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(54) METHOD AND SYSTEM FOR DATA-TRANSFER VIA A DRILL PIPE

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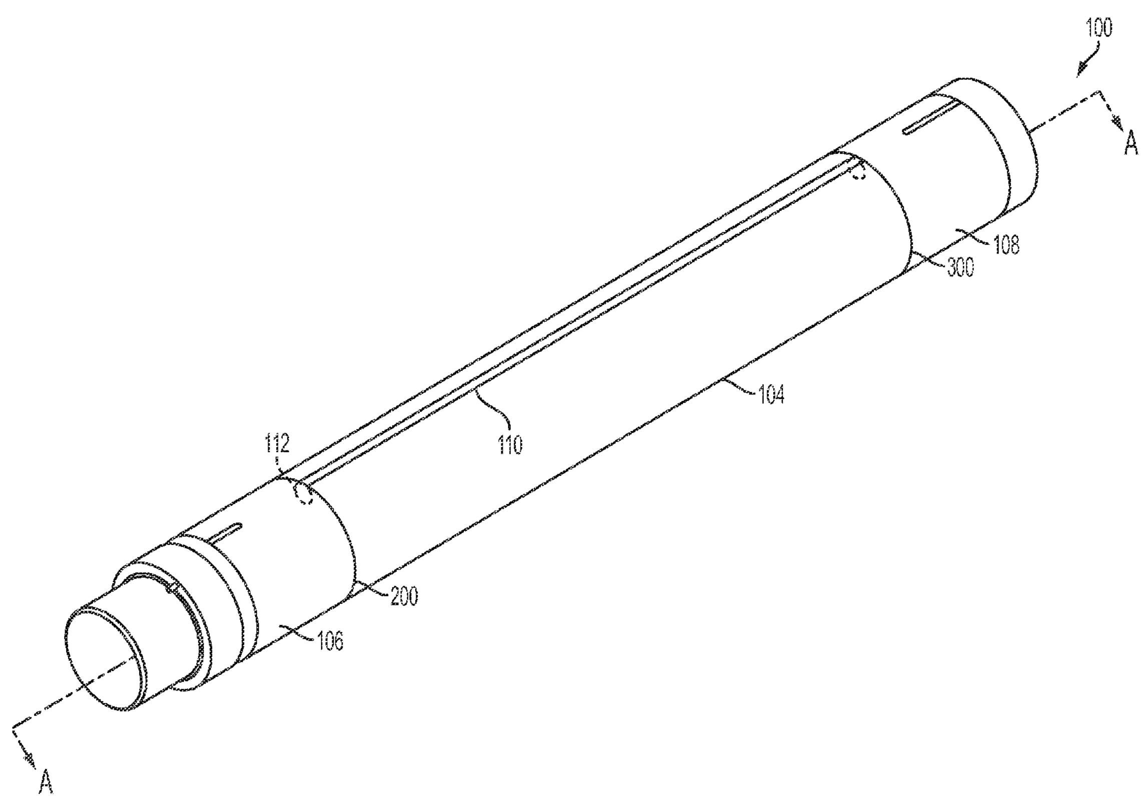
USPC **175/40**; 29/825

(57) **ABSTRACT**

The present invention relates to a drill-pipe communication assembly. The drill-pipe communication assembly includes a first drill pipe and an insulated tube disposed within, and generally concentric with, the first drill pipe. A male insert is disposed within a first end of the first drill pipe and a female insert is disposed within a second end of the first drill pipe. A conductor is electrically coupled to the male insert and the female insert. The conductor extends along a length of the first drill pipe. The conductor facilitates transmission of electrical signals from the first end of the first drill pipe to the second end of the first drill pipe.



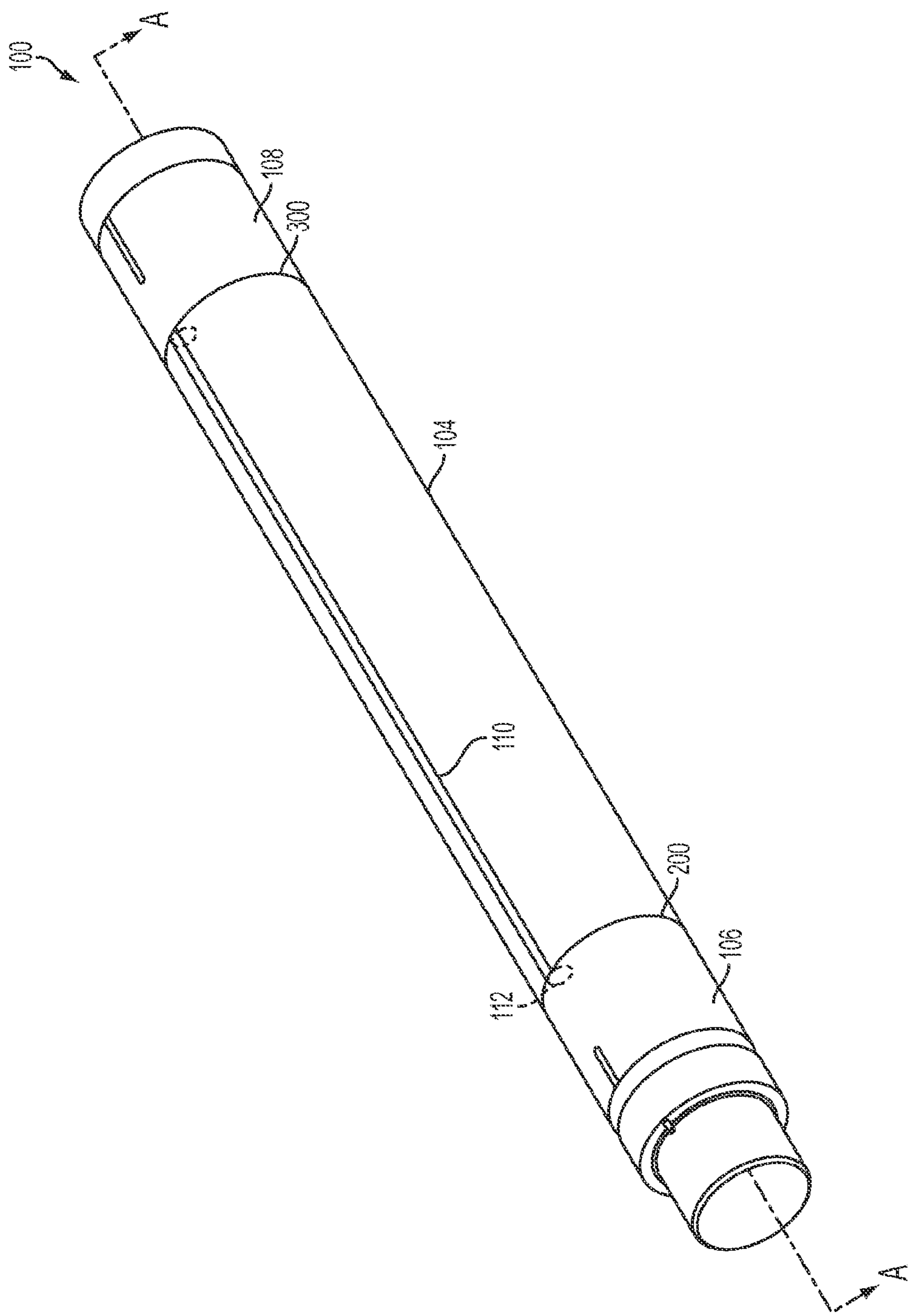


FIG. 1

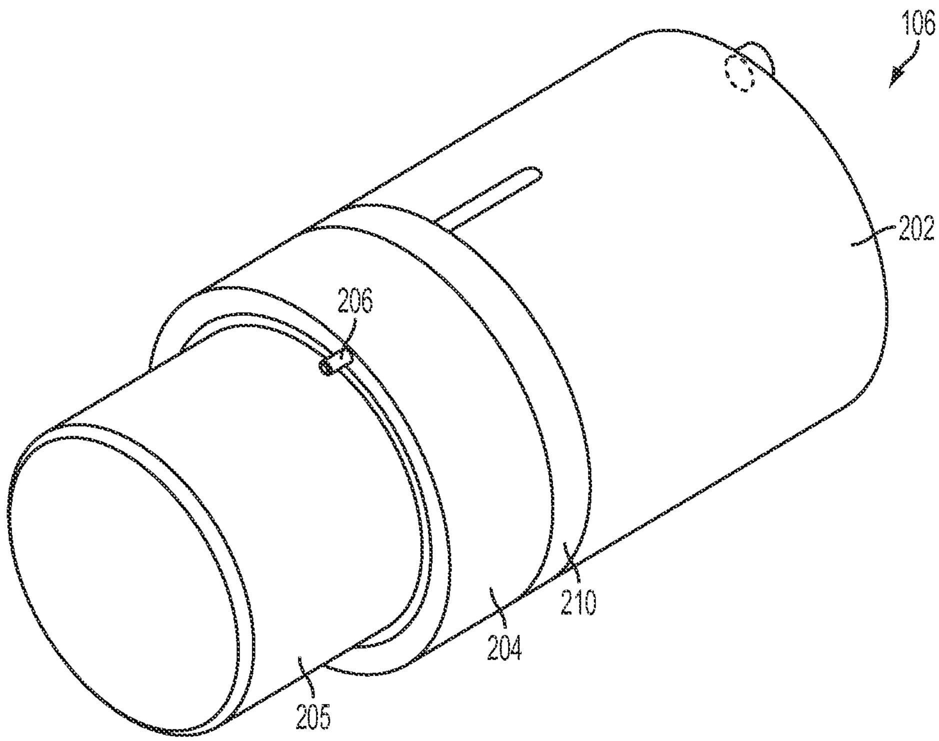


FIG. 2A

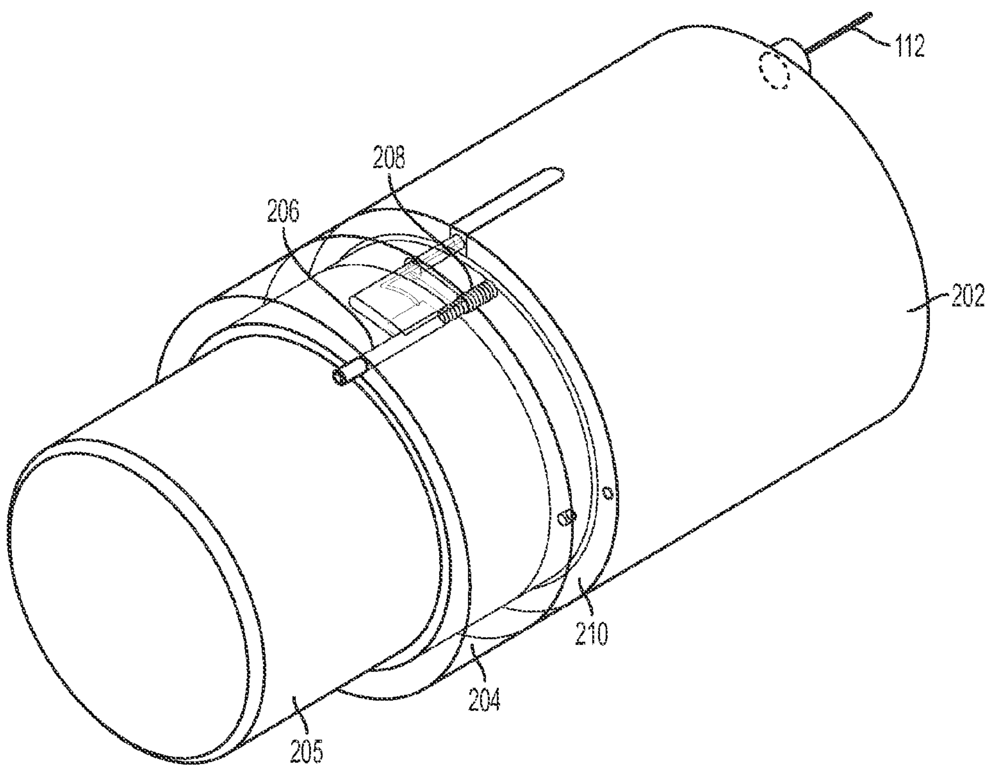


FIG. 2B

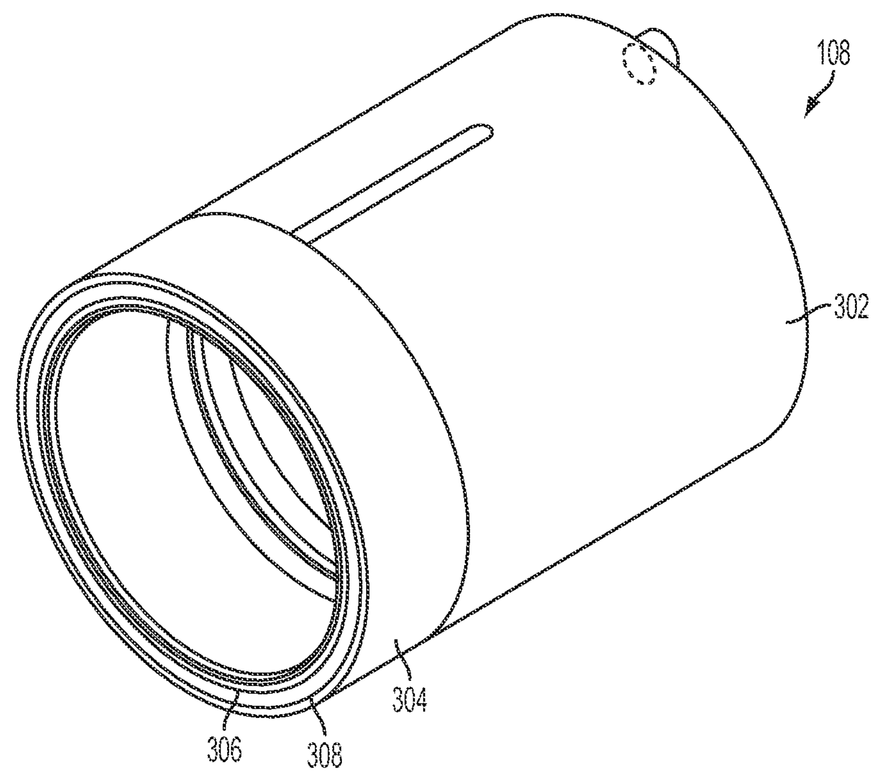


FIG. 3A

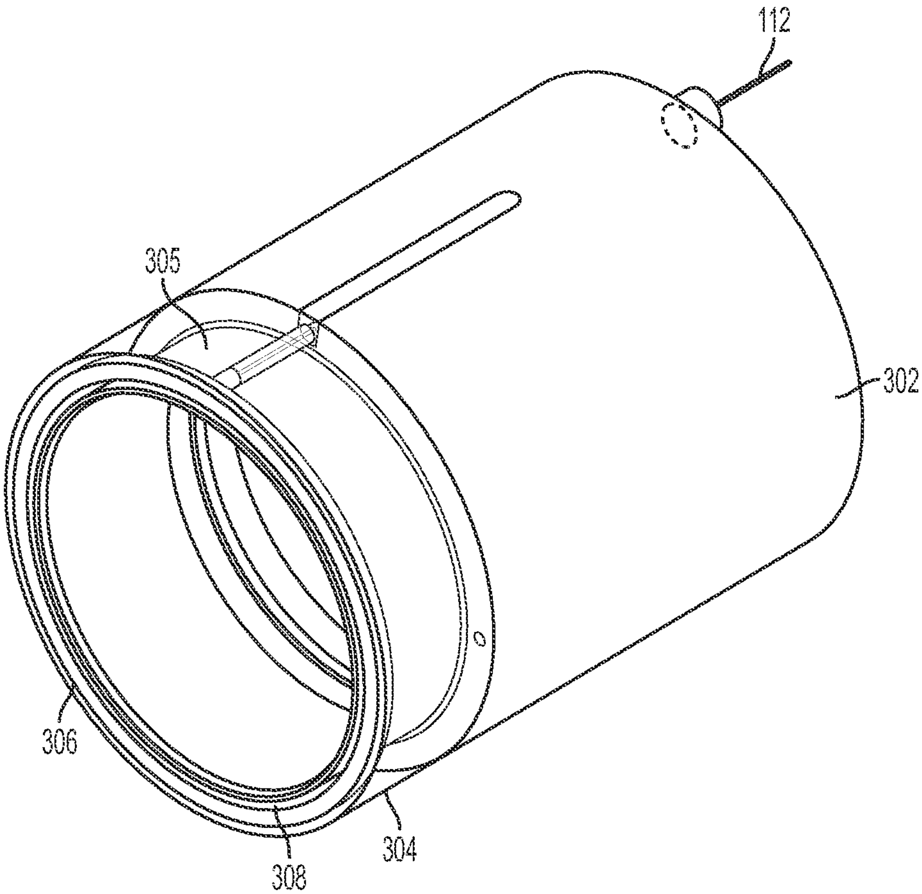


FIG. 3B

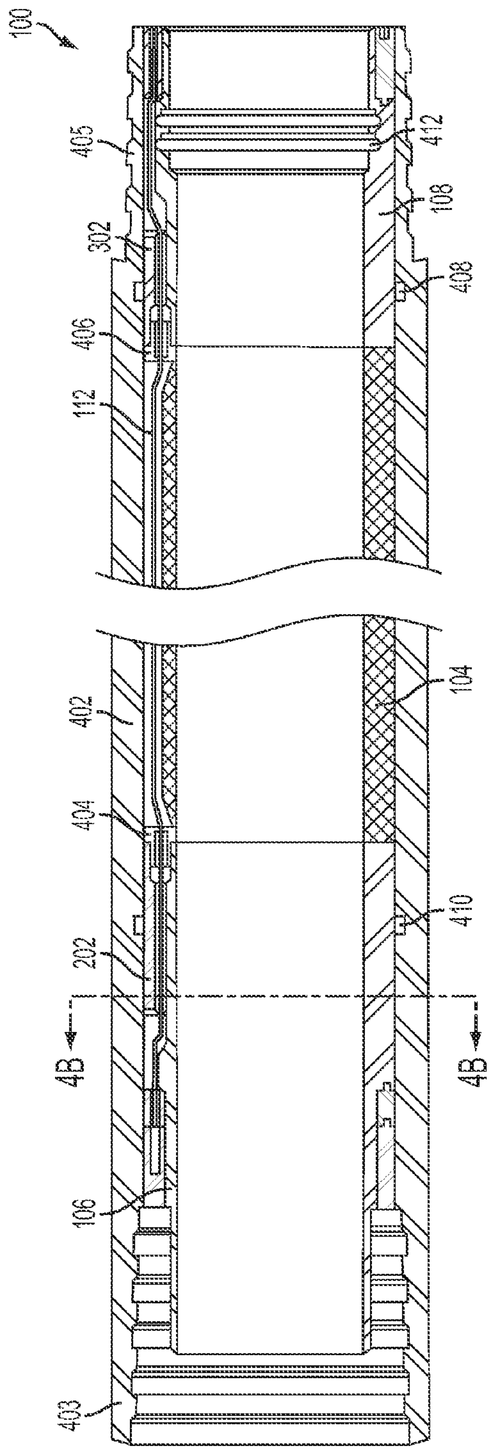

100
405
412
108
302
408
406
112
402
104
404
410
202
4B
4B
106
403

FIG. 4A

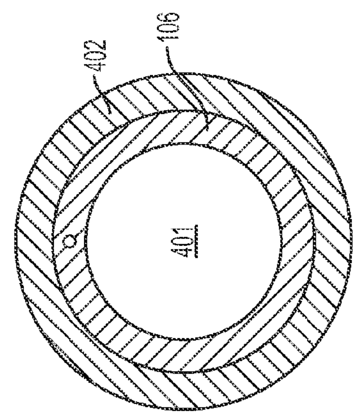

402
106
401

FIG. 4B

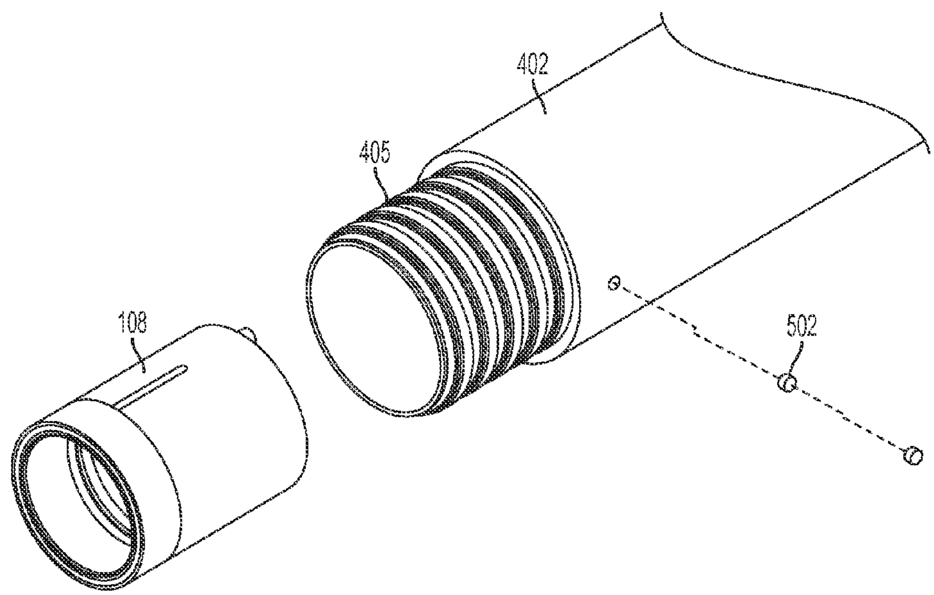


FIG. 5A

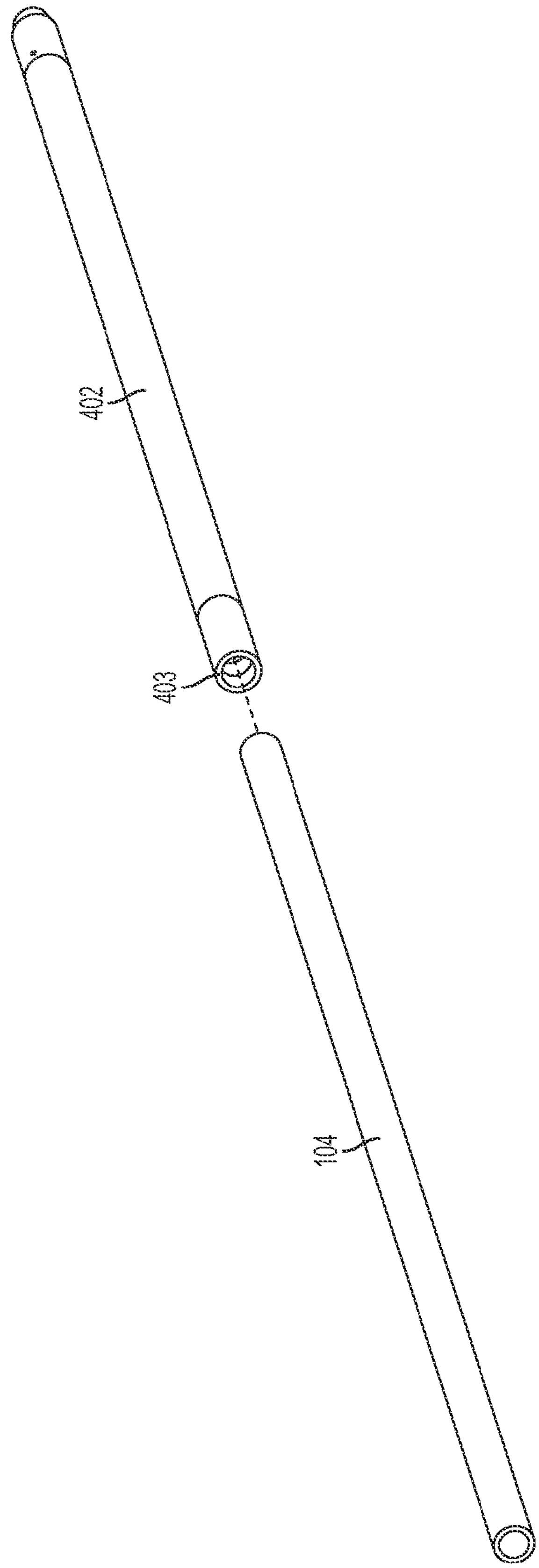


FIG. 5B

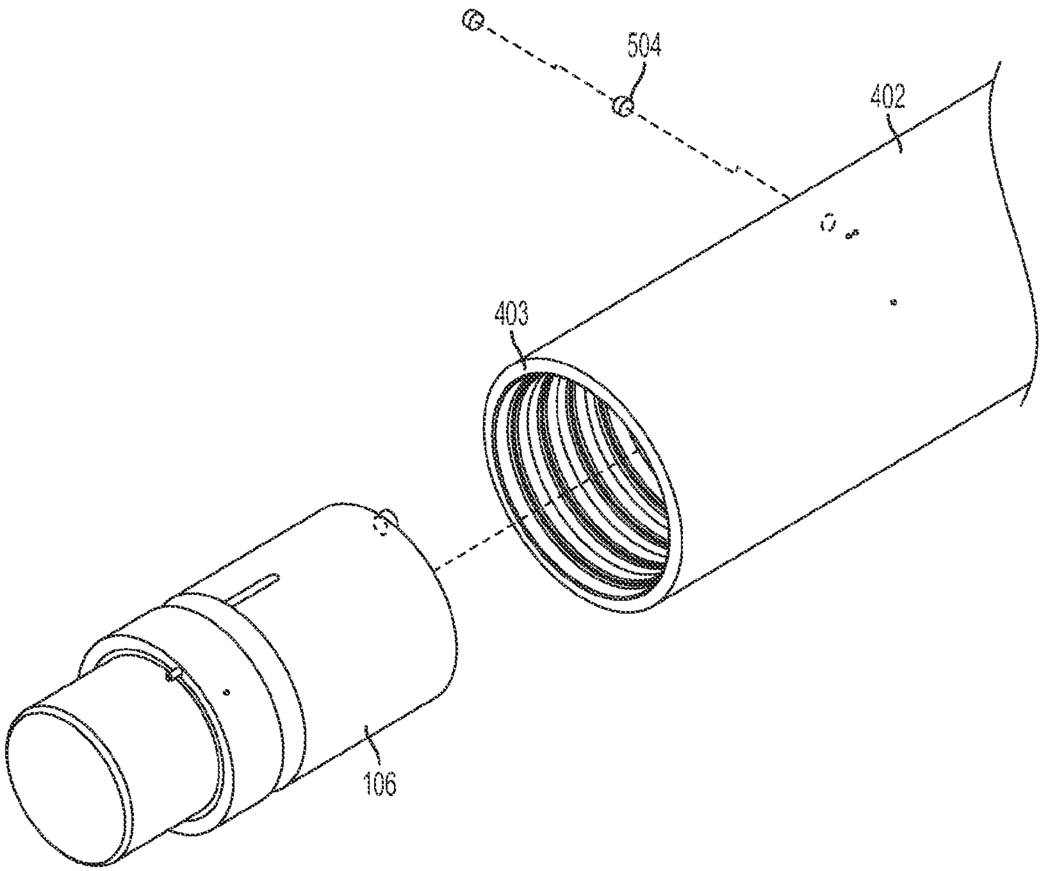


FIG. 5C

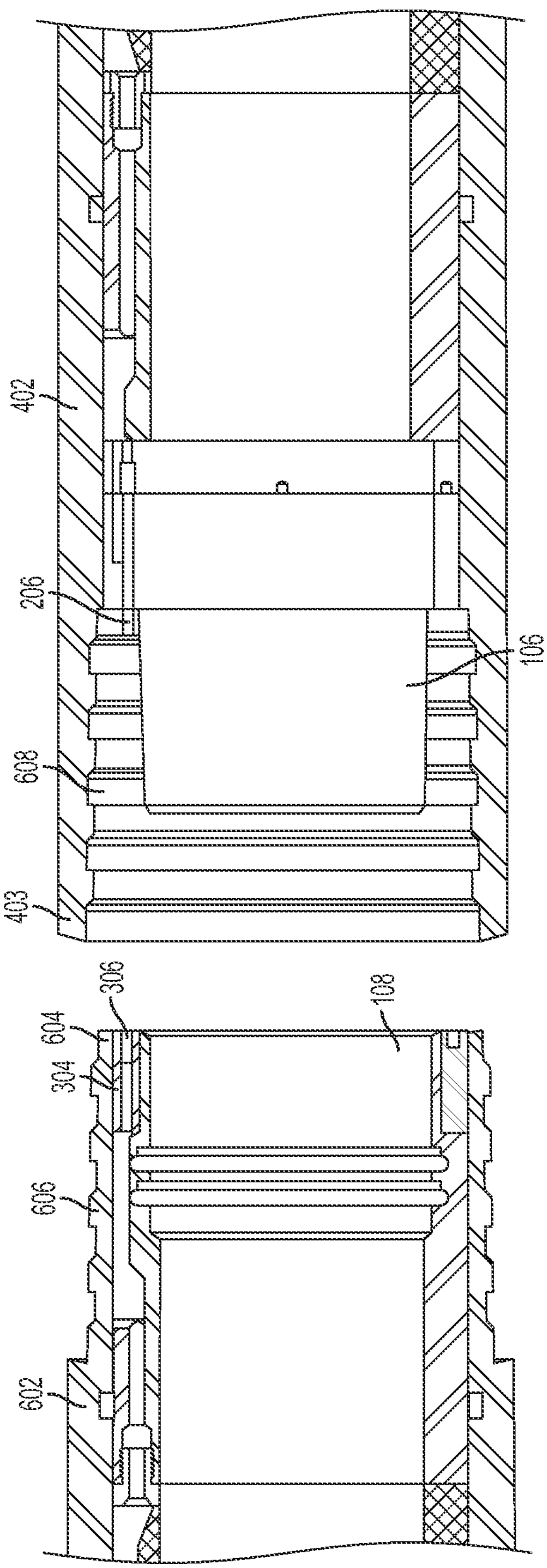


FIG. 6

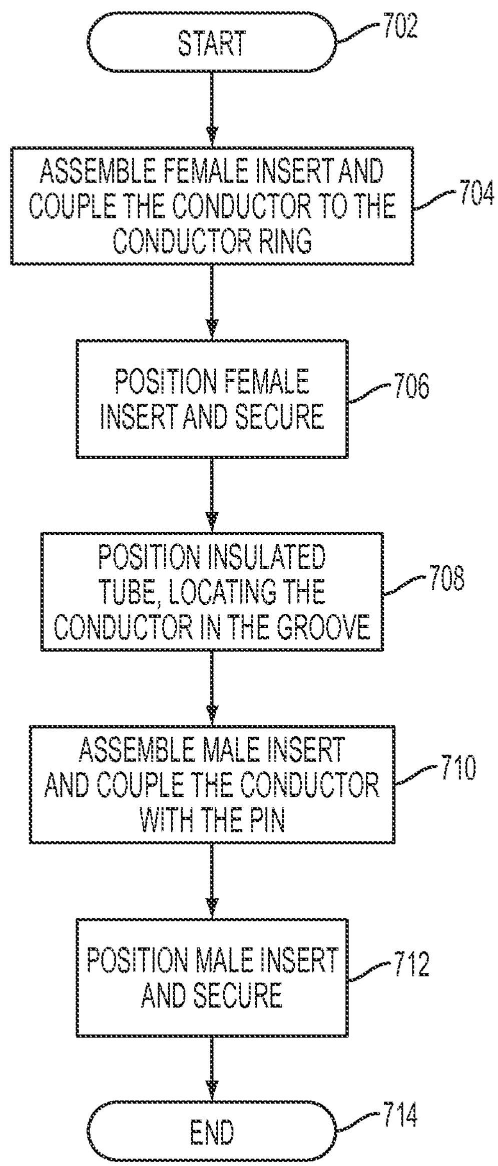

START
702
ASSEMBLE FEMALE INSERT AND COUPLE THE CONDUCTOR TO THE CONDUCTOR RING
704
POSITION FEMALE INSERT AND SECURE
706
POSITION INSULATED TUBE, LOCATING THE CONDUCTOR IN THE GROOVE
708
ASSEMBLE MALE INSERT AND COUPLE THE CONDUCTOR WITH THE PIN
710
POSITION MALE INSERT AND SECURE
712
END
714

FIG. 7

METHOD AND SYSTEM FOR DATA-TRANSFER VIA A DRILL PIPE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to, and incorporates by reference, for any purpose, the entire disclosure of, U.S. Provisional Patent Application No. 61/644,896, filed May 9, 2012.

BACKGROUND

[0002] 1. Field of the Invention

[0003] The present application relates generally to drilling and mining operations and more particularly, but not by way of limitation, to a drill pipe having an insulated conductor embedded therein for transmission of data.

[0004] 2. History of the Related Art

[0005] The practice of drilling non-vertical wells through directional drilling (sometimes referred to as "slant drilling") has become very common in energy and mining industries. Directional drilling exposes a larger section of subterranean reservoirs than vertical drilling, and allows multiple subterranean locations to be reached from a single drilling location thereby reducing costs associated with operating multiple drilling rigs. In addition, directional drilling often allows access to subterranean formations where vertical access is difficult or impossible such as, for example, formations located under a populated area or formations located under a body of water or other natural impediment.

[0006] Despite the many advantages of directional drilling, the high cost associated with completing a well is often cited as the largest shortcoming of directional drilling. This is due to the fact that directional drilling is often much slower than vertical drilling due to requisite data-acquisition steps. Data acquisition requires an electrical connection to be present between a down-hole tool and surface equipment. Embedding an electrical conductor into a drill rod expedites data acquisition associated with directional drilling and reduces overall costs associated with directional drilling.

SUMMARY

[0007] The present application relates generally to drilling and mining operations and more particularly, but not by way of limitation, to a drill pipe having an insulated conductor embedded therein for transmission of data. In one aspect, the present invention relates to a drill-pipe communication assembly. The drill-pipe communication assembly includes a first drill pipe and an insulated tube disposed within, and generally concentric with, the first drill pipe. A male insert is disposed within a first end of the first drill pipe and a female insert is disposed within a second end of the first drill pipe. A conductor is electrically coupled to the male insert and the female insert. The conductor extends along a length of the first drill pipe. The conductor facilitates transmission of electrical signals from the first end of the first drill pipe to the second end of the first drill pipe.

[0008] In another aspect, the present invention relates to a method of installing a drill-pipe communication assembly. The method includes inserting a female insert into a first end of a drill pipe and inserting an insulated tube into a second end of the drill pipe. The method further includes inserting a male insert into the second end of the drill pipe. A conductor is electrically coupled to the female insert and the male insert. Electrical signals are transmitted, via the conductor, from the first end of the drill pipe to the second end of the drill pipe.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] For a more complete understanding of the present invention and for further objects and advantages thereof, reference may now be had to the following description taken in conjunction with the accompanying drawings in which:

[0010] FIG. **1** is a perspective view of a drill-pipe communication assembly according to an exemplary embodiment;

[0011] FIG. **2**A is a perspective view of a male insert according to an exemplary embodiment;

[0012] FIG. **2**B is a perspective view of the male insert of FIG. **2**A with an insulating ring shown as transparent according to an exemplary embodiment;

[0013] FIG. **3**A is a perspective view of a female insert according to an exemplary embodiment;

[0014] FIG. **3**B is a perspective view of the female insert of FIG. **3**B with an insulating ring shown as transparent according to an exemplary embodiment;

[0015] FIG. **4**A is a cross-sectional view along the line A-A of the drill-pipe communication assembly of FIG. **1** according to an exemplary embodiment;

[0016] FIG. **4**B is a cross-sectional view along the line B-B of the drill-pipe communication assembly of FIG. **4**A according to an exemplary embodiment;

[0017] FIG. **5**A is an exploded perspective view of a female insert of FIG. **3**A illustrating assembly with a drill rod according to an exemplary embodiment;

[0018] FIG. **5**B is an exploded perspective view of an insulated tube illustrating assembly with a drill rod according to an exemplary embodiment;

[0019] FIG. **5**C is an exploded perspective view of the male insert of FIG. **2**A illustrating assembly with a drill rod according to an exemplary embodiment;

[0020] FIG. **6** is a cross-section view of a junction between two adjacent drill pipes according to an exemplary embodiment; and

[0021] FIG. **7** is a flow diagram of a process for installing the drill-pipe communication assembly of FIG. **1** according to an exemplary embodiment;

DETAILED DESCRIPTION

[0022] Various embodiments of the present invention will now be described more fully with reference to the accompanying drawings. The invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein.

[0023] FIG. **1** is a perspective view of a drill-pipe communication assembly **100**. In a typical embodiment, the drill-pipe communication assembly **100** is disposed within a drill pipe **402** (shown in FIG. **4**A). An insulated tube **104** is disposed within the drill pipe **402**. In a typical embodiment, the insulated tube **104** is constructed of an electrically-non-conductive material such as, for example, ABS plastic, carbon fiber, ceramic, or other appropriate material. A male insert **106** abuts a first end **200** and a female insert **108** abuts a second **300** end of the insulated tube. In a typical embodiment the drill pipe is constructed of, for example, steel or other appropriate material. A groove **110** is formed in an outer surface of the insulated tube **104** and is oriented generally parallel to a length of the insulated tube **104**. A conductor **112** is disposed in the groove **110** and is electrically coupled to the male insert **106** and the female insert **108**. In a typical embodiment, the conductor **112** is, for example, a co-axial cable. However, in other embodiments, drill-pipe communication assemblies utilizing principles of the invention may include conductors such as, for example, a microstrip, flat or ribbon wire, an Ethernet cable, a fiber-optic cable, a transverse electromagnetic transmission line such as, for example, stripline, or other appropriate conductor as dictated by design requirements.

[0024] FIG. **2**A is a perspective view of the male insert **106**. FIG. **2**B is a perspective view of the male insert **106** with a first insulating ring and a second insulating ring shown as transparent. Referring to FIGS. **2**A and **2**B, in a typical embodiment, the male insert **106** is operable to couple with a female insert **108** (shown in FIG. **1**) associated with an adjacent drill pipe (not shown). The male insert includes a body **202**, a first insulating ring **204** surrounding a portion of the body **202**, a second insulating ring **210** surrounding a portion of the body **202** and positioned adjacent to the first insulating ring **204**, and a pin **206** disposed through the first insulating ring **204**. In a typical embodiment the body **202** is constructed from a material such as, for example, stainless steel; however, in other embodiments, other materials may be utilized. A rabbet **205** is formed in the body **202** and the first insulating ring **204** and the second insulating ring **210** disposed about a circumference of the rabbet **205**. In a typical embodiment, the pin **206** is electrically coupled to the conductor **112** and is constructed of an electrically-conductive material such as, for example copper, aluminum, or other appropriate material. As shown in FIG. **2**B, a spring **208** is disposed within the insulating ring **204** between the pin **206** and the second insulating ring **210**. In a typical embodiment, the spring **208** biases the pin **206** in a forward direction to facilitate electrical contact between the male insert **106** and a female insert **108** (shown in FIG. **1**) associated with an adjacent drill pipe (not shown). In a typical embodiment, the conductor **112**, the pin **206**, and the female conductor ring **306** (shown in FIGS. **3**A-**3**B) form a continuous wire line capable of transmitting data in the form of electrical signals between the male insert **106** and the female insert **108**.

[0025] FIG. **3**A is a perspective view of the female insert **108**. FIG. **3**B is a perspective view of the female insert **108** with an insulating ring shown as transparent. In a typical embodiment, the female insert **108** is, for example, operable to couple with a male insert **106** (shown in FIG. **1**) of an adjacent drill pipe (not shown). The female insert **108** includes a body **302**, an insulating ring **304** disposed about the body **302**, and a female conductor ring **306**. In a typical embodiment, the body **302** is constructed from a material such as, for example, stainless steel; however, in other embodiments, other materials may be utilized. A rabbet **305** is formed in the body **302** and the insulating ring **304** is disposed about a circumference of the rabbet **305**. In a typical embodiment, the female conductor ring **306** is constructed of an electrically-conductive material such as, for example copper, aluminum, or other appropriate material. The female conductor ring **306** is disposed within a groove **308** formed in an outer face of the insulating ring **304**. In a typical embodiment, the groove **308** forms a track that receives a pin (not shown) associated with a male insert **106** (shown in FIG. **1**) of an adjacent drill pipe (not shown). The groove **308** facilitates contact between the pin **206** of an adjacent drill pipe and the female conductor ring **306**. As shown in FIG. **3**B, the female conductor ring **306** is electrically coupled to the conductor **112**. Thus, combination of the pin **206**, the female conductor ring **306**, and the conductor **112** allows transmission of electrical signals from, for example, the male insert **106** to the female insert **108**.

[0026] FIG. **4**A is a cross-sectional view along the line A-A of the drill-pipe communication assembly **100**. FIG. **4**B is a cross-sectional view along the line B-B of the drill-pipe communication assembly **100**. Referring to FIGS. **4**A-**4**B, the insulated tube **104** is received within, and is generally concentric with, the drill pipe **402**. A central space **401** is formed within an interior of the insulated tube **104**. The central space **401** allows for transmission of fluids, tools, and other items through the drill-pipe communication assembly **100**. The insulated tube **104** insulates the conductor **112** from materials that may be present in the central space **401**. Thus, the drill-pipe communication assembly **100** allows data related to, for example, tool depth and telemetry, to be transmitted, via the conductor **112**, without blocking or otherwise reducing a size of the central space **401**.

[0027] Still referring to FIGS. **4**A and **4**B, the male insert **106** is inserted into a female end **403** of the drill pipe **402** and the female insert **108** is inserted into a male end **405** of the drill pipe **402**. The male insert **106** abuts the first end **200** (shown in FIG. **1**) of the insulated tube **104** and the female insert **108** abuts the second end **300** (shown in FIG. **1**) of the insulated tube **104**. The conductor **112** is electrically coupled to both the male insert **106** and the female insert **108**. The conductor **112** traverses a length of the insulated tube **104** between the male insert **106** and the female insert **108**. Thus, the combination of the conductor **112**, the male insert **106**, and the female insert **108** allows transmission of electrical signals along a length of the drill pipe **402**. A first compression grommet **404** is disposed in the body **202** of the male insert **106**. The first compression grommet **404** is disposed about the conductor **112**. In a typical embodiment, the first compression grommet **404** prevents infiltration of, for example, water or drilling fluids, into the male insert **106**. A second compression grommet **406** is disposed in the body **302** of the female insert **108**. The second compression grommet **406** is disposed about the conductor **112**. In a typical embodiment, the second compression grommet **406** prevents infiltration of, for example, water or drilling fluids, into the female insert **108**.

[0028] Still referring to FIGS. **4**A-**4**B, a first seal **408** is disposed about an interior circumference of the drill pipe **402** proximate to the female insert **108**. In a typical embodiment, the first seal **408** includes a single O-ring; however, in alternate embodiments, the first seal **408** may include a double O-ring, a gasket, or other sealing device as dictated by design requirements. During operation, the first seal **408** prevents infiltration of, for example, fluid and other contaminants into a region of the drill pipe **402** containing the female insert **108**. A second seal **410** is disposed about an interior circumference of the drill pipe **402** proximate to the male insert **106**. In a typical embodiment, the second seal **410** includes a single O-ring; however, in alternate embodiments, the second seal **410** may include a double O-ring, a gasket, or other sealing device as dictated by design requirements. During operation, the second seal **410** prevents infiltration of, for example, fluid and other contaminants into a region of the drill pipe **402** containing the male insert **106**. A third seal **412** is disposed about an interior circumference of the female insert **108**. In a typical embodiment, the third seal **412** includes a double O-ring; however, in other embodiments, the third seal **412**

may include a single O-ring or other sealing device as dictated by design requirements. During operation, the third seal **412** seats on a circumferential face of the male insert **106** and prevents infiltration of, for example, fluid and other contaminants into a region of the drill pipe **402** containing a junction between the male insert **106** and the female insert **108**.

[0029] FIG. **5**A is an exploded perspective view of the female insert **108** illustrating assembly with the drill pipe **402**. FIG. **5**B is an exploded perspective view of the insulated tube **104** illustrating assembly with the drill pipe **402**. FIG. **5**C is an exploded perspective view of the male insert **106** illustrating assembly with the drill pipe **402**. As will be illustrated in FIGS. **5**A-**5**C, the drill-pipe communication assembly **100** may be utilized in combination with a pre-existing drill pipe. Thus, the drill-pipe communication assembly **100** allows previously unwired drill pipe to be retro-fitted to allow data transfer.

[0030] As shown in FIG. **5**A, the female insert **108** is inserted into a male end **405** of the drill pipe **402**. The female insert **108** is held in place within the drill pipe **402** via first fasteners **502** or a press fit. In a typical embodiment, the first fasteners **502** are, for example, set screws; however, in other embodiments, the first fasteners **502** may be, for example, pins, rivets, or any other appropriate fastener as dictated by design requirements. As shown in FIG. **5**B, the insulated tube **104** is inserted into a female end **403** of the drill pipe **402**. As discussed hereinabove, the groove **110**, having the conductor **112** disposed therein, is formed in the insulated tube **104**. The conductor **112** is electrically coupled to the female insert **108**. In a typical embodiment, insertion of the insulated tube **104** occurs after insertion of the female insert **108**. As shown in FIG. **5**C, the male insert **106** is inserted into a female end **403** of the drill pipe **402**. The male insert **106** is held in place within the drill pipe **402** via second fasteners **504** or a press fit. In a typical embodiment, the second fasteners **504** are, for example, set screws; however, in other embodiments, the second fasteners **504** may be, for example, pins, rivets, or any other appropriate fastener as dictated by design requirements.

[0031] FIG. **6** is a cross-sectional view of a junction between, for example, the female end **403** of the drill pipe **402** and a male end **604** of an adjacent drill pipe **602**. As shown in FIG. **6**, the male end **604** includes, for example, male threads **606** and the female end **403** includes, for example, female threads **608**. The male insert **106** is disposed in the female end **403** and the female insert **108** is disposed in the male end **604**. Upon engagement of the male threads **606** with the female threads **608**, the pin **206** engages the female conductor ring **306** disposed in the groove **308** thereby facilitating an electrical connection between the drill pipe **402** and the adjacent drill pipe **602**. Such an electrical connection allows the transmission of, for example, measurements, telemetry, and other data obtained by a downhole tool to, for example surface instrumentation.

[0032] The advantages of the drill-pipe communication assembly **100** will be apparent to those skilled in the art. First, the drill-pipe communication assembly **100** provides a continuous wire line for transmission of electrical signals from, for example, a down-hole tool to surface drilling equipment via the conductor **112**, the pin **206**, and the female conductor ring **306**. Second, the drill-pipe communication assembly **100** allows for the passage of fluids, tools, and other items through the central space **401**. Third, the insulated tube **104**, including the conductor **112**, the pin **206**, and the female conductor ring **306**, may be assembled during a manufacturing process for the drill pipe **402** or after manufacturing of a drill pipe. In this sense, the drill-pipe communication assembly **100** allows the existing drill pipe **402** to be fitted or retro-fitted.

[0033] FIG. **7** is a flow diagram of a process **700** for installing the drill-pipe communication assembly **100**. The process **700** begins at step **702**. At step **704**, the female conductor ring **108** is assembled and coupled to the conductor **112**. At step **706**, the female insert **108** is positioned and secured in the male end **405** of the drill pipe **402**. At step **708**, the insulated tube **104** is inserted into the female end **403** of the drill pipe **402**. At step **710**, the male insert **106** is assembled and coupled to the conductor **112**. At step **712**, the male insert is positioned and secured in the female end **403** of the drill pipe **402**. The process ends at step **714**.

[0034] Although various embodiments of the method and system of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Specification, it will be understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications, and substitutions without departing from the spirit and scope of the invention as set forth herein. It is intended that the Specification and examples be considered as illustrative only.

What is claimed is:

1. A drill-pipe communication assembly comprising:

a first drill pipe;

an insulated tube disposed within, and generally concentric with, the first drill pipe;

a male insert disposed within a first end of the first drill pipe;

a female insert disposed within a second end of the first drill pipe;

a conductor electrically coupled to the male insert and the female insert, the conductor extending along a length of the first drill pipe; and

wherein the conductor facilitates transmission of electrical signals from the first end of the first drill pipe to the second end of the first drill pipe.

2. The drill-pipe communication assembly of claim **1**, wherein the male insert comprises:

a body;

a first insulating ring disposed about the body;

a second insulating ring disposed about the body; and

a pin disposed through the insulating ring, the pin being electrically coupled to the conductor.

3. The drill-pipe communication assembly of claim **2** comprising a spring disposed between the pin and the second insulating ring.

4. The drill-pipe communication assembly of claim **3**, wherein the pin is biased by the spring into electrical engagement with a female conductor ring associated with a second adjacent drill pipe.

5. The drill-pipe communication assembly of claim **1**, wherein the female insert comprises:

a body;

an insulating ring disposed about the body; and

a female conductor ring disposed within a groove formed in the insulating ring, the female conductor ring being electrically coupled to the conductor.

6. The drill-pipe communication assembly of claim **5**, wherein the groove and the female conductor ring form a recessed track.

7. The drill-pipe communication assembly of claim **6**, wherein the groove facilitates electrical connection with a male insert of a second adjacent drill pipe.

8. The drill-pipe communication assembly of claim **1**, wherein:
the first end of the drill pipe is a male end; and
the second end of the drill pipe is a female end.

9. The drill-pipe communication assembly of claim **1**, wherein the conductor is at least one of a coaxial cable, a microstrip, a flat wire, a ribbon wire, an Ethernet cable, a fiber-optic cable, and a transverse electromagnetic transmission line.

10. The drill-pipe communication assembly of claim **1**, wherein the conductor is disposed within a groove formed on a surface of the insulated tube.

11. The drill-pipe communication assembly of claim **1**, wherein the male insert, the female insert, the conductor, and the insulated tube may be utilized to retrofit a pre-existing drill pipe.

12. A method of installing a drill-pipe communication assembly, the method comprising:
inserting a female insert into a first end of a drill pipe;
inserting an insulated tube into a second end of the drill pipe;
inserting a male insert into the second end of the drill pipe;
electrically coupling a conductor to the female insert and the male insert; and
transmitting, via the conductor, electrical signals from the first end of the drill pipe to the second end of the drill pipe.

13. The method of claim **12**, wherein the first end is a male end and the second end is a female end.

14. The method of claim **12**, wherein the conductor is disposed within a groove formed in the insulated tube.

15. The method of claim **12**, comprising securing the female insert within the first end of the drill pipe.

16. The method of claim **12**, comprising securing the male insert within the second end of the drill pipe.

17. The method of claim **12**, comprising biasing, via a spring, a pin associated with the male insert into electrical engagement with a female conductor ring associated with a second drill pipe.

18. The method of claim **17**, wherein the female conductor ring is disposed in a groove.

19. The method of claim **12**, wherein the drill pipe is a pre-existing drill pipe.

20. The method of claim **19**, comprising retro-fitting the pre-existing drill pipe.

* * * * *