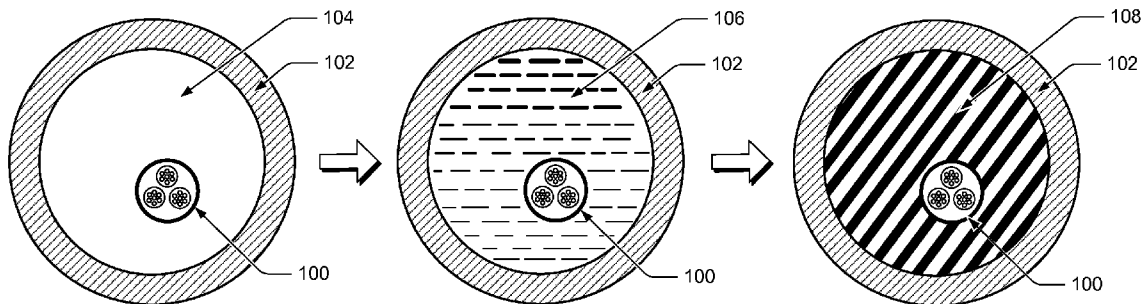




US 20140190706A1

(19) **United States**(12) **Patent Application Publication**
Varkey et al.(10) **Pub. No.: US 2014/0190706 A1**(43) **Pub. Date: Jul. 10, 2014**(54) **ENCAPSULATING AN ELECTRIC
SUBMERSIBLE PUMP CABLE IN COILED
TUBING**(71) Applicant: **SCHLUMBERGER TECHNOLOGY
CORPORATION**, Houston, TX (US)(72) Inventors: **Joseph Varkey**, Sugar Land, TX (US);
Burcu Unal, Richmond, TX (US);
Sheng Chang, Sugar Land, TX (US);
Matthew Garber, Sugar Land, TX (US);
Kevin T. Scarsdale, Pearland, TX (US)(73) Assignee: **SCHLUMBERGER TECHNOLOGY
CORPORATION**, Houston, TX (US)(21) Appl. No.: **14/145,888**(22) Filed: **Dec. 31, 2013****Related U.S. Application Data**(60) Provisional application No. 61/748,383, filed on Jan.
2, 2013.**Publication Classification**(51) **Int. Cl.**
F04B 47/06 (2006.01)
E21B 4/04 (2006.01)
(52) **U.S. Cl.**
CPC .. **F04B 47/06** (2013.01); **E21B 4/04** (2013.01)
USPC **166/378**; 166/66.4(57) **ABSTRACT**

An electric submersible pump (ESP) cable encapsulated in coiled tubing is provided. In an example process, ESP cable is drawn through coiled tubing. Liquid filler that cures into a supportive solid matrix is pumped into the coiled tubing. The solid matrix may be a rubberized filler or a closed-cell foam. Additives in the liquid filler can compensate for thermal expansion during operation of the ESP, or decrease overall weight of the solid matrix, or swell in the presence of oil, water, salt, or gas to seal a hole in the coiled tubing. The coiled tubing may be formed and seam-welded around the ESP cable from flat steel strip. A long coiled tubing resistant to stretch for deep wells may be produced by providing extra ESP cable for slack before the liquid filler cures into solid matrix. The coiled tubing may be clad with corrosion-resistant alloy for corrosive wells.



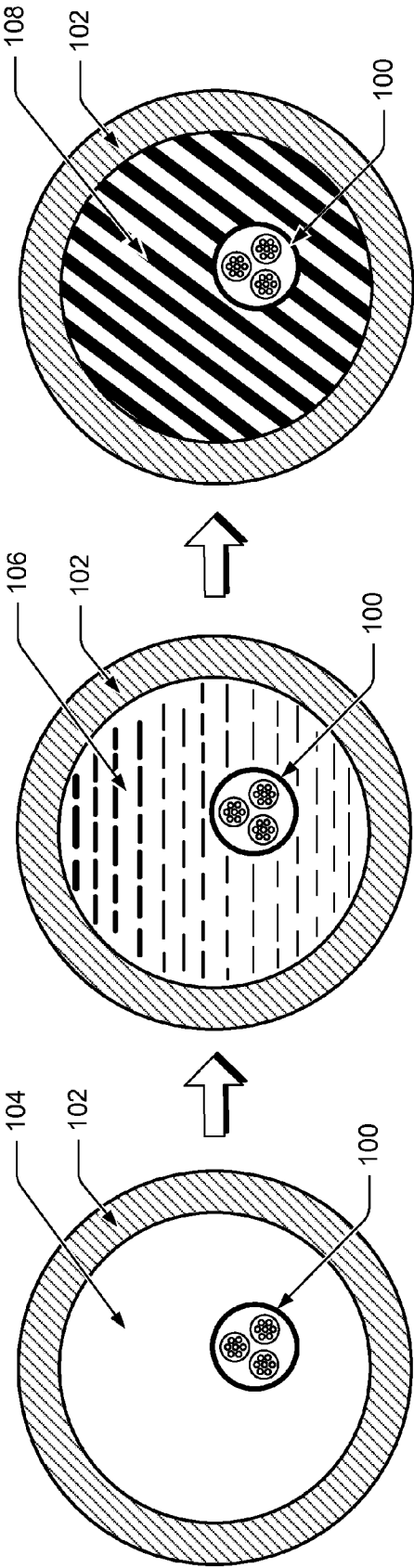


FIG. 1

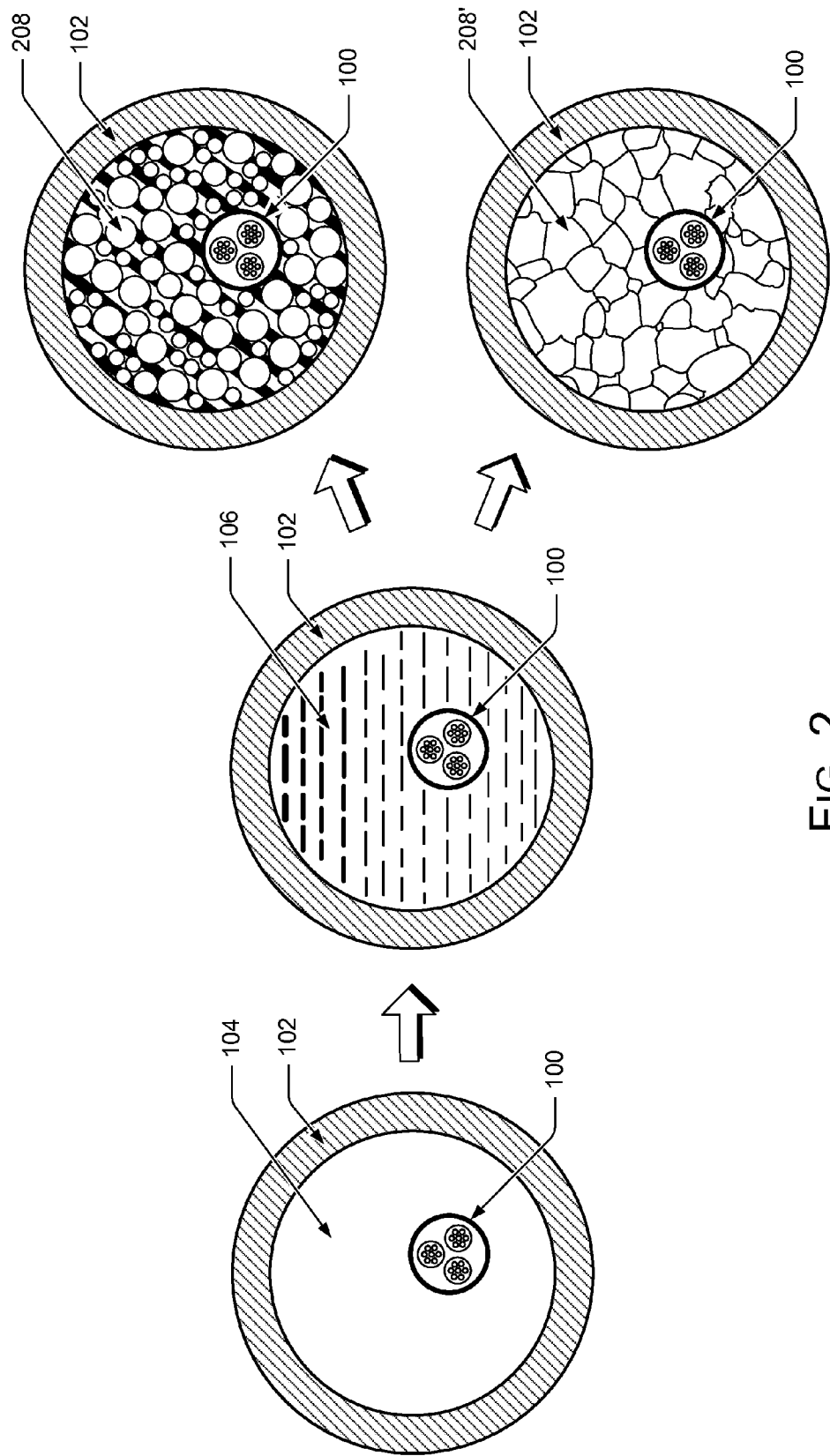


FIG. 2

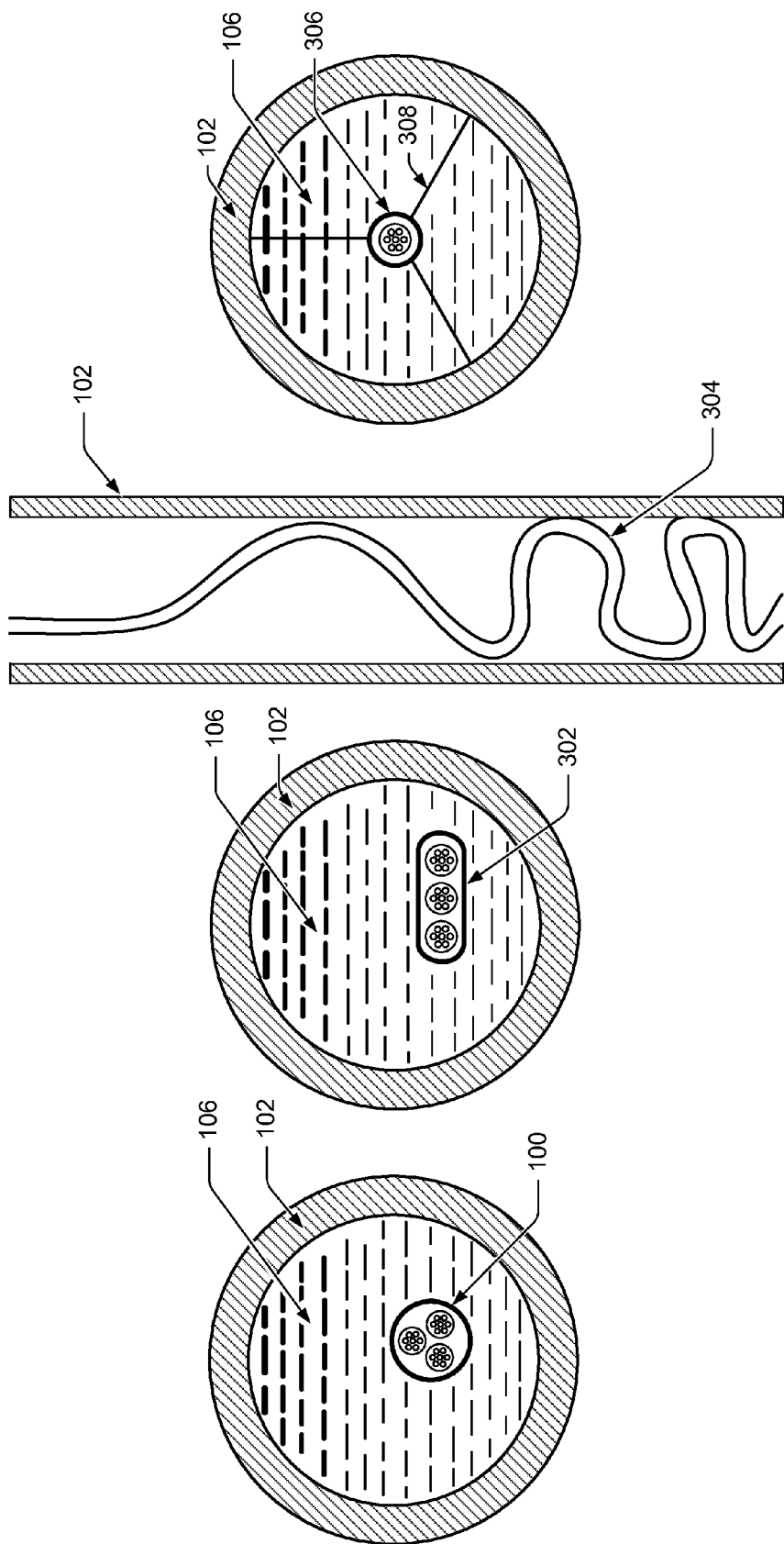


FIG. 3

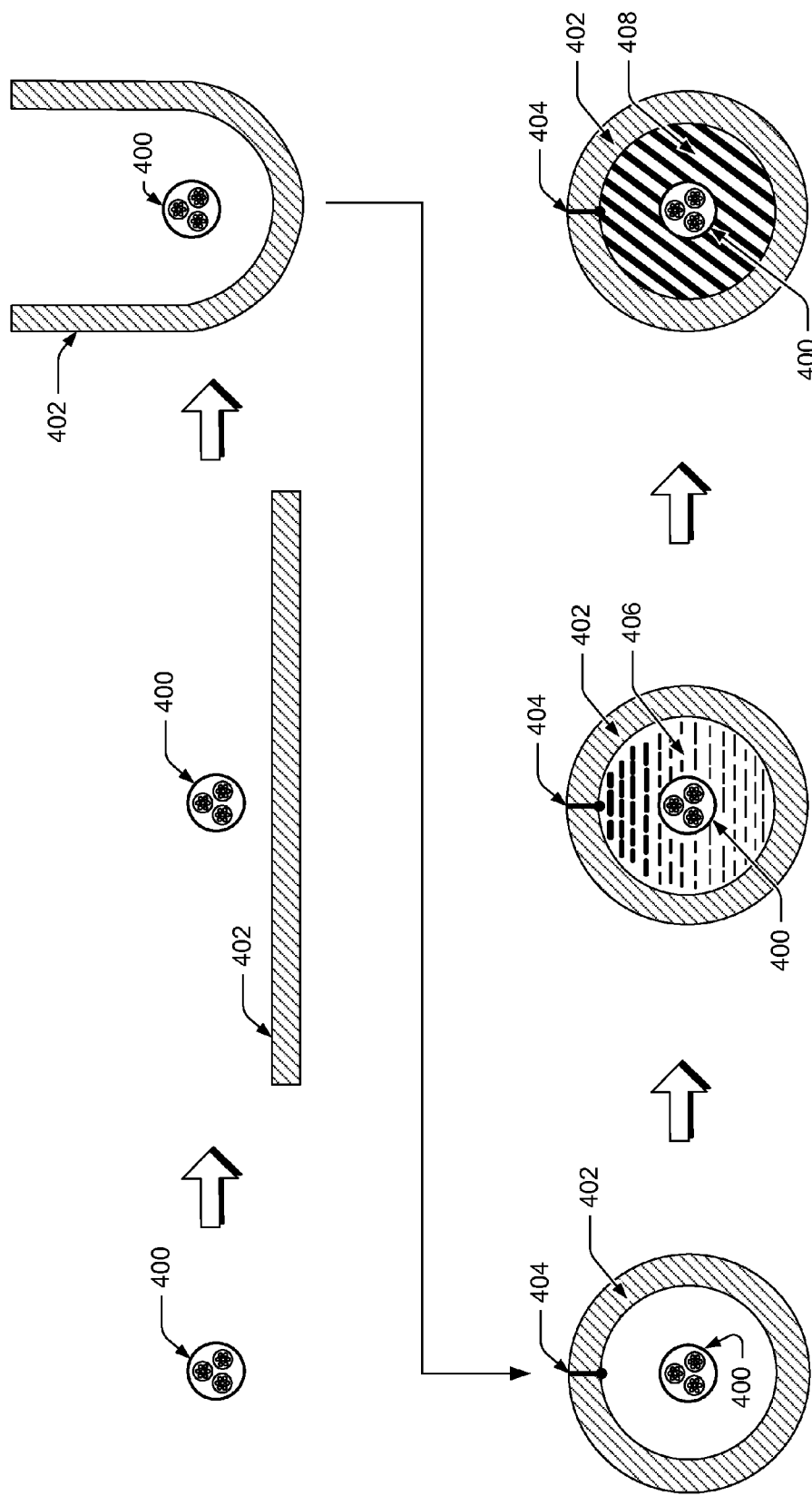


FIG. 4

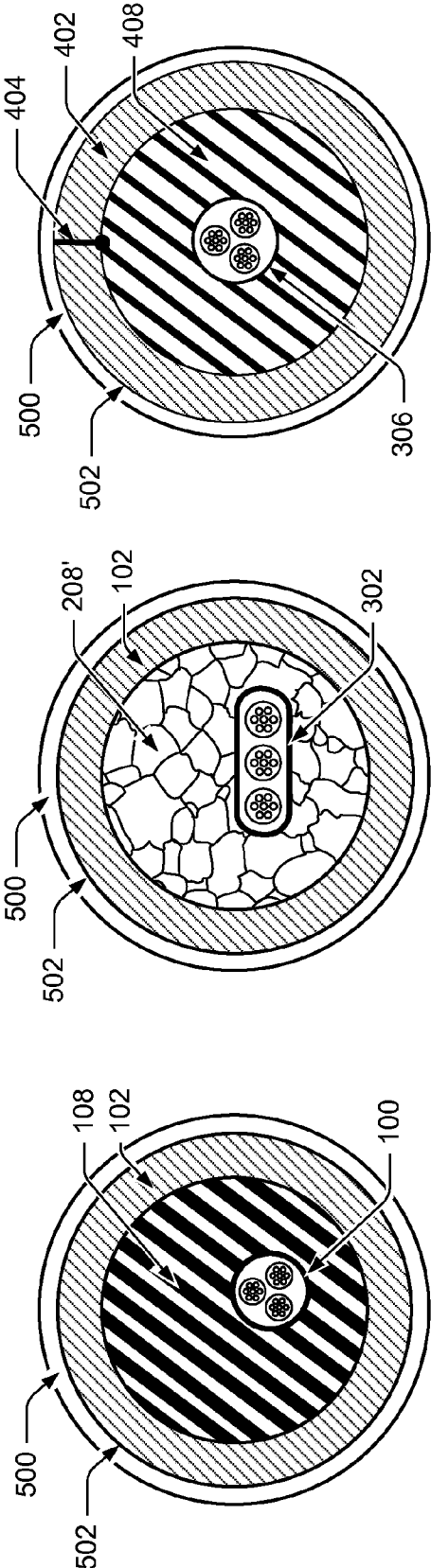


FIG. 5

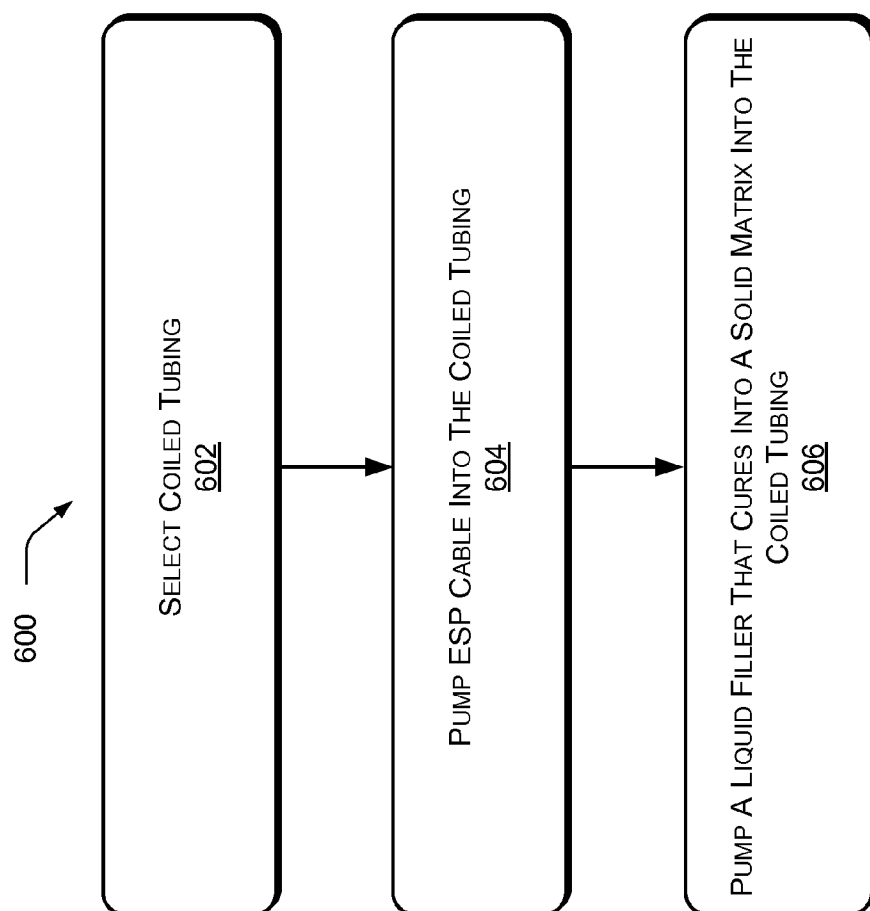


FIG. 6

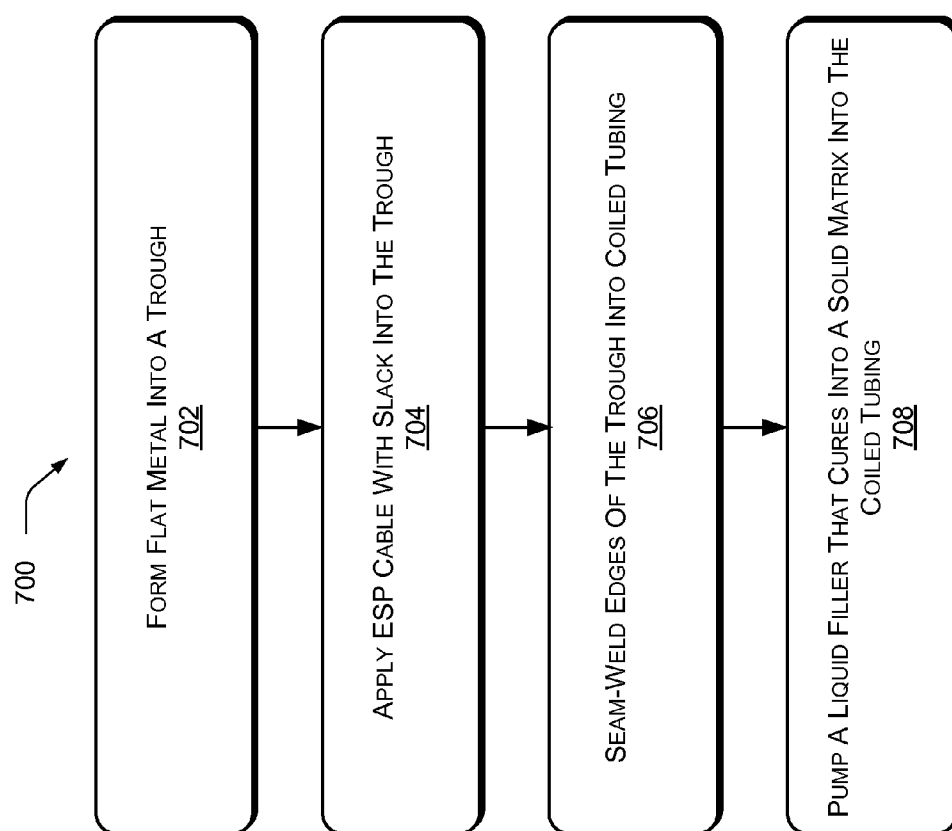


FIG. 7

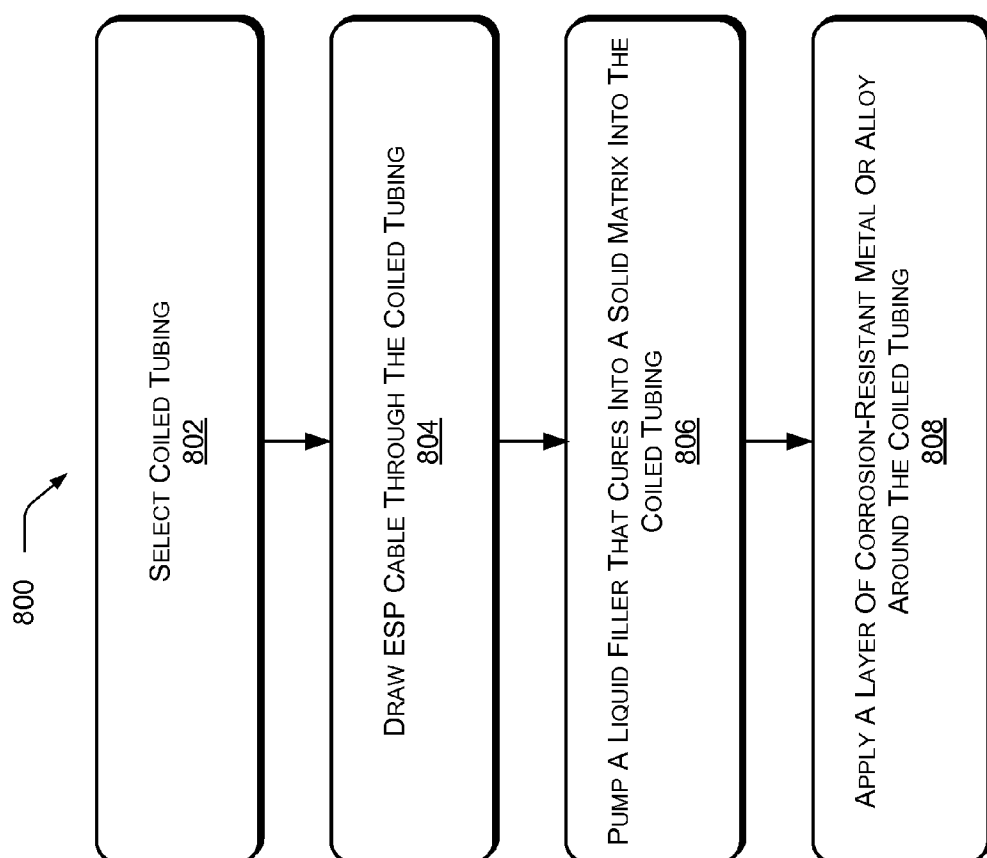


FIG. 8

ENCAPSULATING AN ELECTRIC SUBMERSIBLE PUMP CABLE IN COILED TUBING

RELATED APPLICATIONS

[0001] This patent application claims the benefit of priority to U.S. Provisional Patent Application No. 61/748,383 filed on Jan. 2, 2013 and incorporated herein by reference in its entirety.

BACKGROUND

[0002] In the oil and gas industries, coiled tubing ("coil") is metal piping, usually between 1.00-3.25 inches in diameter, used for well intervention and sometimes used for production tubing. Coiled tubing can be pushed into a well rather than depending only on gravity. The coiled tubing is a continuous length of tubular steel or composite that is flexible enough to be wound on a large reel for transportation. A coiled tubing unit is composed of a reel with the coiled tubing, an injector, control console, power supply, and well-control stack. The coiled tubing is injected into an existing production string, unwound from the reel and inserted into the well. The coiled tubing may be referred to as "coiled" even when it has been unreeled into a well. When a well lacks enough pressure, then an electric submersible pump (ESP) may be suspended from the coiled tubing to apply artificial lift to recover hydrocarbon resources.

[0003] In conventional ESP deployment from coiled tubing, ESP electrical cable may be pulled into the coiled tubing using a wire or wire rope that is pumped into the coil using "pig" attached to the wire rope. The downhole ends of the coiled tubing and ESP cable are terminated and the ESP is hung from the termination of the coiled tubing. The coiled tubing is terminated at the top of well with an ability to allow slack management of cable inside the coiled tubing, to mitigate forces on the upper connection due to the cable sliding further down into the coiled tubing over time. To keep the cable supported inside, the coiled tubing is conventionally filled with fluid, such as glycol.

SUMMARY

[0004] An electric submersible pump (ESP) cable encapsulated in coiled tubing is provided. An apparatus comprises a coiled tubing for deploying an electrical apparatus in a well, a cable in the coiled tubing in communication with the electrical apparatus, and a liquid filler occupying a space between an outside of the cable and an inside of the coiled tubing, the liquid filler curing into a supportive solid matrix. An example method comprises pulling a cable into a coiled tubing for deploying an electrical apparatus in a well, and pumping a liquid filler that cures into a solid matrix into the coiled tubing to secure the cable in relation to the coiled tubing. Another example method comprises shaping a continuous piece of flat metal around a cable for communicating power or data to an electrical apparatus in a well, seam-welding the continuous piece of metal into a coiled tubing around the cable, and pumping a liquid filler that cures into a solid filler into the coiled tubing to secure the cable in relation to the coiled tubing.

[0005] This summary section is not intended to give a full description of the subject matter. A detailed description with example embodiments follows.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 is a diagram of an example coiled-tubing-deployed ESP cable with a liquid filler that cures into a supportive rubberized matrix.

[0007] FIG. 2 is a diagram of an example coiled-tubing-deployed ESP cable with a liquid filler that cures into a supportive closed-cell foam matrix.

[0008] FIG. 3 is a diagram of different example cable types and configurations suitable for encapsulation within a coiled tubing.

[0009] FIG. 4 is a diagram of example construction of a seam-welded tube around an ESP cable with slack and a liquid filler that cures into a supportive rubberized matrix for deep well deployment.

[0010] FIG. 5 is a diagram of example corrosion-resistant cladding around coiled tubing encapsulating an ESP cable.

[0011] FIG. 6 is a flow diagram of an example method of creating a coiled-tubing deployed ESP cable with solid filler matrix.

[0012] FIG. 7 is a flow diagram of an example method of creating a coiled-tubing deployed ESP cable for deep wells.

[0013] FIG. 8 is a flow diagram of an example method of creating a coiled-tubing deployed ESP cable with solid filler matrix suitable for corrosive wells.

DETAILED DESCRIPTION

Overview

[0014] This disclosure describes encapsulating electric submersible pump (ESP) cables that are within coiled tubing. An ESP cable may be either a power cable or a control cable, or both, for providing power and control to an ESP. In a particular scheme, coiled tubing physically suspends the ESP within a well, with ESP cable residing inside the coiled tubing. In an implementation described herein, the coiled tubing, with the ESP cable inside, is filled with a liquid, which then cures to encapsulate the ESP cable within a solid matrix inside the coiled tubing. The solid matrix addresses problems that occur with conventional fluid fillers, and provides a host of advantages.

[0015] In an example process, referring to FIG. 1, an ESP cable **100** is placed into or pulled inside of coiled tubing **102** filled with air **104**, which is then pumped with a liquid filler **106** in fluid state that cures into a solid matrix **108** over time or when exposed to heat. The resulting solid matrix **108** may consist of a rubberized solid **108**. In FIG. 2, the resulting solid filler **208** may consist of a closed-cell foam **208** that permanently secures the ESP cable **100** inside the coiled tubing **102**. As shown in FIG. 3, the example coiled-tubing deployed ESP cable described herein can use a round ESP cable **100** (e.g., tri-conductor), a flat ESP cable **302**, a helically disposed ESP cable **304**, a round ESP cable having only a single conductor **306**, a coaxial ESP cable, or other cross-sectional shapes and types of the ESP cable **100**.

[0016] In another implementation shown in FIG. 4, a continuous strip of steel **402** or other metal that is to become the coiled tubing **402** is formed and seam-welded **404** around the ESP cable **400**. A liquid filler **406** is pumped in, which cures into a solid matrix **408**. This example process can be used to create a coiled tubing with encapsulated ESP cable suitable for deep wells, over **8000** feet deep. For deep wells, the continuous piece of steel **402** or other metal is seam-welded **404** around a loosely lying or helically disposed ESP cable,

such as ESP cable **304** (FIG. 3) that has slack in its pre-encapsulated configuration. The seam-welded steel **402** becomes the coiled tubing **402**. The coiled tubing **402** can then be pressure tested, and then pumped with the liquid filler **406** that cures into the solid matrix **408**. The built-in slack imparts some flexibility when the coiled tubing **402** must deviate around obstacles during well insertion or intervention, or when the ESP cable **400** later tends to descend within the coiled tubing **402** by gravity under the increased weight of its long length in a deep well deployment.

[0017] In an example implementation shown in FIG. 5, the ESP cable **100** (or **302** or **306**, for example) encapsulated within the coiled tubing **102** is made corrosion resistant by adding an exterior cladding **500** of chemical-resistant alloy.

Example Solid Fillers

[0018] Conventional coiled tubing containing an ESP cable and filled interiorly with glycol presents some problems. At high downhole temperatures, glycol can react with and damage the ESP cable. In practical use, filling the conventional coiled tubing with conventional fluid on a rig is a difficult process. Fluid access through the well's "tree" (assembly of valves, spools, and fittings) is required to compensate pressures within the conventional coiled tubing. Also, fluid in the coiled tubing may not be compatible with subsea tree system. Open communication of fluid to the conventional coiled tubing must be maintained during conventional deployment. Cable loss management conventionally requires a large canister to coil the cable, interfering with the tree wellbore and flow characteristics. There are also conventional production limitations on length of a coiled tubing containing an ESP cable, of approximately three kilometers. Large diameter coiled tubing is conventionally required to allow the ESP cable to be pulled into the interior of the coiled tubing. The large diameter of the coiled tubing translates into higher tubing weights. Bulky terminations are therefore conventionally required to support the excessive weight of large tubing. Slack management requirements on both power and control lines conventionally require complex coiling and splicing, at least for deeper wells.

[0019] Coiled tubing methods can be more widely implemented in general with the example implementations described below, which provide compact, solid, fully supported cable-in-tubing construction. The example implementations provide one or more benefits, such as 1) fully supported construction, 2) no cable loss management required, 3) compact end terminations, 4) continuous coiled tubing lengths beyond three kilometers, 5) integrated service lines and control lines fully supported, 6) thermal expansion of the cable can be managed using slack in the cable and additives that can be added into the fluid before solidifying, 7) total weight can be reduced by adding additives that lower the weight of the cured solid, 8) if pin holes develop on the coiled tubing in the solid-matrix-filled tube design, then fluid migration is limited, depending on the pressure differential, and 9) additives can be included in the pre-cured solid filler that swell in the presence of oil, water, salt, or gas to seal off leakage into the coiled tubing from an oil well, providing a self-healing coiled tubing deployment.

Example Filler Materials

[0020] Example implementations may use a polymeric fluid as the liquid filler **106** that cures into a solid matrix to

provide a compact coiled tubing **102** with ESP cable **100** fully supported by solid filler **108** in the coiled tubing **102**. Suitable pumpable filler materials cure in place into a deformable solid **108** that allows for some stretch and movement of the ESP cable **100** when the coiled tubing **102** passes around such items as goose necks, injectors, deviations within the well, sheaves, spools, reels, drums, joints, casings, or as the coiled tubing **102** stretches due to its own weight or thermal expansion in offshore, deep well, or long well deployments.

[0021] Example materials for the solid filler **108** include epoxies, silicones, ethers, esters, liquid fluorosilicones, liquid fluoroelastomers, such as a SHIN-ETSU-SIFEL potting gel (combination of a perfluoropolyether backbone with a terminal silicone crosslinking group), urethanes, or other polymers that solidify over time or when exposed to heat (Shin-Etsu Chemical Company, Ltd, Tokyo, Japan).

[0022] Additives may be included that cause the example filler material **108** to swell if exposed to specific materials, such as oil, gas, water, or salt encountered in a downhole environment. The swellable additive can thus respond to pinhole leaks to make a self-plugging coiled tubing **102**. Likewise, the example solid filler material **108** in its initial liquid form **106** may incorporate additives before being pumped into the coiled tubing **102** to lower density, increase buoyancy, or minimize thermal expansion. The lower density filler **108** can thereby reduce the overall weight of the coiled tubing-encapsulated cable. Such additives may include chopped carbon fiber, glass fiber, synthetic fiber, glass beads with air, formed particles, chopped formed particles, and so forth.

[0023] Referring to FIG. 2, the example solid matrix **208** may consist of a closed-cell foam **208** or **208'**, initially in liquid fluid state **106**, exhibiting desirable properties of curability, flexibility, and chemical resistance. In an implementation, the solid foam **208** may result from gas bubbles remaining in the solid filler **208** when curing from liquid to solid. In another implementation, solid parts of the solid closed-cell foam **208'** may consist mainly of the solid walls forming the closed cells of the foam **208'**. In an implementation, a foam **208** may be selected to have an affinity with the metal of the coiled tubing **102** in order to create a chemical bond between the two, when needed.

Example Coiled Tubing

[0024] Example coiled tubing **102** for use in the example implementations may be a suitable high-strength, low-carbon steel as is often used in conventional coiled tubing. For "sour well" applications where exposure to hydrogen sulfide (H_2S) or carbon dioxide (CO_2) is anticipated, a layer of chemically resistant cladding, such as INCONEL alloy, may be added or drawn over the coiled tubing (see FIG. 6) for enhanced chemical resistance, or the entire coiled tubing **102** may be made out of INCONEL265 or other suitable alloys (Special Metals Corporation, New Hartford, N.Y.).

Coiled-tubing-deployed ESP Cable with Rubberized Filler

[0025] FIG. 1 shows an example ESP cable **100** encapsulated in a rubberized solid **108** inside a coiled tubing **102**. In an implementation, the example coiled-tubing-deployed ESP cable **100** is produced by pulling the ESP cable **100** into the air-filled space inside the coiled tubing **102**, or attaching the ESP cable **100** to a slug or a pig that may be pumped into the coiled tubing **102** by compressed gas or other fluid. Once the

ESP cable **100** is inside the coiled tubing **102**, a curable liquid **106** is pumped in to replace the air, gas, or fluid in the coiled tubing **102**. The curable liquid **106** sets to form a solid rubberized matrix **108** that holds the ESP cable **100** in place and prevents the ESP cable **100** from yielding when the coiled tubing **102** is bent over sheaves and drums or passed over goose necks, deviations within a well, or stretched due to its own weight in offshore or deep well deployments. Thus, the ESP cable **100** may have some excess length and slack intentionally built into its placement in the coiled tubing **102** when the ESP cable **100** is inserted into the coiled tubing **102**.

Coiled-tubing-deployed ESP Cable with Closed-cell Foam

[0026] FIG. 2 shows an example ESP cable **100** encapsulated in a solid foam **208** inside a coiled tubing **102**. In an implementation, the example coiled-tubing-deployed ESP cable **100** is produced by pulling the ESP cable **100** into the air-filled space inside the coiled tubing **102**, or attaching the ESP cable **100** to a pig that may be pumped into the coiled tubing **102** by compressed gas or other fluid. Once the ESP cable **100** is inside the coiled tubing **102**, a curable liquid **106** is pumped in to replace the air, gas, or fluid in the coiled tubing **102**. In this case, the curable liquid **106** may consist of a polymeric fluid that sets to form the closed-cell foam **208** that holds the ESP cable **100** in place and helps to prevent the ESP cable **100** from yielding when the coiled tubing **102** is bent over sheaves, drums, over goose necks, and well curves, or stretched due to its own weight in offshore or deep well deployments. The ESP cable **100** may have some slack intentionally built into its placement in the coiled tubing **102** when the ESP cable **100** is inserted into the coiled tubing **102**, before the curable liquid **106** sets into the solid closed-cell foam.

[0027] The closed-cell foam filler **208** can impart more buoyancy than many solid rubberized fillers **108** and reduce the overall weight of the coiled tubing **102** with ESP cable **100** and foam filler **208** inside.

Example ESP cable

[0028] FIG. 3 shows example ESP cables. The ESP cable to be used in a coiled tubing deployment may be a round ESP cable **100**, such as a tri-conductor cable for three-phase power, a flat ESP cable **302**, a helically coiled ESP cable **304**, a single conductor power or control cable **306**, a coaxial style ESP cable, or a cable of other geometrical cross-section or type. The ESP cable **100** (or **302** or **304** or **306**) may be centralized or stood-off from the inner walls of the coiled tubing **102** with periodic supports, such as periodic fins **308** or studs, that allow the pumped liquid filler **106** to pass by the supports to fill the voids in the coiled-tubing **102** until the filler **106** cures.

Coiled-tubing-deployed ESP Cable for Deeper Wells

[0029] Pulling an ESP cable **100** using a pumped-in wire or wire rope into coiled tubing **102** becomes increasingly difficult as the length of the coiled tubing **102** increases. One solution has been to form a large-diameter outer jacket of solid material over the ESP cable **100** and then seam-weld a tube over the jacket to ultimately create a completely filled coiled tube. An example manufacturing process for this conventional solution includes applying a thick outer jacket to a standard ESP cable, applying a continuous piece of steel to

the jacketed ESP cable, forming the steel into a loose circular tube over the jacketed ESP cable through a series of shaping rollers, seam welding the loose circular tube to form the a completed steel tube, and drawing down the steel tube over the jacketed ESP cable to complete the coiled-tubing-deployed ESP cable.

[0030] One drawback of this conventional method is that there is no opportunity to pressure test the resulting coiled tubing to ensure that the seam weld is continuous and defect free. In this conventional process, there is also no possibility to impart slack in the ESP cable and so there is a possibility of yielding the cable as the coiled tubing stretches beyond the yield point of the ESP conductors inside. During the welding process a waste consisting of 10% to 15% scrap is also common, and a percentage of cable is also lost during this conventional process.

[0031] FIG. 4 shows parts of an example manufacturing process, addressing deeper wells that need coiled tubing lengths greater than approximately 8000 feet (greater than 2.4 kilometers). A strip of continuous steel **402** is formed lengthwise into a rounded trough around an ESP cable **400**, using forms and shaping rollers. Additional series of rollers form the metal **402** into a loose circular tube **402** over the ESP cable **402**. The ESP cable **402** can be centralized or stood-off, as described above, with fins **308**, supports, or studs, etc. When the loose circular tube **402** is seam-welded **404** to make coiled tubing, the ESP cable **400** is placed in a configuration that is loose with slack, to provide play for the ESP cable **400** in the finished coiled tubing **402**. The resulting coiled tubing **402** can then be pressure tested, which is not possible in the conventional manufacture technique described above. The resulting coiled tubing **402** can then be filled with a curable liquid **406** that becomes the solid filler **408**. If the welding of the seam-welded coiled tubing **402** is faulty, then the ESP cable **400** can be retrieved from the coiled tubing **402** without scrapping both the ESP cable **400** and the coiled tubing **402**.

Resistant Cladding

[0032] FIG. 5 shows example coiled tubing **102** with chemically resistant cladding **500**. In "sour well" applications where exposure to hydrogen sulfide (H_2S) or carbon dioxide (CO_2) is anticipated, standard low-carbon steel quickly deteriorates and fails. Special alloy materials for the coiled tubing **102**, such as INCONEL alloy, can be used as a substitute for the low-carbon steel, but this type of alloy tubing can be cost-prohibitive. An example implementation applies a suitable thickness of a layer of a resistant alloy **500**, such as an INCONEL cladding, over example coiled tubing **102** or seam-welded coiled tubing **402** that includes a solid-filler stabilized cable, such as ESP cable **100** or ESP cable **302**, for example.

[0033] A metallic coating, such as a metallic bonding layer **502**, may be applied first over the outer surface of the low-carbon steel coiled tubing **102** or **402** so that when the resistant cladding **500**, such as INCONEL alloy is drawn down to the low carbon steel **102** or **402** the heat generated and the chemical affinity with the metallic bonding layer **502** allows the bonding of the resistant cladding **500** to the steel coiled tubing **102** or **402**. The ESP cable **100** (or **302** or **304** or **306**) inside the coiled tubing **102** or **402** may be round, flat, helical, coaxial, or of other suitable configuration.

Example Methods

[0034] FIG. 6 shows an example method 600 of creating a coiled-tubing deployed ESP cable with supportive solid matrix. In the flow diagram, the operations are summarized in individual blocks.

[0035] At block 602, a coiled tube of appropriate size for inserting into a well is selected.

[0036] At block 604, a wire or wire rope is pumped into the coiled tube by a fluid, such as air or water. For example, the air or water may move a “pig” attached to a first end of the wire rope to draw the wire rope through the coiled tube. An ESP cable is attached to the other end of the wire rope, and can be pulled through the coiled tubing by the wire rope. The fluid used to pump the ESP cable may be replaced by air.

[0037] At block 606, a liquid filler that cures into a solid matrix is pumped into the coiled tubing. The liquid filler may cure over time or through application of heat into a rubberized matrix or a closed-cell foam. Both ends of the coiled tubing may be capped and a slight pressure applied during the cure time to minimize shrinkage. The tubing may be drawn down onto the cured matrix when shrinkage or air gaps cause separation between the ESP cable elements and the inner wall of the coiled tubing.

[0038] The ESP cable used for the above example process may be round, flat or another suitable configuration. The ESP conductors may be bundled into a helix to match the thermal expansion of the coiled tubing. Additionally, centralizers or stand-offs, designed to allow through-flow, can be used along the length of the ESP cable to keep the cable off the tubing inner wall, during curing time.

[0039] FIG. 7 shows an example method 700 of creating a coiled-tubing deployed ESP cable for deep wells. In the flow diagram, the operations are summarized in individual blocks.

[0040] At block 702, a continuous piece of flat steel or other metal is formed through a series of shaping rollers into a length with an arc-shaped or trough-shaped cross-section.

[0041] At block 704, an ESP cable with extra slack is applied into the bottom of the arc-shaped or trough-shaped metal. The ESP cable and its conductors may have a round, flat, or other cross-sectional profile, or may be of helical or coaxial configuration. An additional series of rollers form the metal into a loose circular tube over the ESP cable. The cable can be centralized or stood-off, as described above.

[0042] At block 706, the adjacent edges of the metal are seam-welded to form a completed coiled tube. The completed tube may be pressure-tested. When a faulty seam weld is detected during the pressure testing, then the ESP cable can be retrieved from the coiled tubing without scrapping both the ESP cable and the coiled tubing.

[0043] At block 708, a liquid filler that cures into a solid matrix or forms into a closed-cell foam is pumped in to fill the space between the ESP cable and the coiled tubing.

[0044] The ESP cable is given slack in the coiled tubing so that the ESP cable does not lay completely straight in the coiled tubing before the curable or formable fluid is pumped in. The slack or excess length helps to minimize the possibility of the conductors of the ESP cable yielding when the coiled tubing stretches under its own increased weight due to extended length.

[0045] FIG. 8 shows an example method 800 of creating a coiled-tubing deployed ESP cable with solid filler matrix and suitable for corrosive wells. In the flow diagram, the operations are summarized in individual blocks.

[0046] At block 802, a coiled tube of appropriate size for inserting into a well is selected.

[0047] At block 804, an ESP cable is drawn through the coiled tubing.

[0048] At block 806, a liquid filler that cures into a solid matrix is pumped into the coiled tubing.

[0049] At block 808, a layer of corrosion-resistant metal or alloy is applied around the outside of the coiled tubing. For example, INCONEL alloy may be applied as a cladding around the coiled tubing.

Conclusion

[0050] Although only a few example embodiments have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the example embodiments without materially departing from the subject matter. 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. 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.

What is claimed is:

1. An apparatus, comprising:

a coiled tubing for deploying an electrical apparatus in a well;

a cable in the coiled tubing in communication with the electrical apparatus; and

a liquid filler occupying a space between an outside of the cable and an inside of the coiled tubing, the liquid filler curing into a supportive solid matrix.

2. The apparatus of claim 1, wherein the cable powers the electrical apparatus and the electrical apparatus comprises an electric submersible pump (ESP).

3. The apparatus of claim 1, wherein the supportive solid matrix comprises a rubberized filler.

4. The apparatus of claim 1, wherein the supportive solid matrix comprises a closed-cell foam matrix.

5. The apparatus of claim 1, wherein the supportive solid matrix comprises one of an epoxy, a silicone, an ether, an ester, a liquid fluorosilicone, a liquid fluoroelastomer, a SHIN-ETSU-SIFEL potting gel, a urethane, or a polymer that solidifies over time or when exposed to heat.

6. The apparatus of claim 1, wherein the supportive solid matrix further comprises an additive compensating for thermal expansion of the cable during an operation of the electrical apparatus.

7. The apparatus of claim 1, wherein the supportive solid matrix further comprises an additive for decreasing a weight of the supportive solid matrix, including one of a chopped carbon fiber, a glass fiber, a synthetic fiber, glass beads with air, formed particles, or chopped formed particles.

8. The apparatus of claim 1, wherein the supportive solid matrix further comprises an additive to swell in the presence of one of an oil, water, a salt, or a gas to seal off a hole in the coiled tubing.

9. The apparatus of claim 1, wherein the liquid filler cures into the supportive solid matrix due to an elapse of time or when exposed to heat.

10. The apparatus of claim **1**, wherein the supportive solid matrix remains pliable and deformable in response to a stretch or a movement of the cable in relation to the coiled tubing, or in response to a deformation of the coiled tubing deviating around a spool, a reel, a drum, a well head, a goose neck, an injector, a joint, a casing, an annulus, a well wall, a well curve, a hangar, a termination, or a sheave.

11. The apparatus of claim **1**, wherein the cable comprises one of a round cable, a flat cable, a coaxial cable, or a helically coiled cable.

12. The apparatus of claim **1**, wherein the coiled tubing comprises a seam-welded tube formed over the cable and an excess of the cable comprising a slack.

13. The apparatus of claim **1**, wherein the coiled tubing further comprises a corrosion resistant cladding.

14. The apparatus of claim **13**, further comprising a low-carbon steel coiled tubing and a metallic bonding layer added on the low-carbon steel coiled tubing, wherein the corrosion resistant cladding bonds to the low-carbon steel coiled tubing via a chemical affinity with the metallic bonding layer and an associated heat of reaction from the chemical affinity.

15. A method, comprising:

pulling a cable into a coiled tubing for deploying an electrical apparatus in a well; and

pumping a liquid filler that cures into a solid matrix into the coiled tubing to secure the cable in relation to the coiled tubing.

16. The method of claim **15**, wherein the solid matrix comprises one of a rubberized filler or a closed-cell-foam.

17. The method of claim **15**, further comprising drawing the coiled tubing down onto the solid filler when air gaps cause separation between the solid filler and the coiled tubing.

18. A method, comprising:

shaping a continuous piece of flat metal around a cable for communicating power or data to an electrical apparatus in a well;

seam-welding the continuous piece of metal into a coiled tubing around the cable; and

pumping a liquid filler that cures into a solid filler into the coiled tubing to secure the cable in relation to the coiled tubing.

19. The method of claim **18**, further comprising shaping the continuous piece of flat metal around an excess of the cable to provide a slack for the cable when the coiled tubing stretches under an increased weight in a deep well application.

20. The method of claim **18**, further comprising cladding an outside surface of the coiled tubing with a corrosion-resistant metal or alloy to resist a chemical corrosion.

* * * * *