spliced onto a power cable to allow each of the conductors to physically connect to an appropriate corresponding connector of an electric motor (see, e.g., the connector 352 of Fig. 3). As an example, MLEs may be bundled within an outer casing (e.g., a layer of armor, etc.).

[0051] As shown, the power cable 411 connects to a motor block 415, which may be a motor (or motors) of an ESP and be controllable via the VSD block 470. In the example of Fig. 4, the conductors of the power cable 411 electrically connect at a wye point 425. The circuitry block 450 may derive power via the wye point 425 and may optionally transmit, receive or transmit and receive data via the wye point 425. As shown, the circuitry block 450 may be grounded.

[0052] As an example, power cables and MLEs that can resist damaging forces, whether mechanical, electrical or chemical, may help ensure proper operation of a motor, circuitry, sensors, etc.; noting that a faulty power cable (or MLE) can potentially damage a motor, circuitry, sensors, etc. Further, as mentioned, an ESP may be located several kilometers into a wellbore. Accordingly, time and cost to replace a faulty ESP, power cable, MLE, etc., can be substantial (e.g., time to withdraw, downtime for fluid pumping, time to insert, etc.).

[0053] As an example, a cable may allow for extended run life, low cost, and improved manufacturability. For example, a downhole power cable for electrical submersible pumps (ESP) may include various features, materials of construction, etc. that may improve reliability and reduce environmental impact (e.g., during use, after use, etc.).

[0054] As an example, a cable may be rated. For example, ESP cables may be rated by voltage such as about 3 kV, about 4 kV or about 5 kV. As to form, a round cable may be implemented in boreholes where sufficient room exists and a so-called “flat” cable may be implemented where less room may be available (e.g., to provide clearance, etc.).

[0055] As an example, a round ESP cable rated to about 5 kV may include a copper conductor(s), oil and heat resistant ethylene propylene diene monomer (M-class) rubber insulation (EPDM insulation), a barrier layer (e.g., lead and/or fluoropolymer or without a barrier layer), a jacket layer (e.g., oil resistant EPDM or nitrile rubber), and armor (e.g., galvanized or stainless steel or alloys that include

nickel and copper such as MONEL™ alloys, Huntington Alloys Corporation, Huntington, West Virginia).

[0056] As an example, a flat ESP cable rated to about 5 kV may include a copper conductor(s), oil and heat resistant EPDM rubber insulation, a barrier layer (e.g., lead and/or fluoropolymer or without a barrier layer), a jacket layer (e.g., oil resistant EPDM or nitrile rubber or without a jacket layer), and armor (e.g., galvanized or stainless steel or alloys that include nickel and copper such as MONEL™ alloys).

[0057] In the foregoing examples, armor on the outside of a cable acts to protect the cable from damage, for example, from handling during transport, equipment installation, and equipment removal from the wellbore. Additionally, armor can help to prevent an underlying jacket, barrier, and insulation layers from swelling and abrasion during operation. In such examples, as armor is formed out of metallic strips and wrapped around the cable, voids exist between the overlapping armor layers which can collect well fluid after the cable has been installed in a wellbore. In such scenarios, when the cable is removed from the wellbore the well fluid tends to remain trapped in voids and therefore can cause environmental damage as it drips off of the cable during transport and recycling. Further, as an example, if armor is not present, well fluid can become trapped inside a jacket layer and, for example, lead to environmental challenging situations when the cable is removed from a wellbore.

[0058] As an example, a cable can reduce environmental impact via a reduction of features that may pose potential risks for well fluid (e.g., oil, etc.) to be trapped inside the cable. For example, such a cable can include a durable polymeric coating over an armor layer (e.g., or a jacket layer) to help prevent well fluid from becoming trapped between overlapping armor layers (e.g., or inside the jacket if the cable does not have armor). In such an example, the polymeric coating may be an outermost layer that is smooth (e.g., without ridges, etc. as may be formed by overlying metal strips of armor).

[0059] As an example, a layer disposed over an armor layer (e.g., over an outer surface of an armor layer) may be of sufficient robustness to reduce risk of damage, for example, during installation. In such an example, the layer may be resistant to abrasion from well fluid.

[0060] Fig. 5 shows an example of a cable 500 that includes various components. For example, the cable 500 can include conductors 510, conductor shields (e.g., which may be optional), insulation 520, insulation shields (optional), conductive layers (e.g., which may be optional), barrier layers 530 (e.g., which may be optional), a cable jacket 540, cable armor 550 (e.g., which may be optional) and an outer coating 560 (e.g., an outermost coating or layer).

[0061] As an example, insulation material may include EPDM and/or PEEK. As an example, where insulation material is EPDM, a compound formulation for oil and decompression resistance may be used.

[0062] As an example, an insulation layer may adhere to or be bonded to a conductor shield, for example, where a conductor shield is present. As an example, an insulation layer may be continuous with an insulation shield, for example, with complete bonding or without complete bonding thereto. As an example, where PEEK is selected as a material for an insulation layer, mechanical properties thereof may allow for improved damage resistance, for example, to resist damage to a cable during cable install, cable operation, cable repositioning, cable removal, etc. In such an example, PEEK can offer relatively high stiffness, which may allow for greater ease in sealing over a cable (e.g., cable members such as members that each include a conductor), for example, at a cable termination point or points (e.g., motor pothead, well connectors, feed-throughs, etc.). As an example, such an approach may improve cable and system reliability.

[0063] As an example, a cable may include a barrier layer to help protect the cable from corrosive downhole gases and fluids. As an example, one or more additional barrier layers may be used, for example, depending on intended use, environmental conditions, etc. As an example, a barrier may be formed of extruded material, tape, etc. As an example, a barrier layer may include a fluoropolymer or fluoropolymers, lead, and/or other material (e.g., to help protect against well fluids, etc.). As an example, a combination of extruded and taped layers may be used.

[0064] In the example of Fig. 5, the cable 500 is shown as including a contiguous cable jacket 540 that jackets the first, second and third conductors 510 (e.g., including layers of the first, second and third conductors 510).

[0065] As an example, for a flat cable configuration (e.g., and for a round cable configuration where conductors may be twisted together), a fluid, gas and

temperature resistant jacket may be used. Such a jacket may help protect a cable from damage, for example, in challenging downhole environments.

[0066] As an example, a cable jacket may include one or more layers of EPDM, nitrile, hydrogenated nitrile butadiene rubber (HNBR), fluoropolymer, chloroprene, and/or other material resistant to constituents, conditions, etc. in a downhole environment.

[0067] As an example, a jacket may be made of a fluid resistant nitrile elastomer, for example, with low swell ratings in water and in hydrocarbon oil and, for example, with appropriate resistance to wellbore gases.

[0068] As an example, low swell property of the jacket may act to reduce (e.g., minimize) an amount of well fluid that may possibly be absorbed into the cable. As an example, an elastomer jacket may help to prevent fluid migration into a cable and help to provide mechanical protection of insulated conductors set within the elastomer jacket (e.g., jacketed by the elastomer jacket).

[0069] As an example, cable armor, which may be optional, may include galvanized steel, stainless steel, alloys that include nickel and copper such as MONEL™ alloys, or other metal, metal alloy, or non-metal resistant to downhole conditions.

[0070] As shown in the example of Fig. 5, the cable 500 includes a cable outer coating 560. Such a coating may optionally be provided over cable armor, if present. As mentioned, a cable outer coating may help to reduce environmental impact, for example, by reducing presence of features that may pose potential risks for well fluid (e.g., oil, etc.) to be trapped inside the cable. For example, a cable outer coating may be a durable polymeric coating over an armor layer (e.g., or other layer such as a jacket layer) to help prevent well fluid from becoming trapped between overlapping armor layers (e.g., or inside the jacket if the cable does not have armor). In such an example, an outermost layer of a cable may be formed in a manner that has reduced surface roughness, reduced undulations, reduced corrugations, etc., for example, which may act to carry and/or entrap fluid, debris, etc. As an example, a cable outer coating may be relatively smooth and be resistant to swell (e.g., via gasses, liquids, etc.).

[0071] As an example, a cable outer coating may be made of polyvinylidene fluoride (PVDF, KYNAR™ polymer (Arkema, Inc., King of Prussia, Pennsylvania), TEDLAR™ polymer (E. I. du Pont de Nemours & Co., Wilmington, Delaware), etc.).

As an example, a cable outer coating may be made of PVDF modified with about 0.1 percent to about 10 percent by weight adducted maleic anhydride, for example, to facilitate bonding to a metallic armor or elastomer jacket (e.g. where armor is not employed).

[0072] Fig. 6 shows an example of a geometric arrangement of components of a round cable 610 and an example of a geometric arrangement of components of an oblong cable 630. As shown the cable 610 includes three conductors 612, a polymeric layer 614 and an outer layer 616 and the oblong cable 630 includes three conductors 632, a polymeric layer 634 (e.g., optionally a composite material with desirable heat transfer properties) and an optional outer polymeric layer 636 (e.g., outer polymeric coat, which may be a composite material). In the examples of Fig. 6, a conductor may be surrounded by one or more optional layers, as generally illustrated via dashed lines. For example, as to the cable 630, consider three 1 gauge conductors (e.g., a diameter of about 7.35 mm), each with a 2 mm layer and a 1 mm layer. In such an example, the polymeric layer 634 may encapsulate the three 1 gauge conductors and their respective layers where, at ends, the polymeric layer 634 may be about 1 mm thick. In such an example, an optional armor layer may be of a thickness of about 0.5 mm. In such an example, the optional outer polymeric layer 636 (e.g., as covering armor) may be of a thickness of about 1 mm (e.g., a 1 mm layer).

[0073] As shown in Fig. 6, the cable 610 includes a circular cross-sectional shape while the cable 630 includes an oblong cross-sectional shape. In the example of Fig. 6, the cable 610 with the circular cross-sectional shape has an area of unity and the cable 630 with the oblong cross-sectional shape has area of about 0.82. As to perimeter, where the cable 610 has a perimeter of unity, the cable 630 has a perimeter of about 1.05. Thus, the cable 630 has a smaller volume and a larger surface area when compared to the cable 610. A smaller volume can provide for a smaller mass and, for example, less tensile stress on a cable that may be deployed a distance in a downhole environment (e.g., due to mass of the cable itself).

[0074] In the cable 630, the conductors 632 may be about 7.35 mm (e.g., about 1 AWG) in diameter with insulation of about 2 mm thickness, lead (Pb) of about 1 mm thickness, a jacket layer (e.g., the layer 634) over the lead (Pb) of about 1 mm thickness at ends of the cable 630, optional armor of about 0.5 mm thickness and an optional polymeric layer of about 1 mm thickness (e.g., the layer 636 as an

outer polymeric coat). As an example, the cable 630 may be of a width of about 20 mm (e.g., about 0.8 inches) and a length of about 50 mm (e.g., about 2 inches), for example, about a 2.5 to 1 width to length ratio).

[0075] As an example, a cable may be formed with phases split out from each other where each phase is encased in solid metallic tubing.

[0076] As an example, a cable can include multiple conductors where each conductor can carry current of a phase of a multiphase power supply for a multiphase electric motor. In such an example, a conductor may be in a range from about 8 AWG (about 3.7 mm) to about 00 AWG (about 9.3 mm).

[0077] Table 1. Examples Components.

Cable Component	Dimensions
Conductor (Cu)	8 AWG to 00 AWG (3.7 mm to 9.3 mm)
Insulation	58 mils to 130 mils (1.5 mm to 3.3 mm)
Lead (Pb)	20 mils to 60 mils (0.5 mm to 1.5 mm)
Jacket over Lead (Pb)	20 mils to 85 mils (0.5 mm to 2.2 mm)
Aarmor (e.g., optional)	10 mils to 20 mils (0.25 mm to 0.5 mm)
Polymeric Coat (e.g., optional)	20 mils to 60 mils (0.5 mm to 1.5 mm)

[0078] In Table 1, where a cable has an oblong cross-sectional shape, the jacket over lead (Pb) layer may be, for example, of a thickness of about 20 mils to about 85 mils (e.g., about 0.5 mm to about 2.2 mm) at ends of the oblong cross-sectional shape and, for example, at various points along opposing sides of the oblong cross-sectional shape. For example, material forming the jacket over lead (Pb) layer may be thicker in regions between conductors (e.g., consider approximately triangular shaped regions).

[0079] As an example, a cable may include conductors for delivery of power to a multiphase electric motor with a voltage range of about 3 kV to about 8 kV. As an example, a cable may carry power, at times, for example, with amperage of up to about 200 A or more.

[0080] As to operational conditions, where an electric motor operates a pump, locking of the pump can cause current to increase and, where fluid flow past a cable

may decrease, heat may build rapidly within the cable. As an example, locking may occur due to gas in one or more pump stages, bearing issues, particulate matter, etc.

[0081] As an example, a cable may carry current to power a multiphase electric motor or other piece of equipment (e.g., downhole equipment powerable by a cable).

[0082] Fig. 7 shows various examples of motor equipment. A pothead unit 701 includes opposing ends 702 and 704 and a through bore, for example, defined by a bore wall 705. As shown, the ends 702 and 704 may include flanges configured for connection to other units (e.g., a protector unit at the end 702 and a motor unit at the end 704). The pothead unit 701 includes cable passages 707-1, 707-2 and 707-3 (e.g., cable connector sockets) configured for receipt of cable connectors 716-1, 716-2 and 716-3 of respective cables 714-1, 714-2 and 714-3. As an example, the cables 714-1, 714-2 and 714-3 and/or the cable connectors 716-1, 716-2 and 716-3 may include one or more polymeric materials. For example, a cable may include polymeric insulation while a cable connector may include polymeric insulation, a polymeric component (e.g., a bushing), etc. As an example, the cables 714-1, 714-2 and 714-3 may be coupled to a single larger cable. The single larger cable may extend to a connector end for connection to a power source or, for example, equipment intermediate the cable and a power source (e.g., an electrical filter unit, etc.). As an example, a power source may be a VSD unit that provides three-phase power for operation of a motor.

[0083] Fig. 7 also shows a pothead unit 720 that includes a socket 721. As an example, a cable 722 may include a plug 724 that can couple to the socket 721 of the pothead unit 720. In such an example, the cable 722 may include one or more conductors 726. As an example, a cable may include at least one fiber optic cable or one or more other types of cables.

[0084] As explained above, equipment may be placed in a geologic environment where such equipment may be subject to conditions associated with function or functions of the equipment and/or be subject to conditions associated with the geologic environment. Equipment may experience conditions that are persistent (e.g., relatively constant), transient or a combination of both. As an example, to enhance equipment integrity (e.g., reduction in failures, increased performance, longevity, etc.), equipment may include at least one polymeric material.

[0085] Fig. 8 shows a perspective cut-away view of an example of a motor assembly 800 that includes a power cable 844 (e.g., MLEs, etc.) to supply energy, a shaft 850, a housing 860 that may be made of multiple components (e.g., multiple units joined to form the housing 860), stacked laminations 880, stator windings 870 of wire (e.g., magnet wire) and rotor laminations 890 and rotor windings 895 coupled to the shaft 850 (e.g., rotatably driven by energizing the stator windings 870).

[0086] As shown in Fig. 8, the housing 860 includes an inner surface 861 and an outer surface 865. As an example, the housing 860 can define one or more cavities via its inner surface 861 where one or more of the cavities may be hermetically sealed. As an example, such a cavity may be filled at least partially with dielectric oil. As an example, dielectric oil may be formulated to have a desired viscosity and/or viscoelastic properties, etc.

[0087] As shown, the shaft 850 may be fitted with a coupling 852 to couple the shaft to another shaft. A coupling may include, for example, splines that engage splines of one or more shafts. The shaft 850 may be supported by bearings 854-1, 854-2, 854-3, etc. disposed in the housing 860.

[0088] As shown, the housing 860 includes opposing axial ends 862 and 864 with the substantially cylindrical outer surface 865 extending therebetween. The outer surface 865 can include one or more sealable openings for passage of oil (e.g., dielectric oil), for example, to lubricate the bearings and to protect various components of the motor assembly 800. As an example, the motor assembly 800 may include one or more sealable cavities. For example, a passage 866 allows for passage of one or more conductors of the cable 844 (e.g., or cables) to a motor cavity 867 of the motor assembly 800 where the motor cavity 867 may be a sealable cavity. As shown, the motor cavity 867 houses the stator windings 870 and the stator laminations 880. As an example, an individual winding may include a plurality of conductors (e.g., magnet wires). For example, a cross-section 872 of an individual winding may reveal a plurality of conductors that are disposed in a matrix (e.g., of material or materials) or otherwise bound together (e.g., by a material or materials). In the example of Fig. 8, the motor housing 860 includes an oil reservoir 868, for example, that may include one or more passages (e.g., a sealable external passage and a passage to the motor cavity 867) for passage of oil.

[0089] As an example, a shaft may be reciprocating, for example, where a shaft includes one or more magnets (e.g., permanent magnets) that respond to current that passes through stator windings.

[0090] Fig. 9 shows an example of a method 900 that includes a treatment block 910 for treating a component (e.g., a plasma treatment that reduces presence of contaminants or otherwise cleans one or more surfaces of dielectric material of the component), a formulation block 920 for formulating a polymer dispersion, a coat block 930 for coating at least one surface of the component with the polymer dispersion (e.g., forming a coating of the polymer dispersion on the component), drying block 940 to remove moisture, and a sinter block 950 for sintering the coated component to produce a sintered, coated component.

[0091] Fig. 10 shows an example of a method 1000 that includes a dip block 1010 for dip coating one or more components, a dry block 1020 for drying one or more dip coated components and a sinter block 1030 for sintering one or more dried, dip coated components. In such an example, the dry block 1020 can include air drying. As an example, the sinter block 1030 can include sintering in an environment such as a nitrogen gas environment (e.g., nitrogen atmosphere).

[0092] Fig. 11 shows an example of a system 1100 that includes a plasma chamber 1110 where one or more components 1120 are disposed within the plasma chamber 1110. In such an example, plasma may be utilized to treat the one or more components 1120 (see, e.g., the treatment block 910 of Fig. 9).

[0093] The system 1100 can utilize at least partially ionized gas where charged particles provide for high electrical conductivity. Such particles can interact with a surface for plasma treatment of that surface. As an example, the plasma chamber 1110 can be utilized for plasma treatment of one or more components, for example, for one or more of cleaning, surface activation, deposition, and etching.

[0094] As an example, a method can include coating a hydrophilic polymeric surface of a component with an aqueous polymer dispersion to form a coated component; and sintering the coated component to form a sintered, coated component that includes a less hydrophilic polymeric surface, which may, for example, a hydrophobic surface.

[0095] As an example, a formulation may be an aqueous dispersion that includes one or more polymeric materials. As an example, a coating formed from an aqueous dispersion can be a hydrophobic coating. As an example, an aqueous

dispersion may include one or more of FEP (fluorinated ethylene propylene), PTFE (polytetrafluoroethylene), PFA (perfluoroalkoxy copolymer), MFA (perfluoro-methyl-alkoxy copolymer) and HFP/VDF/TFE terpolymer (hexafluoropropylene/vinylidene fluoride/tetrafluoroethylene). As an example, a formulation may be a mixture of various polymeric materials and optionally one or more other materials.

[0096] Polyetheretherketone (PEEK) is a semi-crystalline thermoplastic that can be used as a material of construction for one or more components such as, for example, one or more components of motor lead extensions (MLEs) and electrical connectors (e.g., potheads, etc.). PEEK tends to exhibit chemical resistance, mechanical strength, resistance to hydrolysis in boiling water and superheated steam, and tends to be a dielectric with low loss at high temperatures and frequencies. However, PEEK can be susceptible to absorption of moisture (e.g., adsorb humidity from a wet environment due to the polarity of the carbonyl group in its chemical backbone structure). As an example, as to PEEK, humidity may decrease dielectric strength, produce arc tracking and consequently cause high electrical test failure rates in a manufacturing process.

[0097] As an example, a coating material may be applied to a component such as a component formed at least in part from a semi-crystalline thermoplastic such as, for example, PEEK. In such an example, the coating material may help to protect the surface of the component from humidity (e.g., help to keep it dry during operation).

[0098] As an example, a coating material can make a material such as PEEK more hydrophobic. In turn, the material can better resist water penetration and water uptake.

[0099] As an example, a method can include coating a PEEK surface with one or more hydrophobic and thermally stable materials, such as, for example, one or more of polytetrafluoroethylene (PTFE) and perfluoroalkoxy copolymer (PFA). Such an approach can improve the surface resistivity and arc track resistance of a component during electrical testing and medium voltage operation (e.g., about 4 kV to about 8 kV).

[00100] As an example, an aqueous dispersion of PTFE and PFA can be used to fabricate a protective relatively homogeneously thin film on a PEEK surface. As an example, plasma treatment of a PEEK surface before the application of one or more coatings may be employed to improve interfacial adhesion between PEEK and PTFE

and/or PFA. As an example, interfacial adhesion can include one or more of chemical and physical types of adhesion mechanisms (e.g., intermolecular forces, chain entanglements, etc.).

[00101] In electrical connector systems for downhole use, polyaryletherketones (PEK, PEEK, PEKEKK) and composites thereof can be used due to their high temperature stability, resistance to downhole chemicals, and dielectric properties. While these materials tend to be suitable for such applications, they also tend to be susceptible to electrical arc tracking in the presence of moisture. When this occurs, a connector can be destroyed by the electrical arc. As an example, electrical arc tracking can be caused by a loss of surface resistivity due to moisture adsorption. As such, one or more coating materials that tend to be hydrophobic can help to reduce adsorption of moisture. As an example, a coating may be a hydrophobic, arc-track resistant coating that is mechanically and thermally stable at high temperature and in various types of wellbore fluid(s).

[00102] PTFE and PFA are performance polymers with characteristics, such as, high dielectric strength, low dissipation factor, non-flammability, chemical inertness, corrosion resistance, and heat resistance. A thin protective layer of PTFE and/or PFA on a surface of a PEEK component can improve the surface free energy and can decrease the permittivity and dissipation factor. The low surface energy of PTFE and PFA and their high water contact angle can act to provide a desired level of low water wettability for a PEEK surface.

[00103] As an example, a thin protective layer of PTFE can be applied to a PEEK surface via a powder coating process. However, where shape of a PEEK surface has undulations, interior corners, etc., surface coating via a powder coating process may lead to some inhomogeneity of coverage. For example, consider shapes of ESP connectors that might include relatively inaccessible narrow regions. Where such narrow regions are uncoated, they may absorb humidity. As an example, a PTFE powder coating process may include sintering at a temperature up to about 400 degrees C, which can be higher than the melting point of PEEK (~340 degrees C); therefore, a PEEK connector may melt during sintering.

[00104] As an example, a method can include formulating an aqueous PTFE and/or PFA dispersion. As an example, such a dispersion may have at a relatively low viscosity and be liquid that can efficiently coat a PEEK pothead surface to form a relatively homogenous flexible thin film layer.

[00105] PFA exhibits various properties akin to PTFE and can be sintered at a lower temperature than that of PTFE (e.g., lower than the melting point of PEEK). As an example, an aqueous dispersion can be an alternative to a solvent-based counterpart in various applications, for example, to limit detrimental health and/or environmental effects.

[00106] As an example, water may be utilized as an environmentally benign solvent used in the formulation of PFA. A PFA dispersion may be obtained commercially, for example, with a solids content of around 50 percent by weight and an average particle size of approximately 200 nm.

[00107] As an example, a thickness of a PFA film can be controlled by changing the PFA concentration of a dispersion. As an example, a PFA aqueous dispersion can have (i) high shear stability and low settling tendency; (ii) high chemical resistance; (iii) minimal volatile organic compound; (iii) creep resistance at high temperature; and (iv) suitable electrical properties (e.g., low dielectric constant, low dissipation factor, high dielectric breakdown, and high resistivity).

[00108] As mentioned, PTFE and/or PFA aqueous dispersions can be used to decrease the water uptake and hydrolytic degradation of PEEK electrical connectors. Various trials included dip coating PEEK electrical connectors in aqueous dispersions and then drying at room temperature for 1 h. Another drying process was carried out for an additional 1 h at 120 degrees C. A sintering process was performed at 250 degrees C for 2h and 325 degrees C for another 3 h. The electrical connectors were homogenously coated with a thin film of PFA with a high degree of adhesion after the sintering process.

[00109] Fig. 12 shows examples of components with and without coating materials. Coated components are shown in photographs 1212, 1216, 1222, 1226, 1232 and 1236 while uncoated components are shown in photographs 1214, 1218, 1224, 1228, 1234 and 1238. Specifically, Fig. 12 shows photographs for different coated and uncoated samples with PFA aqueous dispersion after sintering process at about 250 degrees C for about 2 h and 325 degrees C for about 3 h.

[00110] As an example, a surface of a component or blank or stock material can be treated with plasma prior to performing a coating process, for example, to improve interfacial adhesion between a PFA coating material (e.g., film) and a PEEK surface.

[00111] Fig. 13 shows photographs of coated and uncoated PEEK with a drop of water 1310 and 1320, respectively, and cross-sections 1340 of coated PEEK 1342 and uncoated PEEK 1344.

[00112] In the example of Fig. 13, the coated component (see, e.g., the photographs 1310 and 1342) has a layer of about 20 μm thickness on opposing sides of the component. In Fig. 13, a clear interface between PEEK and PFA interface is not observed (e.g., interface is indiscernible).

[00113] The contact angle of water on the PEEK surface with and without the PFA coating is shown in Fig. 13 in the photographs 1310 and 1320, respectively. Water can wet the uncoated PEEK (see the photograph 1320) while a high contact angle is observed for water on the coated PEEK (see photograph 1310). In the photographs 1310 and 1320, an approximate diameter is shown for the water drops where the diameter for the water drop in the photograph 1320 exceeds the diameter for the water drop in the photograph 1310 (e.g., where the volume of the water drops is substantially the same).

[00114] In the cross-section photographs 1340 for the coated and the uncoated PEEK, the widths of the uncoated and the coated materials are about 2.26 mm and about 3.0 mm, respectively. Therefore, there is about a 20 μm thick PFA coated layer on each side of the PEEK material. Again, a clear interface between the PFA coated layer and the bulk PEEK surface is not apparent in Fig. 13, indicating that the PFA has to at least some extent defused into the PEEK material via the surface (e.g., during the drying and/or sintering processes). The information presented in Fig. 13 demonstrates that PFA and PEEK have a suitably strong interaction and adhesion.

[00115] Fig. 14 shows additional photographs 1410 and 1420 as to coated material and uncoated material, respectively, along with a plot 1420 of contact angle for the coated and uncoated materials with respect to time in seconds and a classification scheme 1450. As indicated, the coating results in a contact angle that is about 35 degrees greater than the uncoated material.

[00116] A contact angle can be defined as an angle where a liquid–vapor interface meets a material surface (e.g., a solid surface, etc.). Contact angle can be used to quantify wettability of a surface by a liquid via the Young equation.

[00117] As an example, where a water contact angle is smaller than about 90 degrees, a surface may be considered to be hydrophilic and, for example, if a water contact angle is larger than about 90 degrees, the surface may be considered to be hydrophobic. Referring again to Fig. 14 and the plot 1420, the coated material exhibits a contact angle that is greater than 90 degrees whereas the uncoated material exhibits a contact angle that is less than 90 degrees.

[00118] In Fig. 14, the classification scheme 1450 shows two hydrophilic materials with respect to liquid and gas 1452 and 1454, a hydrophobic material with respect to liquid and gas 1456 and a superhydrophobic material with respect to liquid and gas 1458. As an example, the uncoated material of the photograph 1420 may be classified as being hydrophilic and the coated material of the photograph 1410 may be classified as being hydrophobic.

[00119] Fig. 15 shows photographs of an uncoated magnet wire 1510 and of a coated magnet wire 1530. Specifically, the photographs 1510 and 1530 correspond to magnet wires after 14 days in REDA oil #5 and about 0.1 weight percent water at about 225 degrees C and about 1500 psi under a nitrogen atmosphere. The coated magnet wire includes a PFA coating (e.g., a PFA coated magnet wire) while the uncoated magnet wire does not include a PFA coating. As indicated by labels, one or more defects such as delamination occur after performing an accelerated aging test for the uncoated magnet wire.

[00120] Fig. 16 shows data pertaining to interactions between PFA coating and PEEK or PEEK composites (e.g. glass filled PEEK) per dynamic mechanical analysis (DMA) and differential scanning calorimetry (DSC) measurements.

[00121] For DSC measurements, shown in a plot 1610 of Fig. 16, the melting temperature (T_m) of pure PFA sample obtained from the solvent cast of the aqueous dispersion is 311 degrees C, while the uncoated glass filled PEEK has $T_m = 340$ degrees C. In addition the glass filled PEEK sample has a glass transition temperature (T_g) of approximately 155 degrees C. The values of T_g and T_m of the glass filled PEEK were not affected by coating, while the T_m of PFA shifted to 324 degrees C (about 13 degrees C higher than that of pure PFA). This increase in the T_m of PFA can be related to the strong interaction between PEEK and PFA.

[00122] The DMA for the coated and uncoated glass filled PEEK is shown in a plot 1630 of Fig. 16. The storage modulus of the coated sample is lower than that of uncoated one due to the high elasticity of PFA compared with the glass filled PEEK.

The T_g (peak maximum of the $\tan\delta$) does not exhibit change by coating process, which is in agreement with the DSC data.

[00123] Fig. 17 shows example plots 1710 that include the dielectric constant, $\tan\delta$, and volume resistivity as a function of temperature for both uncoated and PFA coated PEEK film. In the examples of Fig. 17, the dielectric constant and $\tan\delta$ of the PFA coated PEEK are lower than that of the uncoated PEEK, while the volume resistivity of the coated PEEK is higher than the uncoated one. These data indicate that a relatively thin PFA coating can improve the dielectric properties of PEEK (e.g., a component made of PEEK, a component that includes a layer of PEEK, etc.).

[00124] In addition to the PAEK polymers and/or other polymers mentioned, such an approach to coating may be applied to high temperature dielectric material that is prone to moisture absorption. For example, consider applications to one or more of polyimides, bismaleimides, cyanate esters, epoxies, or another high temperature material used in a dielectric application.

[00125] As explained, an aqueous polymer dispersion can be used to provide a relatively homogenous highly bonded hydrophobic thin film as a protective layer, for example, to protect against water and corrosion to a component such as, for example, an ESP electrical connector component. As an example, an aqueous polymer dispersion may be applied to one or more components of an electric motor to make the electric motor more water resistance. As an example, where a treated component is utilized in an ESP system, such a component (e.g., or components) may increase lifetime and reliability of the ESP.

[00126] As an example, a method can include coating a hydrophilic polymeric surface of a component with an aqueous polymer dispersion to form a coated component; and sintering the coated component to form a sintered, coated component that includes a less hydrophilic polymeric surface. As an example, such a method can include installing the sintered, coated component in an electrical submersible pump system. In such an example, the less hydrophilic polymeric surface can extend the operational lifetime of the component, in comparison to a non-sintered, coated component, where moisture is present. In such an example, the operational lifetime of the electric submersible pump may be extended.

[00127] As an example, a method can include coating a hydrophilic polymeric surface of a component with an aqueous polymer dispersion to form a coated

component; and sintering the coated component to form a sintered, coated component that includes a less hydrophilic polymeric surface. In such an example, the less hydrophilic polymeric surface is a hydrophobic polymeric surface.

[00128] As an example, a hydrophilic polymeric surface of a component can be a thermoplastic surface that can be coated with an aqueous polymer dispersion to form a coated component. Such a coated component can then be sintered to form a sintered, coated component that includes a less hydrophilic polymeric surface. As an example, a hydrophilic polymeric surface of a component to be coated can be a polyetheretherketone surface.

[00129] As an example, an aqueous polymer dispersion can include fluorinated ethylene propylene. In such an example, the dispersion can be utilized to coat a hydrophilic polymeric surface to form a coated surface where sintering of the coated surface forms a less hydrophilic polymeric surface, which may be a hydrophobic surface, that includes fluorinated ethylene propylene.

[00130] As an example, an aqueous polymer dispersion can include polytetrafluoroethylene. In such an example, the dispersion can be utilized to coat a hydrophilic polymeric surface to form a coated surface where sintering of the coated surface forms a less hydrophilic polymeric surface, which may be a hydrophobic surface, that includes polytetrafluoroethylene.

[00131] As an example, an aqueous polymer dispersion can include perfluoroalkoxy copolymer. In such an example, the dispersion can be utilized to coat a hydrophilic polymeric surface to form a coated surface where sintering of the coated surface forms a less hydrophilic polymeric surface, which may be a hydrophobic surface, that includes perfluoroalkoxy copolymer.

[00132] As an example, an aqueous polymer dispersion can include perfluoro-methyl-alkoxy copolymer. In such an example, the dispersion can be utilized to coat a hydrophilic polymeric surface to form a coated surface where sintering of the coated surface forms a less hydrophilic polymeric surface, which may be a hydrophobic surface, that includes perfluoro-methyl-alkoxy copolymer.

[00133] As an example, an aqueous polymer dispersion can include a terpolymer. In such an example, the dispersion can be utilized to coat a hydrophilic polymeric surface to form a coated surface where sintering of the coated surface forms a less hydrophilic polymeric surface, which may be a hydrophobic surface, that

includes the terpolymer. In such an example, the terpolymer can include hexafluoropropylene, vinylidene fluoride and tetrafluoroethylene.

[00134] As an example, an aqueous polymer dispersion can include at least one of FEP (fluorinated ethylene propylene), PTFE (polytetrafluoroethylene), PFA (perfluoroalkoxy copolymer), MFA (perfluoro-methyl-alkoxy copolymer) and HFP/VDF/TFE terpolymer (hexafluoropropylene/vinylidene fluoride/tetrafluoroethylene).

[00135] As an example, a method can include coating a hydrophilic polymeric surface of a component with an aqueous polymer dispersion to form a coated component; and sintering the coated component to form a sintered, coated component that includes a less hydrophilic polymeric surface where the less hydrophilic polymeric surface can include at least one of FEP (fluorinated ethylene propylene), PTFE (polytetrafluoroethylene), PFA (perfluoroalkoxy copolymer), MFA (perfluoro-methyl-alkoxy copolymer) and HFP/VDF/TFE terpolymer (hexafluoropropylene/vinylidene fluoride/tetrafluoroethylene).

[00136] As an example, a method can include coating a hydrophilic polymeric surface of a component with an aqueous polymer dispersion to form a coated component; and sintering the coated component to form a sintered, coated component that includes a less hydrophilic polymeric surface where, for example, the component is a thermoplastic component. In such an example, the thermoplastic component can include, for example, PEEK (e.g., may be a component made of PEEK).

[00137] As an example, a method can include coating a hydrophilic polymeric surface of a component with an aqueous polymer dispersion to form a coated component; and sintering the coated component to form a sintered, coated component that includes a less hydrophilic polymeric surface where the sintering includes sintering at a maximum sintering temperature that is less than approximately 350 degrees C.

[00138] As an example, an electrical connector can include a thermoplastic core that includes a sintered hydrophobic polymeric surface. In such an example, the sintered hydrophobic polymeric surface can include, for example, at least one of FEP (fluorinated ethylene propylene), PTFE (polytetrafluoroethylene), PFA (perfluoroalkoxy copolymer), MFA (perfluoro-methyl-alkoxy copolymer) and

HFP/VDF/TFE terpolymer (hexafluoropropylene/vinylidene fluoride/tetrafluoroethylene).

[00139] As an example, an electric submersible pump pot head assembly can include a component that includes a thermoplastic core that includes a sintered hydrophobic polymeric surface. In such an example, the sintered hydrophobic polymeric surface can include, for example, at least one of FEP (fluorinated ethylene propylene), PTFE (polytetrafluoroethylene), PFA (perfluoroalkoxy copolymer), MFA (perfluoro-methyl-alkoxy copolymer) and HFP/VDF/TFE terpolymer (hexafluoropropylene/vinylidene fluoride/tetrafluoroethylene).

[00140] As an example, an aqueous polymer dispersion can include monomers of one or more types of chemical structures where such monomers can polymerize to form one or more polymers. As an example, where polymer dispersion is mentioned, it can include one or more types of polymers, which may be of one or more molecular weights. As an example, polymers may further polymerize with polymers to form polymers with larger molecular weights. In such an example, the polymers may differ in their chemical structures. For example, an amount of one type of polymer may be mixed in water with an amount of another type of polymer to form an aqueous dispersion where such types of polymers may polymerize with themselves and/or cross-polymerize. As an example, a polymer dispersion can include one or more types of monomers (e.g., which can differ in their chemical structures). As an example, monomers may polymerize with a type of monomer or types of monomers to form polymers (e.g., of one or more types).

[00141] As an example, one or more of various types of aqueous polymer dispersions, which can include monomers and/or polymers, can be utilized to form polymer coatings. For example, consider a method that includes coating a hydrophilic polymeric surface of a component with an aqueous polymer dispersion to form a coated component; and sintering the coated component to form a sintered, coated component that includes a less hydrophilic polymeric surface. In such an example, at least one chemical structure in the aqueous polymer dispersion (e.g., monomeric or polymeric) can coat the hydrophilic polymeric surface of the component to form a less hydrophilic polymeric surface, which may be, for example, a hydrophobic polymeric surface (e.g., as may be characterized via surface tension testing, etc.).

[00142] As an example, a polymeric coating can be a bonded polymeric coating that bonds to a surface of a component, which can be a polymeric surface of the component. For example, an aqueous polymer dispersion can be utilized to coat a polymeric surface where bonding may occur between chemical structures of the aqueous polymer dispersion and the polymeric surface being coated. As an example, interfacial adhesion can be a bonding mechanism. As an example, plasma treatment of a polymeric surface to be coated can enhance interfacial adhesion. As an example, sintering of a polymeric surface coated with one or more chemical structures of an aqueous polymer dispersion can promote adhesion of those one or more chemical structures to the polymeric surface.

[00143] As an example, coating a hydrophilic polymeric surface of a component with an aqueous polymer dispersion to form a coated component can optionally include polymerizing. For example, where the aqueous polymer dispersion includes monomers that can polymerize and/or where the aqueous polymer dispersion includes polymers that can polymerize. As an example, coating a hydrophilic polymeric surface of a component with an aqueous polymer dispersion to form a coated component can optionally include coating without polymerization. For example, consider an aqueous polymer dispersion that includes polymers that deposit on a surface (e.g., the aforementioned hydrophilic polymeric surface). As an example, a polymeric surface can optionally be a surface of a composite material that includes polymers and one or more other types of material (e.g., ceramic, etc.). As an example, a composite material can include glass, which may be present in one or more forms (e.g., particles, fibers, etc.).

[00144] As an example, one or more methods described herein may include associated computer-readable storage media (CRM) blocks. Such blocks can include instructions suitable for execution by one or more processors (or cores) to instruct a computing device or system to perform one or more actions.

[00145] According to an embodiment, one or more computer-readable media may include computer-executable instructions to instruct a computing system to output information for controlling a process. For example, such instructions may provide for output to sensing process, an injection process, drilling process, an extraction process, an extrusion process, a pumping process, a heating process, etc.

[00146] Fig. 18 shows components of a computing system 1800 and a networked system 1810. The system 1800 includes one or more processors 1802,

memory and/or storage components 1804, one or more input and/or output devices 1806 and a bus 1808. According to an embodiment, instructions may be stored in one or more computer-readable media (e.g., memory/storage components 1804). Such instructions may be read by one or more processors (e.g., the processor(s) 1802) via a communication bus (e.g., the bus 1808), which may be wired or wireless. The one or more processors may execute such instructions to implement (wholly or in part) one or more attributes (e.g., as part of a method). A user may view output from and interact with a process via an I/O device (e.g., the device 1806). According to an embodiment, a computer-readable medium may be a storage component such as a physical memory storage device, for example, a chip, a chip on a package, a memory card, etc.

[00147] According to an embodiment, components may be distributed, such as in the network system 1810. The network system 1810 includes components 1822-1, 1822-2, 1822-3, . . . , 1822-N. For example, the components 1822-1 may include the processor(s) 1802 while the component(s) 1822-3 may include memory accessible by the processor(s) 1802. Further, the component(s) 1802-2 may include an I/O device for display and optionally interaction with a method. The network may be or include the Internet, an intranet, a cellular network, a satellite network, etc.

[00148] Although only a few examples have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the examples. Accordingly, all such modifications are intended to be included within the scope of this disclosure as defined in the following claims. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents, but also equivalent structures. Thus, although a nail and a screw may not be structural equivalents in that a nail employs a cylindrical surface to secure wooden parts together, whereas a screw employs a helical surface, in the environment of fastening wooden parts, a nail and a screw may be equivalent structures. It is the express intention of the applicant not to invoke 35 U.S.C. § 112, paragraph 6 for any limitations of any of the claims herein, except for those in which the claim expressly uses the words “means for” together with an associated function.

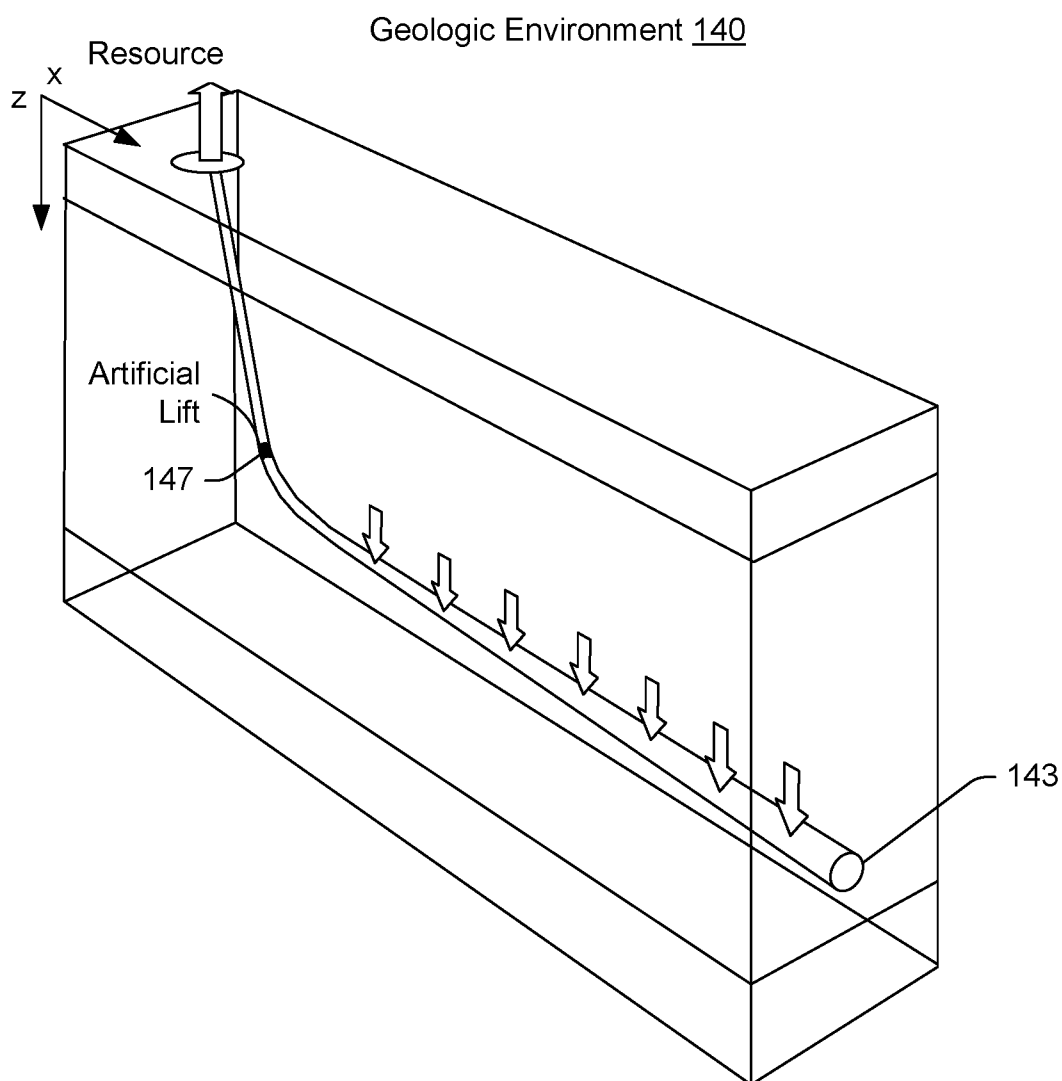
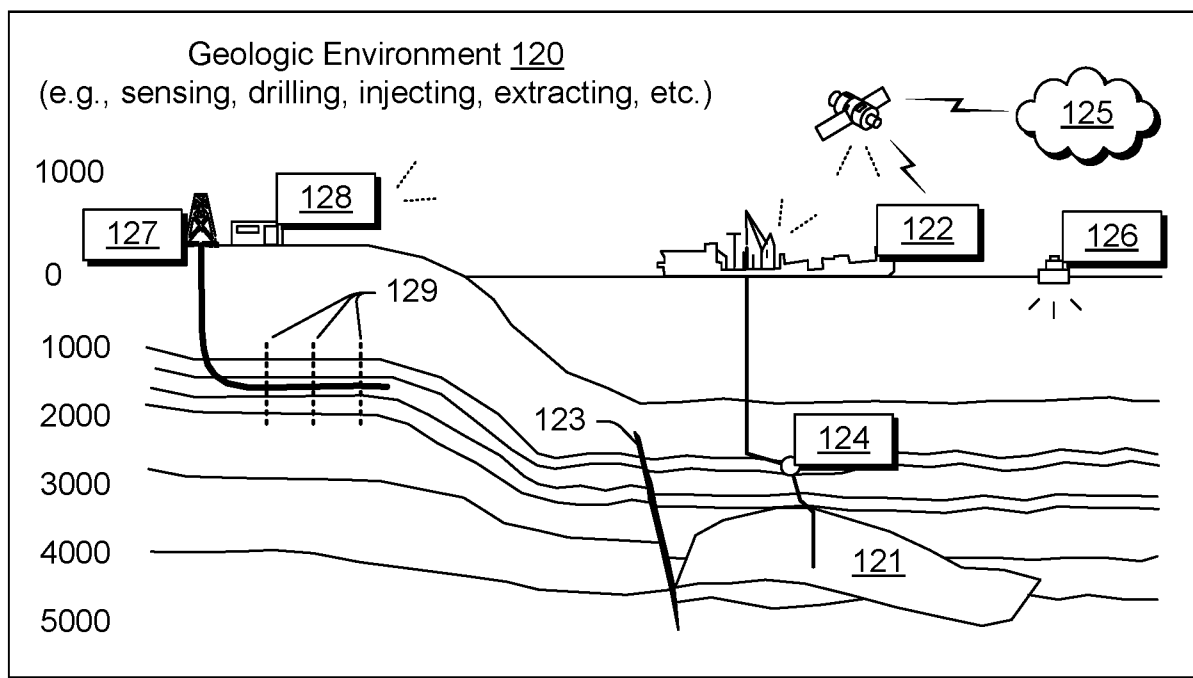
CLAIMS

What is claimed is:

1. A method comprising:
coating a hydrophilic polymeric surface of a component with an aqueous polymer dispersion to form a coated component; and
sintering the coated component to form a sintered, coated component that comprises a less hydrophilic polymeric surface.
2. The method of claim 1 comprising installing the sintered, coated component in an electrical submersible pump system.
3. The method of claim 1 wherein the less hydrophilic polymeric surface is a hydrophobic polymeric surface.
4. The method of claim 1 wherein the hydrophilic polymeric surface comprises a thermoplastic surface.
5. The method of claim 1 wherein the hydrophilic polymeric surface comprises a polyetheretherketone surface.
6. The method of claim 1 wherein the aqueous polymer dispersion comprises fluorinated ethylene propylene and wherein the less hydrophilic polymeric surface comprises fluorinated ethylene propylene.
7. The method of claim 1 wherein the aqueous polymer dispersion comprises polytetrafluoroethylene and wherein the less hydrophilic polymeric surface comprises polytetrafluoroethylene.
8. The method of claim 1 wherein the aqueous polymer dispersion comprises perfluoroalkoxy copolymer and wherein the less hydrophilic polymeric surface comprises perfluoroalkoxy copolymer.

9. The method of claim 1 wherein the aqueous polymer dispersion comprises perfluoro-methyl-alkoxy copolymer and wherein the less hydrophilic polymeric surface comprises perfluoro-methyl-alkoxy copolymer.
10. The method of claim 1 wherein the aqueous polymer dispersion comprises a terpolymer.
11. The method of claim 10 wherein the terpolymer comprises hexafluoropropylene, vinylidene fluoride and tetrafluoroethylene and wherein the less hydrophilic polymeric surface comprises hexafluoropropylene, vinylidene fluoride and tetrafluoroethylene.
12. The method of claim 1 wherein the aqueous polymer dispersion comprises at least one member selected from a group consisting of FEP (fluorinated ethylene propylene), PTFE (polytetrafluoroethylene), PFA (perfluoroalkoxy copolymer), MFA (perfluoro-methyl-alkoxy copolymer) and HFP/VDF/TFE terpolymer (hexafluoropropylene/vinylidene fluoride/tetrafluoroethylene).
13. The method of claim 1 wherein the less hydrophilic polymeric surface comprises at least one member selected from a group consisting of FEP (fluorinated ethylene propylene), PTFE (polytetrafluoroethylene), PFA (perfluoroalkoxy copolymer), MFA (perfluoro-methyl-alkoxy copolymer) and HFP/VDF/TFE terpolymer (hexafluoropropylene/vinylidene fluoride/tetrafluoroethylene).
14. The method of claim 1 wherein the component comprises a thermoplastic component.
15. The method of claim 14 wherein the thermoplastic component comprises PEEK.
16. The method of claim 1 wherein the sintering comprises at a maximum sintering temperature that is less than approximately 350 degrees C.

17. An electrical connector comprising:
a thermoplastic core that comprises a sintered hydrophobic polymeric surface.
18. The electrical connector of claim 17 wherein the sintered hydrophobic polymeric surface comprises at least one member selected from a group consisting of FEP (fluorinated ethylene propylene), PTFE (polytetrafluoroethylene), PFA (perfluoroalkoxy copolymer), MFA (perfluoro-methyl-alkoxy copolymer) and HFP/VDF/TFE terpolymer (hexafluoropropylene/vinylidene fluoride/tetrafluoroethylene).
19. An electric submersible pump pot head assembly comprising:
a component that comprises a thermoplastic core that comprises a sintered hydrophobic polymeric surface.
20. The electrical connector of claim 19 wherein the sintered hydrophobic polymeric surface comprises at least one member selected from a group consisting of FEP (fluorinated ethylene propylene), PTFE (polytetrafluoroethylene), PFA (perfluoroalkoxy copolymer), MFA (perfluoro-methyl-alkoxy copolymer) and HFP/VDF/TFE terpolymer (hexafluoropropylene/vinylidene fluoride/tetrafluoroethylene).

**Fig. 1**

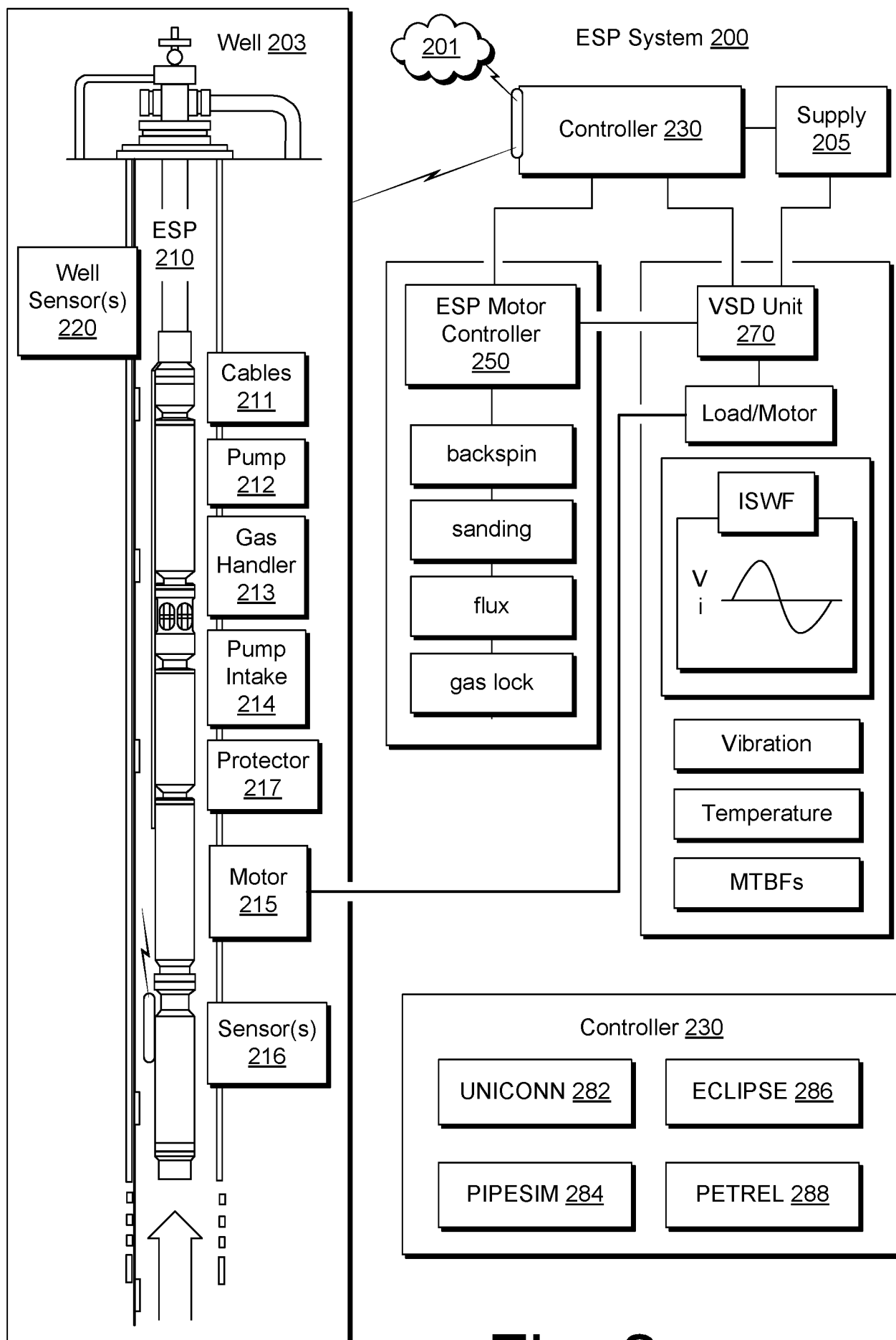


Fig. 2

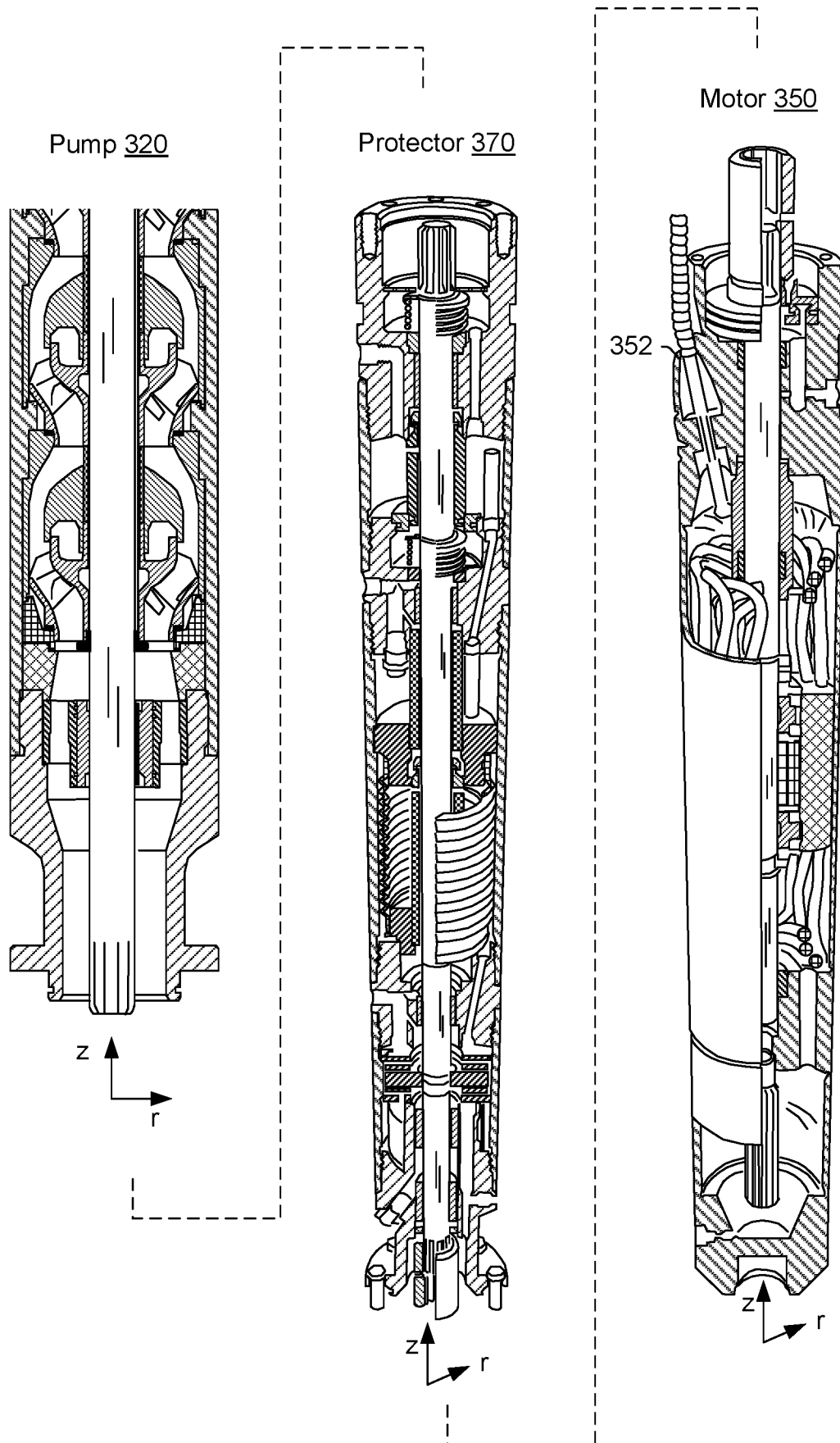


Fig. 3

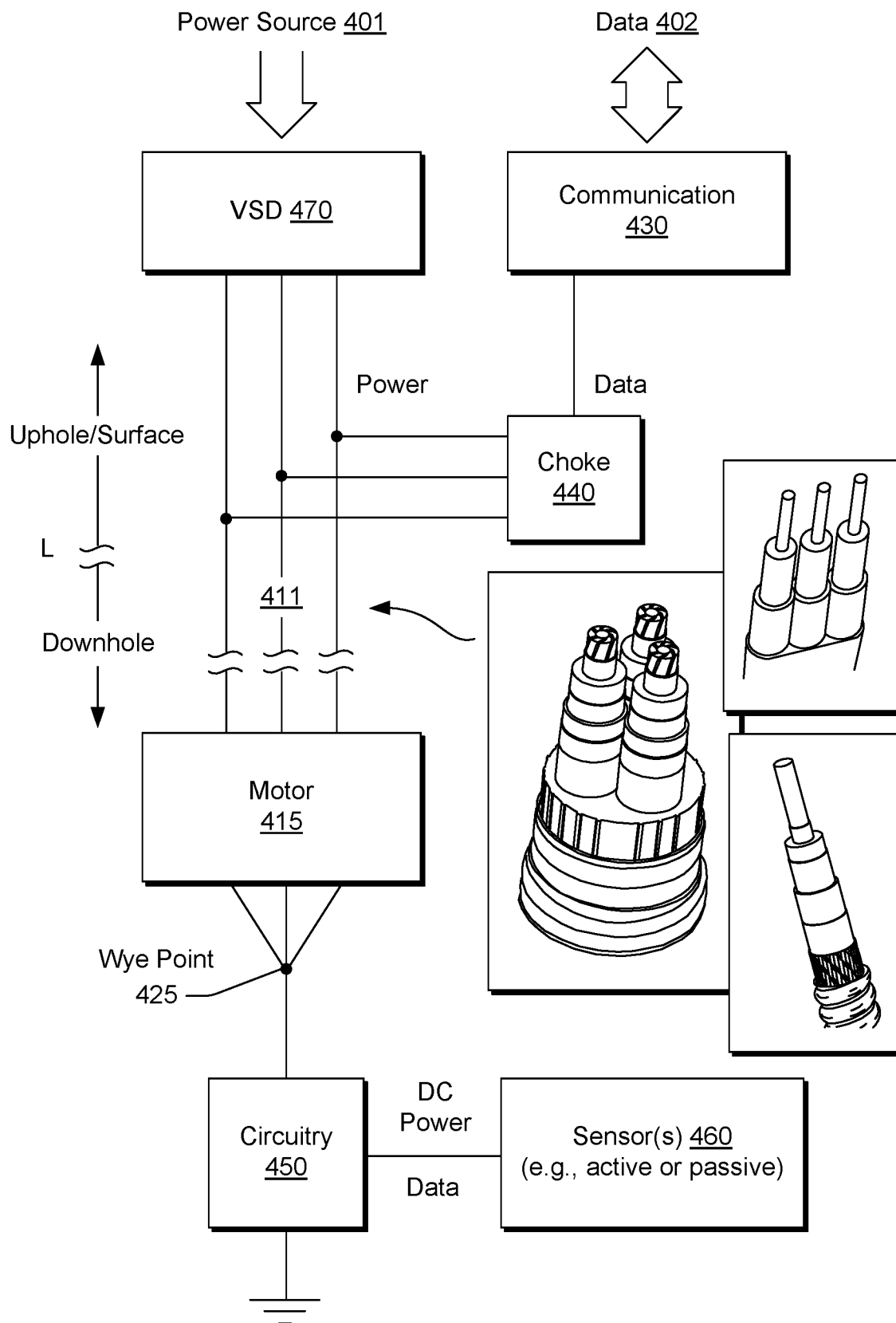


Fig. 4

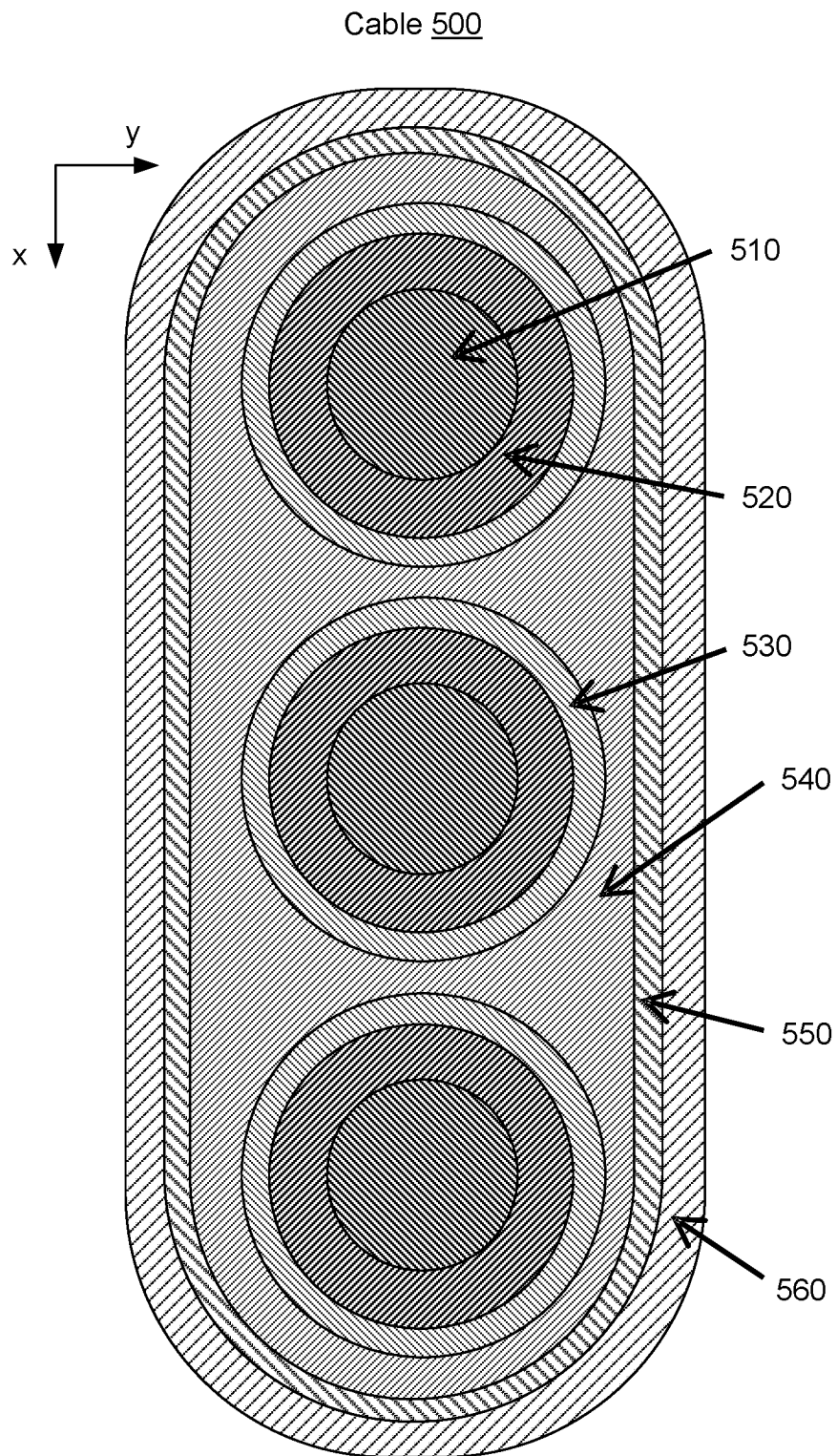
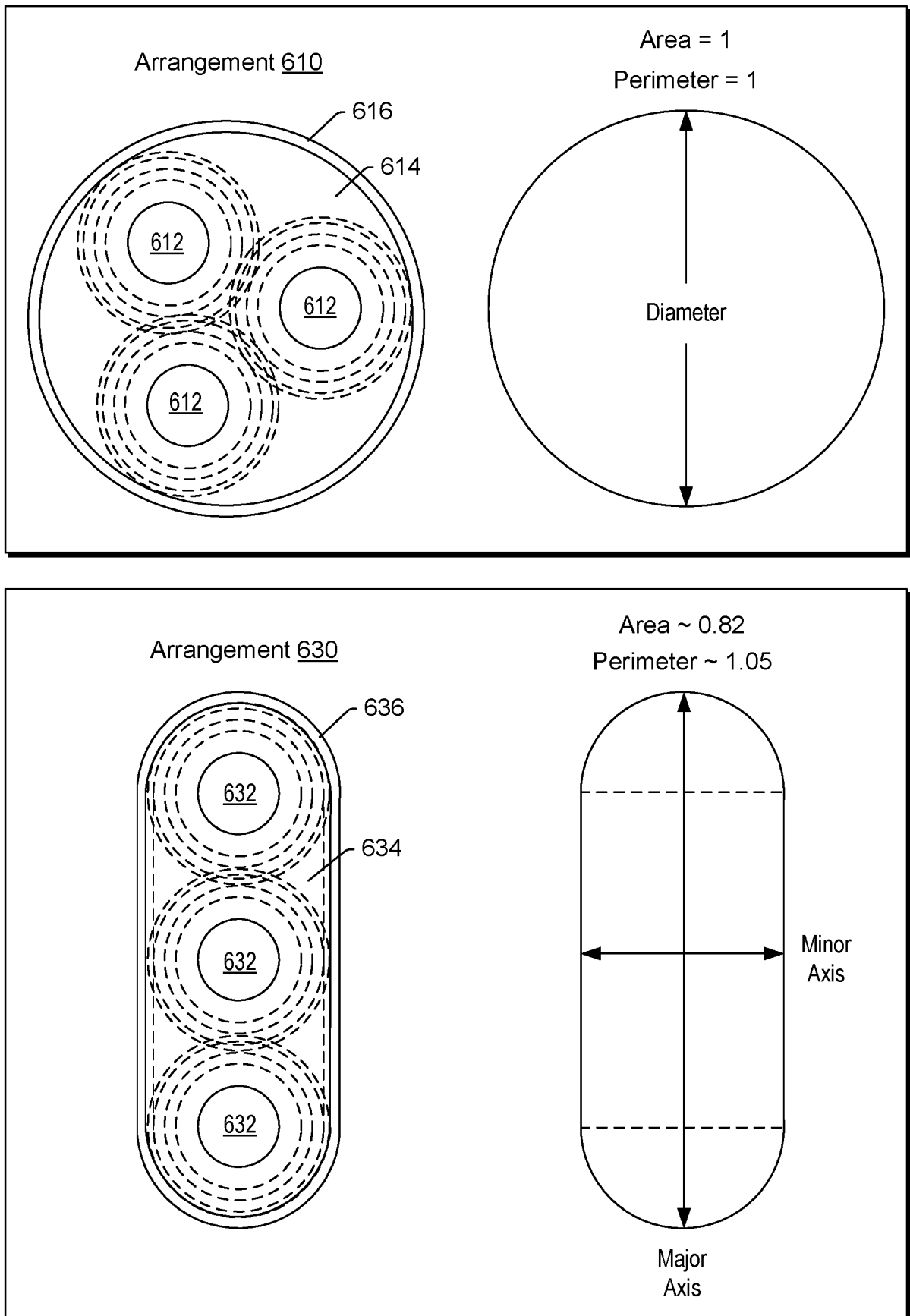
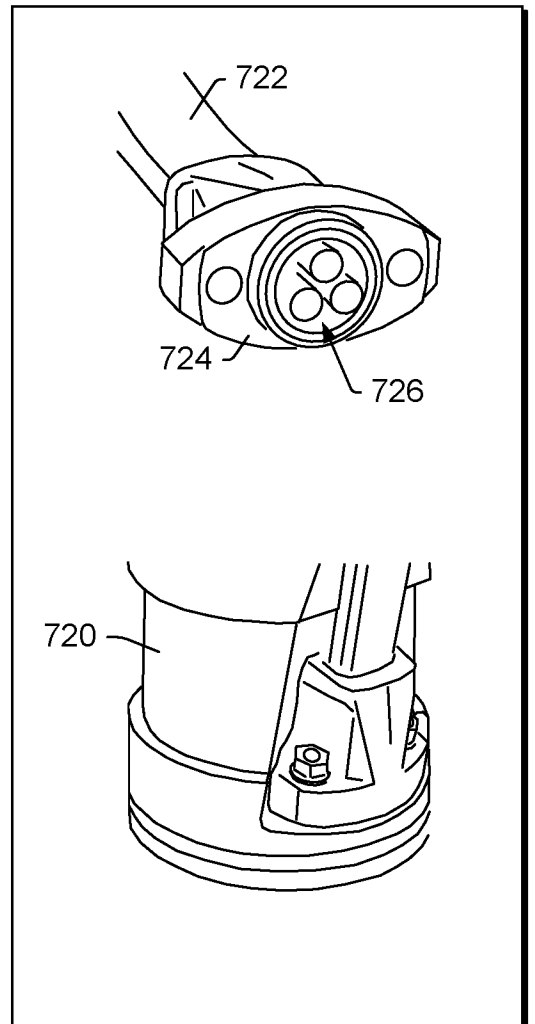
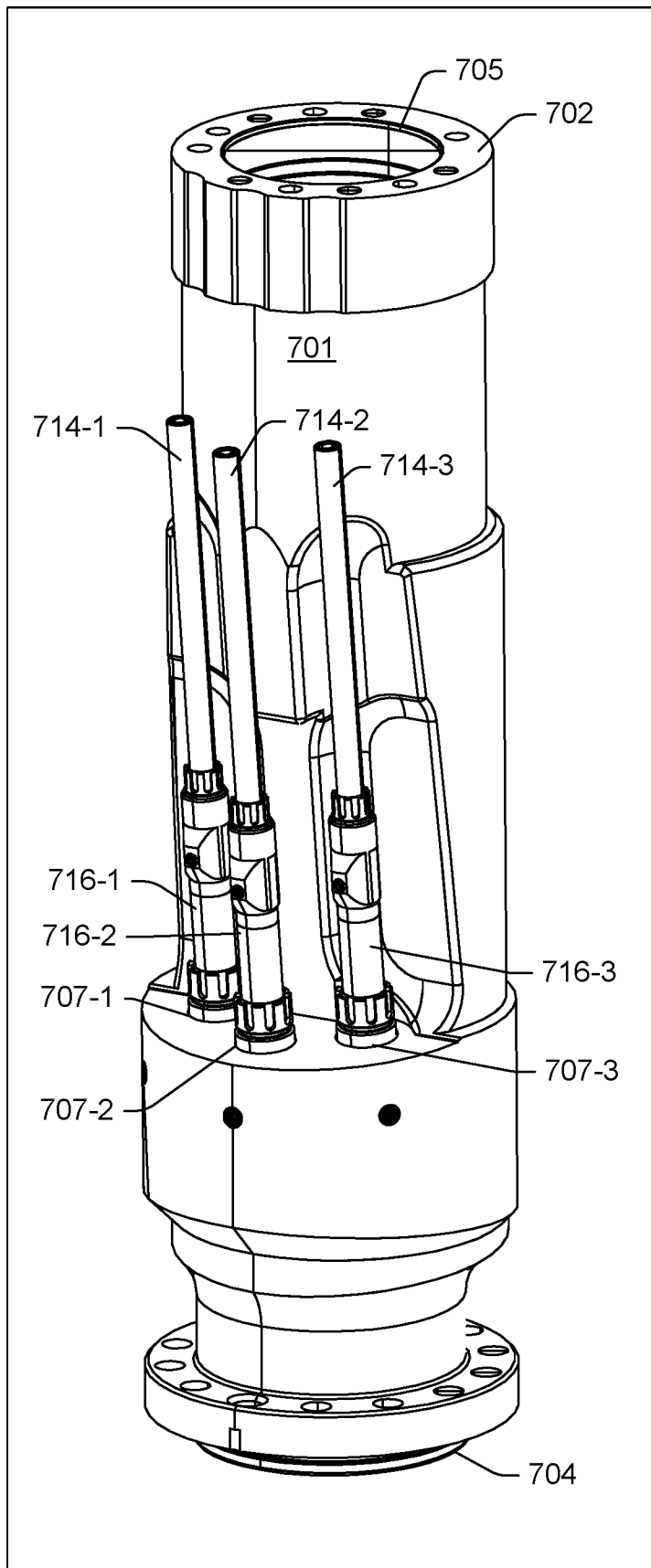


Fig. 5

**Fig. 6**

**Fig. 7**

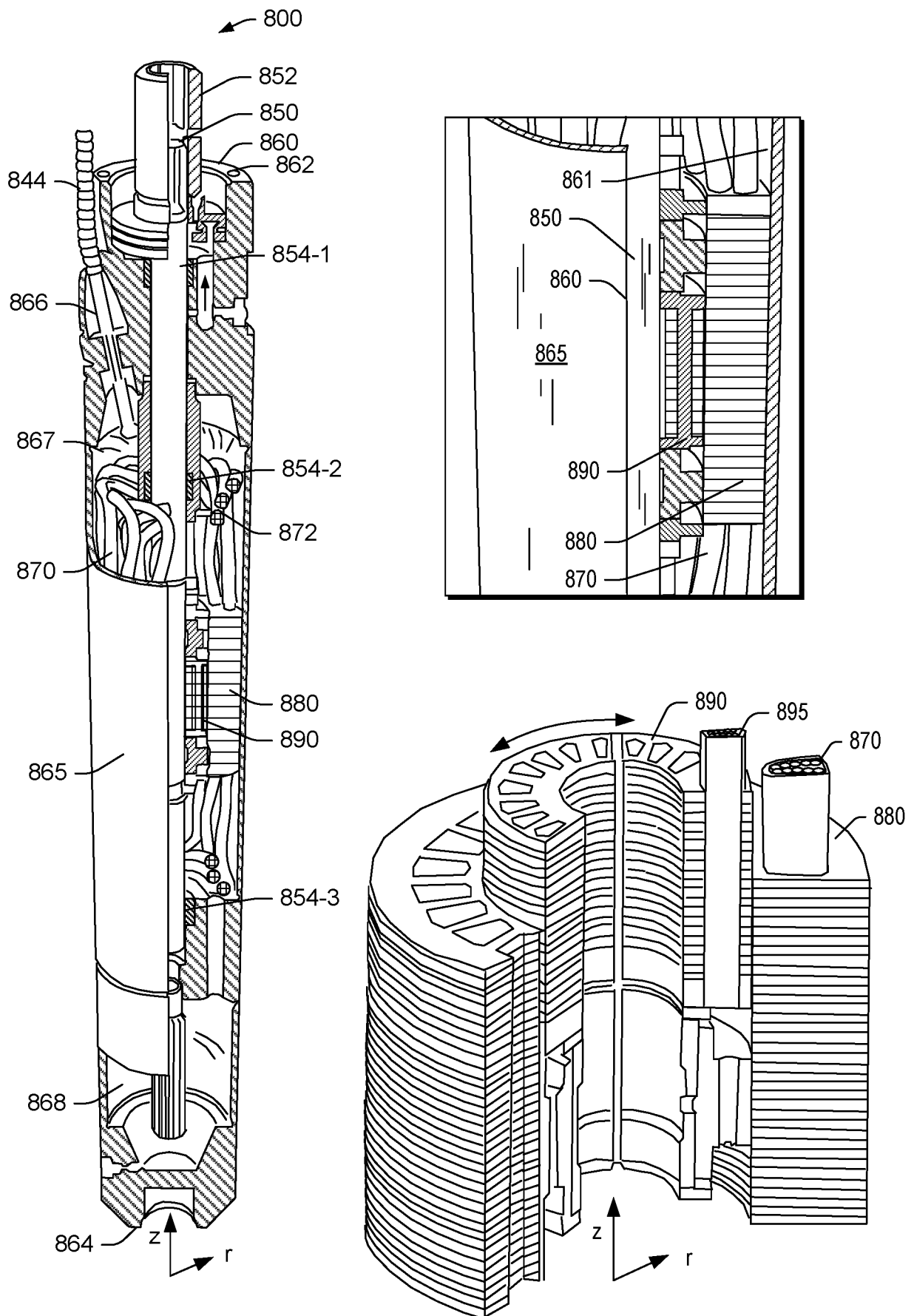


Fig. 8

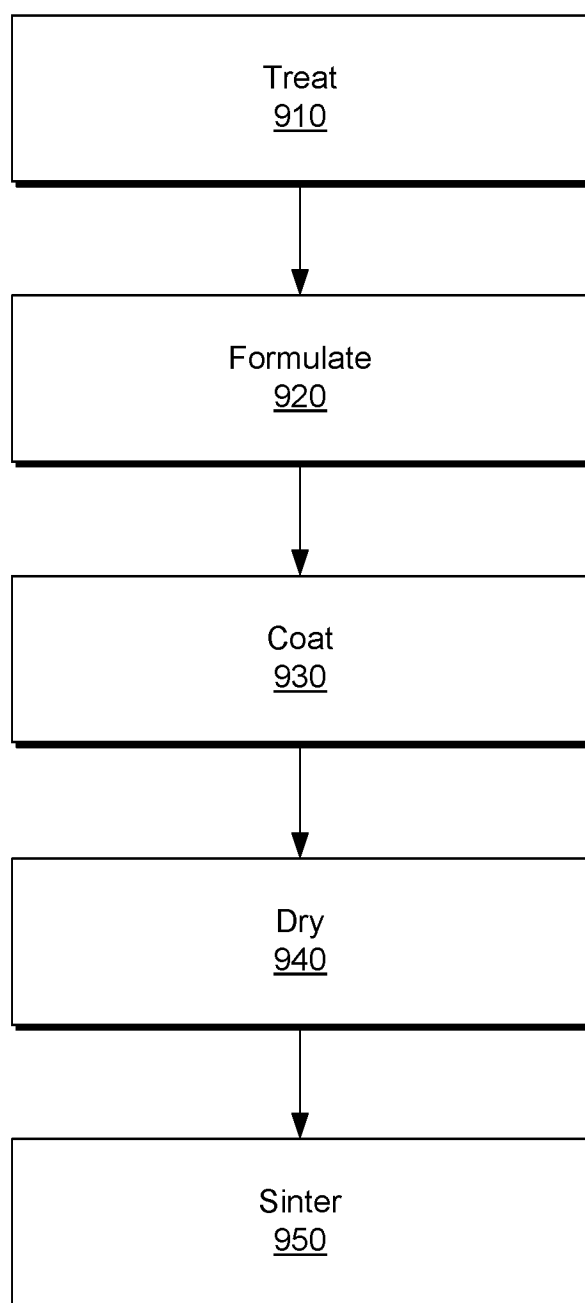
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Fig. 9

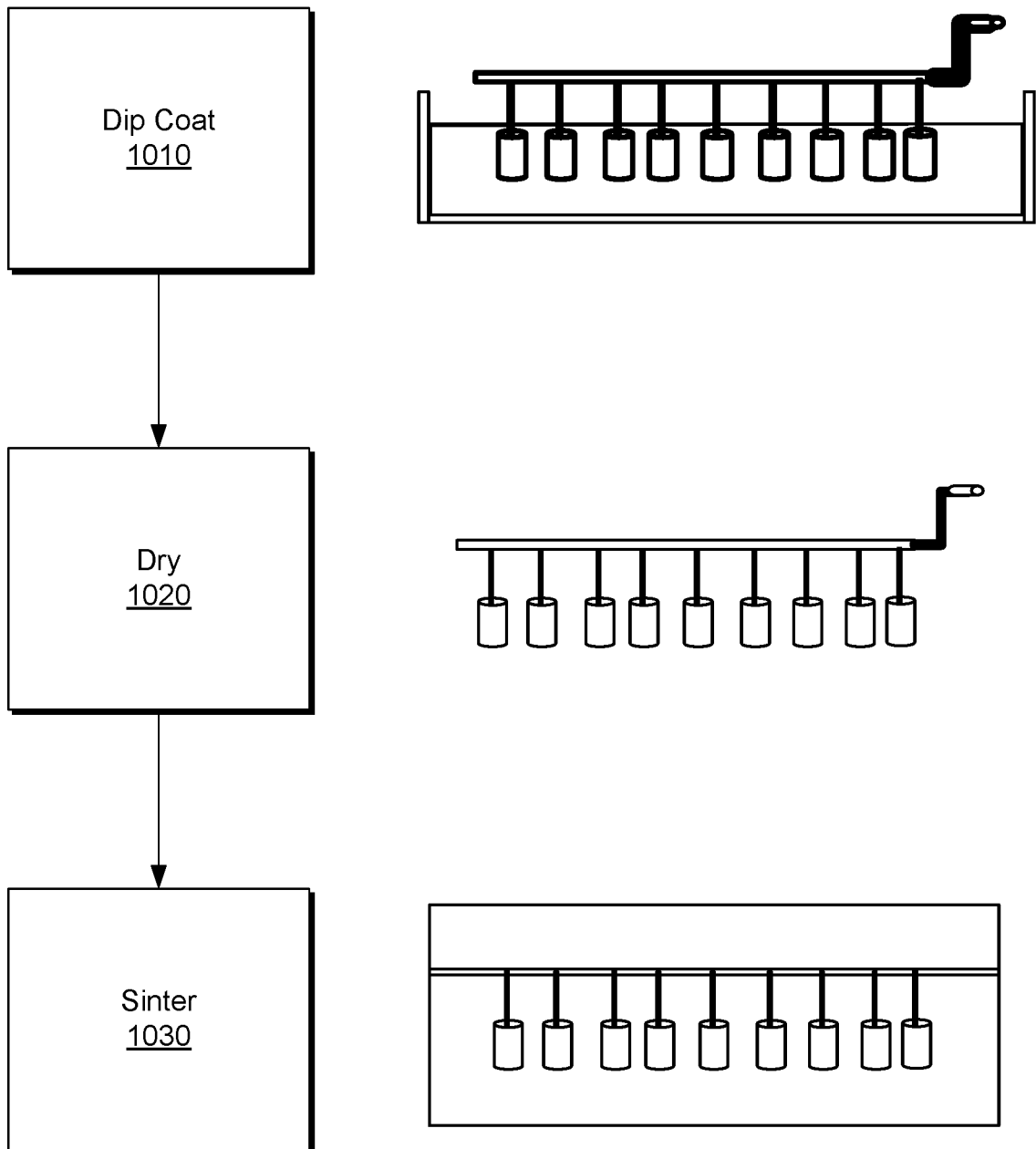
Method 1000

Fig. 10

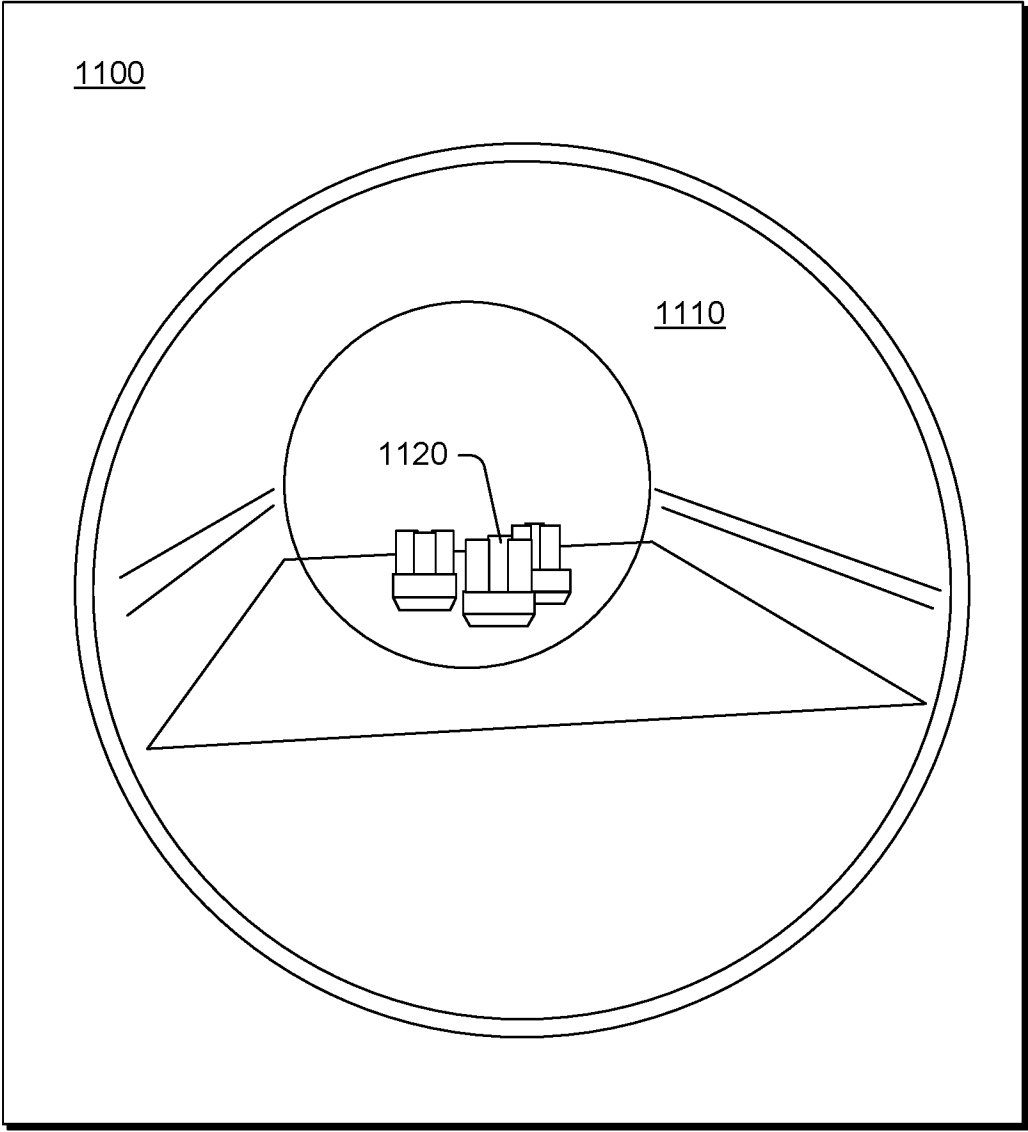


Fig. 11



Fig. 12

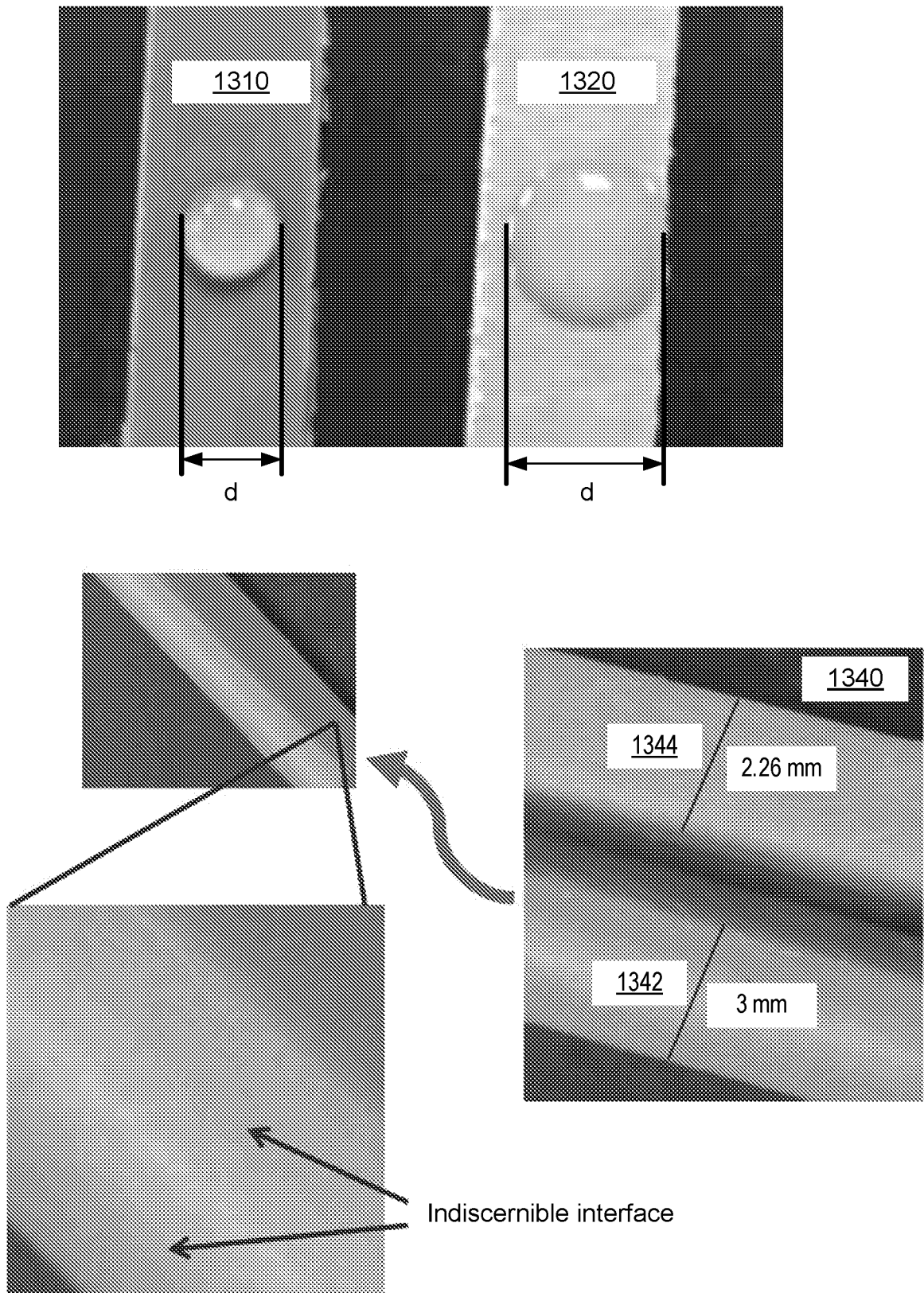


Fig. 13

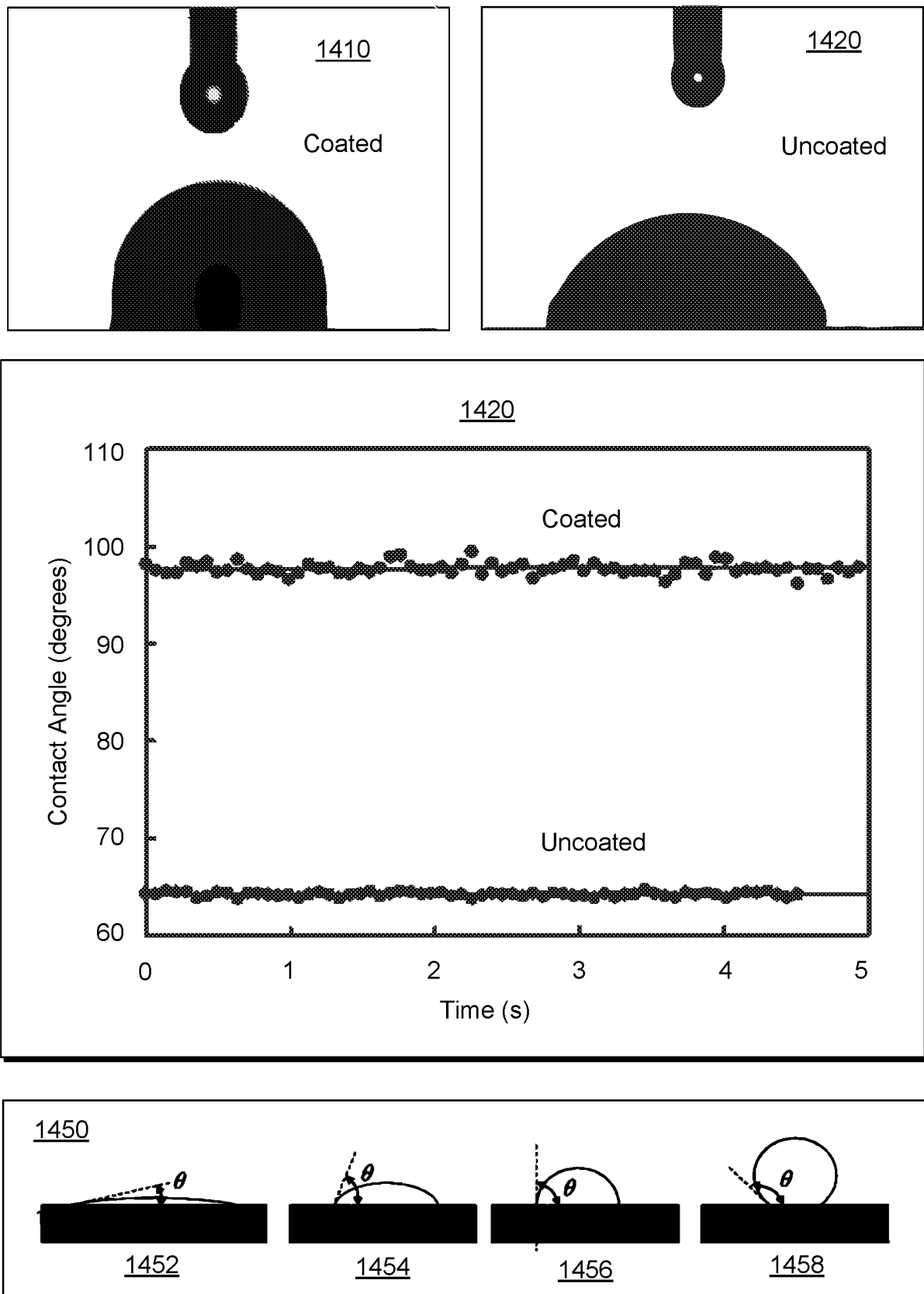


Fig. 14

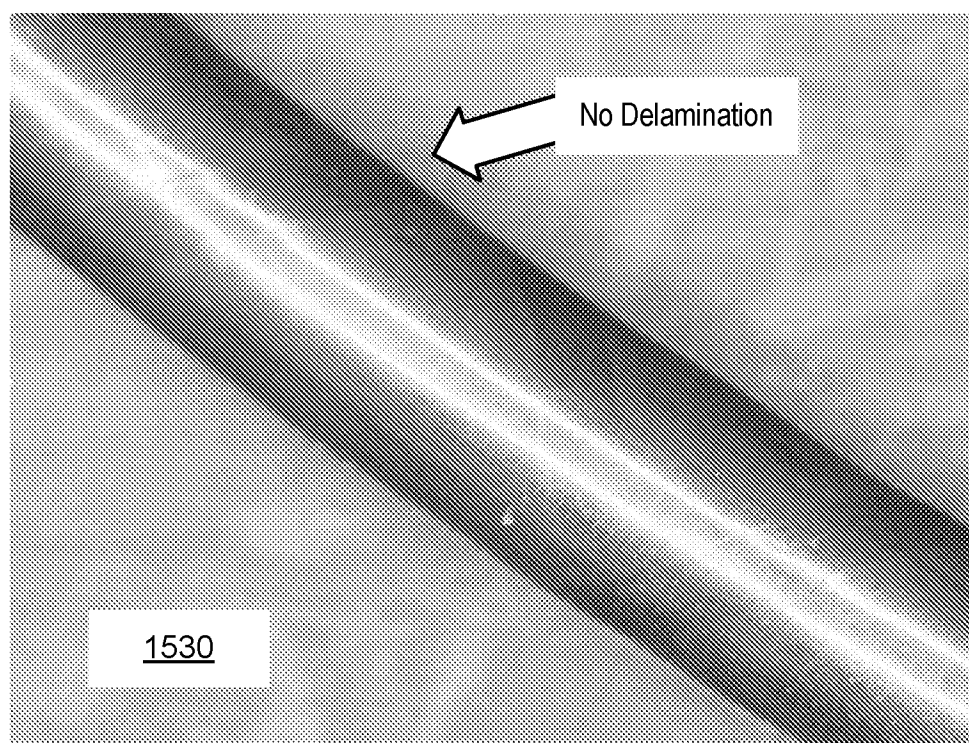
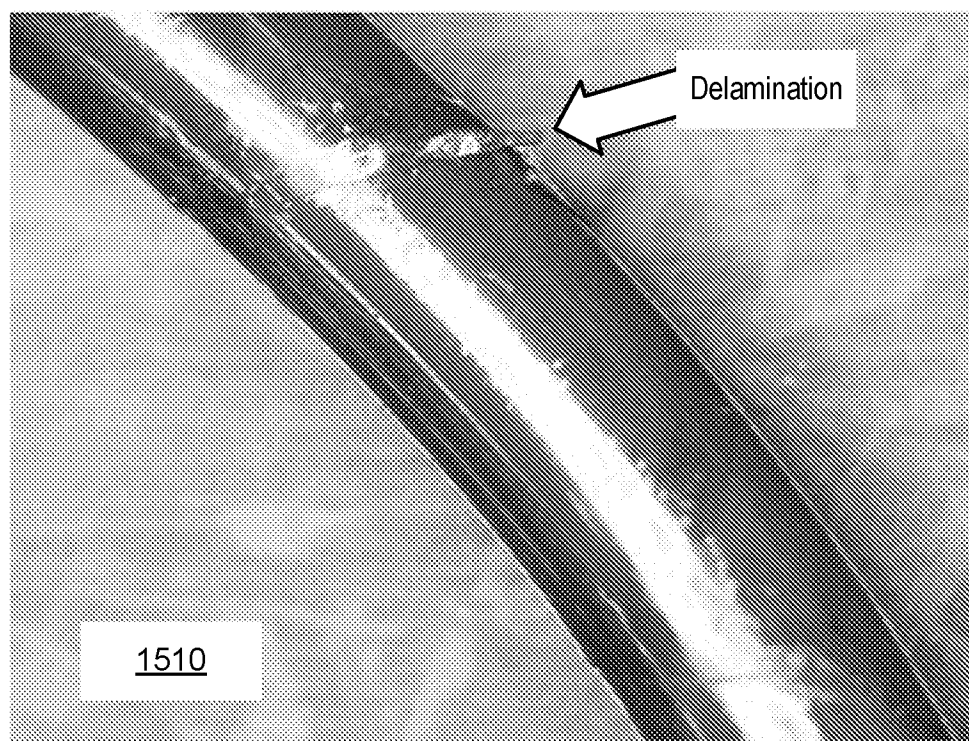


Fig. 15

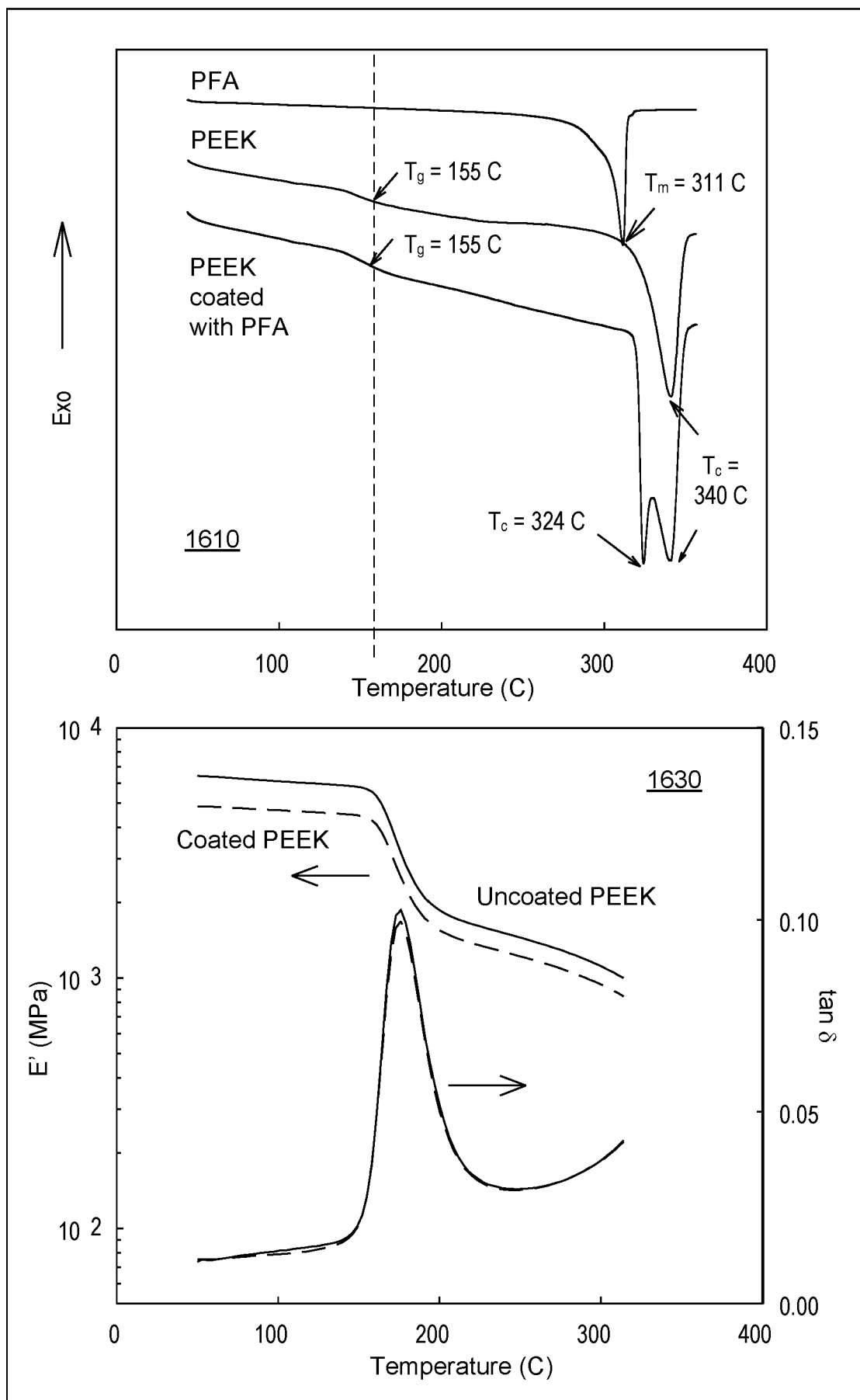


Fig. 16

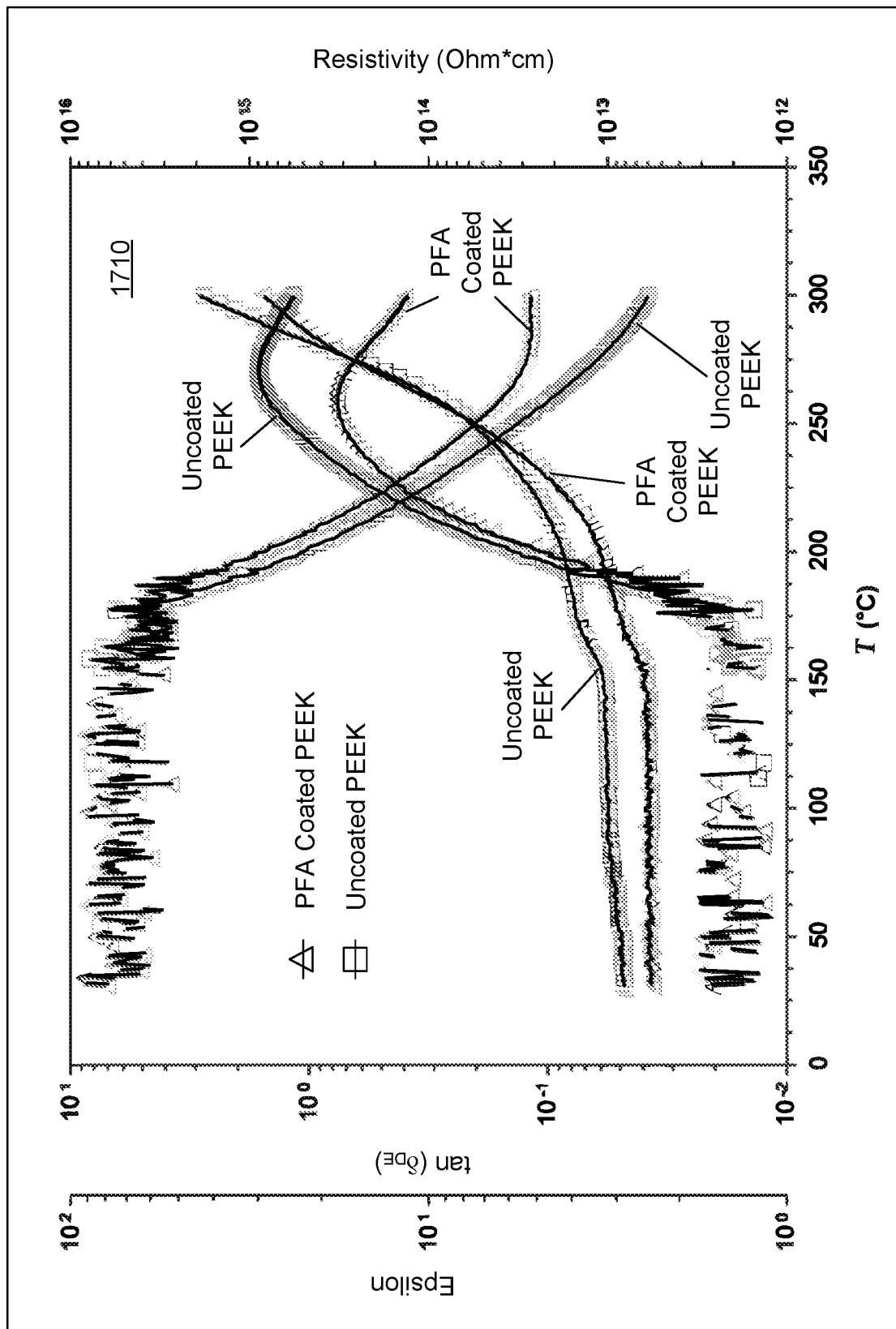


Fig. 17

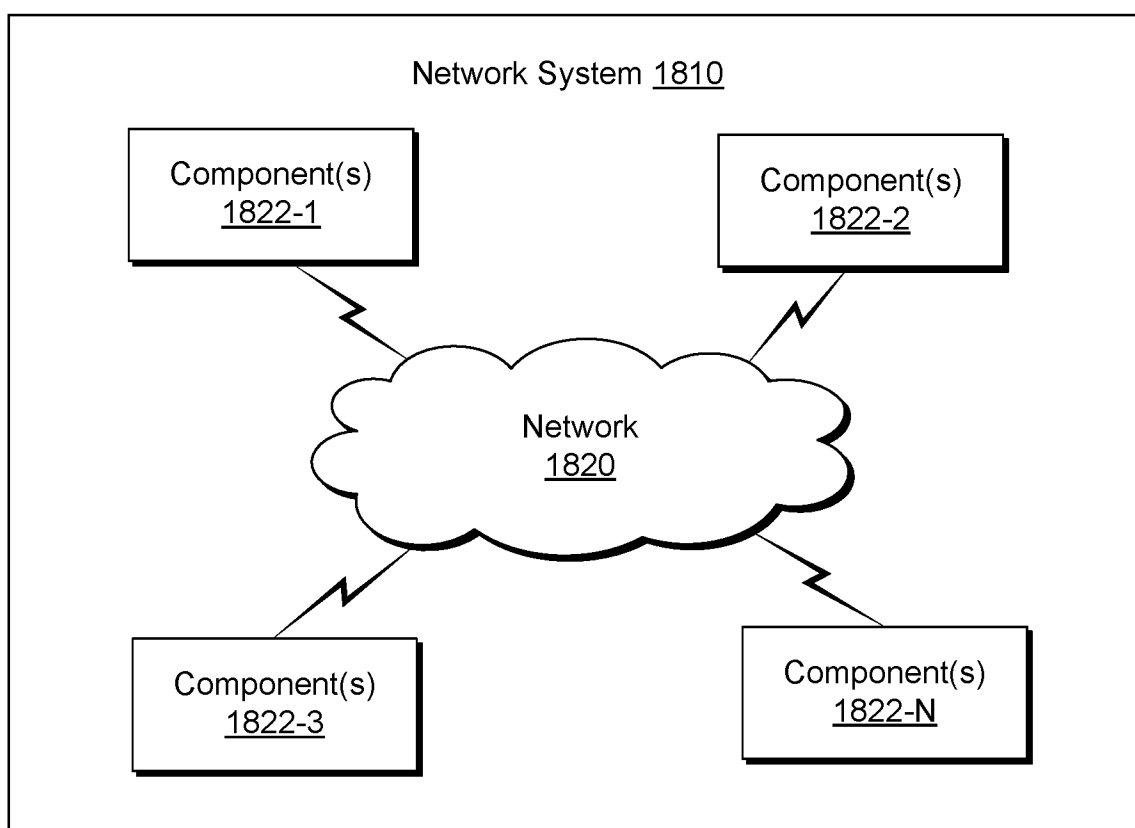
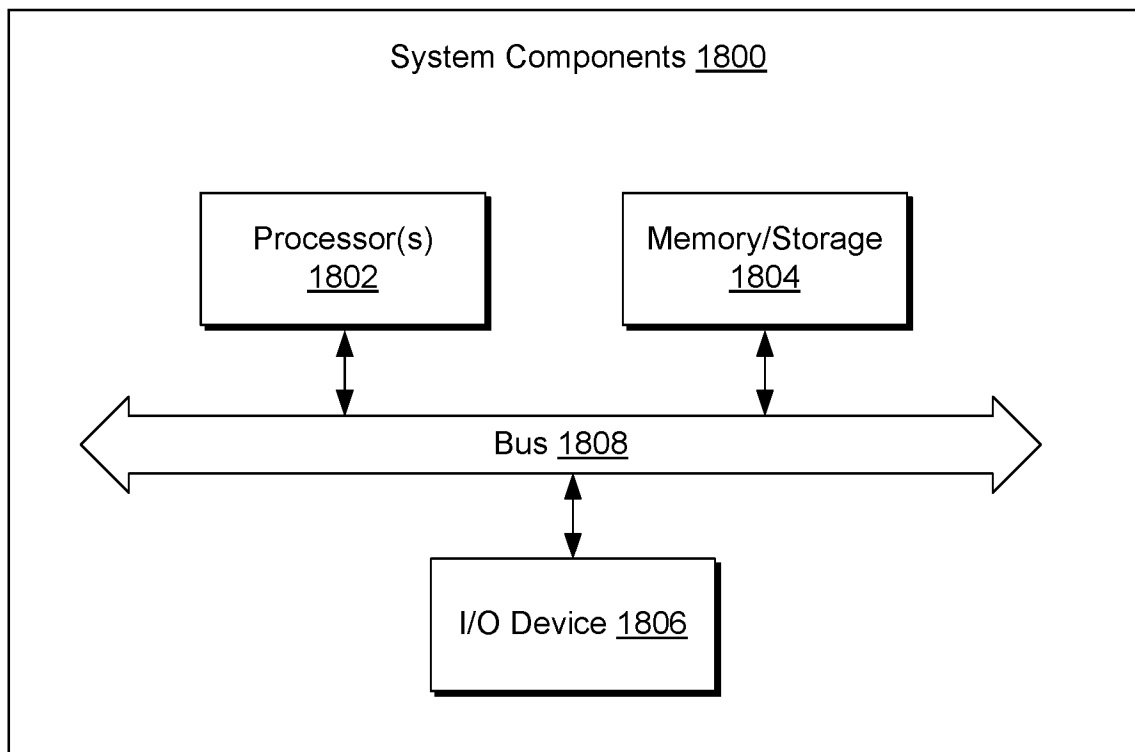


Fig. 18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/022745**A. CLASSIFICATION OF SUBJECT MATTER****B05D 5/08(2006.01)i, F04B 47/06(2006.01)i, E21B 43/12(2006.01)i, B05D 3/02(2006.01)i, C09D 129/12(2006.01)i, C09D 129/10(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B05D 5/08; H02K 5/02; E21B 43/00; H01B 7/02; F04B 35/04; H01B 3/30; H02K 3/30; H02K 15/10; H02K 5/124; E21B 17/00; F04B 47/06; E21B 43/12; B05D 3/02; C09D 129/12; C09D 129/10

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: coating, sintering, hydrophilic, hydrophobic, polymer, FEP, PTFE, PFA, MFA, PEEK, electrical submersible pump, electrical connector**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2007-0051510 A1 (VENERUSO, A. F. et al.) 08 March 2007 See paragraph [0014]; claims 1, 11, 16, 17.	1-20
Y	US 2014-0027152 A1 (HOLZMUELLER, J. et al.) 30 January 2014 See claims 11, 16, 17, 19.	1-20
A	US 2014-0154113 A1 (GE OIL & GAS ESP, INC.) 05 June 2014 See claims 24, 25, 30.	1-20
A	US 2014-0042835 A1 (SCHLUMBERGER TECHNOLOGY CORPORATION) 13 February 2014 See claims 1, 19.	1-20
A	US 2012-0063934 A1 (RUMBAUGH, M. R. et al.) 15 March 2012 See claims 1, 3.	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

21 July 2016 (21.07.2016)

Date of mailing of the international search report

25 July 2016 (25.07.2016)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/022745

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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