A downhole electromagnetic telemetry system and method whereby electrically insulating material is placed above and/or below an electrical current launching device or receiver along a well string in order to extend the range of the telemetry system, increase the telemetry rate, and/or reduce downhole power requirements.
Current on pipe and/or casing, 1" gap, no further insulation

Current on pipe

Current on Casing

25 ohm meter mud

Fig. 2A

Log10 of Current in amperes

Depth in feet
Fig. 2C

Current on pipe and/or casing, 800 feet of insulation centered on the gap

Log10 of Current in amperes

Current on pipe
Current on Casing

.25 ohm meter mud

Depth in feet

-3000
-2500
-2000
-1500
-1000
-500
0
DOWNHOLE ELECTROMAGNETIC TELEMETRY SYSTEM UTILIZING ELECTRICALLY INSULATING MATERIAL AND RELATED METHODS

FIELD OF THE INVENTION

[0001] The present invention relates generally to electromagnetic telemetry and, more specifically, to a downhole telemetry system in which electrically insulating material is placed around one or more portions of a well string in order to extend the range of the telemetry system, increase the telemetry rate, and/or reduce downhole power requirements.

BACKGROUND

[0002] Electromagnetic telemetry systems are used in downhole operations to transmit and receive electromagnetic signals for a variety of purposes. An electromagnetic telemetry transmitter launches an electrical signal into drill pipe either by impressing a potential difference across a portion of drill collar connected to the drill pipe or by launching a current on the drill string by way of a toroid that is placed around a section of the drill string.

[0003] However, when an electromagnetic transmitter is within casing, signal losses can be excessive as the current on the pipe jumps to the casing, thus launching part of the signal to the casing, but also shorting part of the signal along the casing. Furthermore, and especially when there is direct contact between any part of the pipe and the casing, motion of the drill string can cause intermittent contact and, thus, introduce a very significant noise into the telemetry signal. Moreover, as the signal travels up or down the pipe and/or casing, it is attenuated substantially as current leaks into the formation surrounding the borehole. As a result, the signal received at the surface or downhole receiver can be attenuated to the point where the signal to noise ratio is not high enough to allow for reliable communication, even at a data rate of a few bits per second.

[0004] In view of the foregoing, there is a need in the art for a cost effective method by which to extend the range of the telemetry system and/or to prevent short circuits through the mud and into the casing or directly into the casing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIGS. 1A and 1B illustrate a drilling rig and an electromagnetic telemetry system 10 according to one or more exemplary embodiments of the present invention; and

[0006] FIGS. 2A, 2B and 2C are graphs illustrating the signal improvement effects of adding electrically insulating material above and/or below the current launching device, according to one or more exemplary embodiments of the present invention.

DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0007] Illustrative embodiments and related methodologies of the present invention are described below as they might be employed in a downhole telemetry system in which electrically insulating material is placed around one or more portions of the well string. In the interest of clarity, not all features of an actual implementation or methodology are described in this specification. Also, the "exemplary" embodiments described herein refer to examples of the present invention. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developers’ specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure. Further aspects and advantages of the various embodiments and related methodologies of the invention will become apparent from consideration of the following description and drawings.

[0008] As described herein, exemplary embodiments of the present invention extend the range of an electromagnetic telemetry system when the system is within a cased or uncased section of a well. To achieve this objective, electrically insulating material is applied to the well string immediately above and/or immediately below the electrical current launching device (gap sub assembly or toroid, for example) or receiver. In other embodiments, the electrically insulating material may also cover the current launching device or receiver. Accordingly, as the current launching device launches the electrical signal into the drill pipe, the electrically insulating material prevents the current from jumping to the casing either directly or through the drilling mud, thus preventing or reducing the severity of short circuits through the casing and/or electrical current leakage into the formation in situations where casing is not present around the transmitter, thereby improving the range and/or signal to noise ratio of the telemetry system, and/or reducing the power required by the system. Moreover, in those embodiments where a downhole receiver is utilized, the electrically insulating material acts to reduce current leakage from the well string to the casing or formation during downlink operations.

[0009] In certain exemplary embodiments, the electrically insulating material is one or more sheets of material wrapped around the bottom hole assembly or drill pipe using an adhesive backing. In others, for example, electrically insulating swellable material or a variety of coatings may also be utilized. As a result, the range of the electromagnetic telemetry system within and without the cased section is increased by roughly the same amount of pipe that is electrically insulated. Therefore, the data rate of the electromagnetic telemetry system may also be increased without the need for adding repeaters.

[0010] FIGS. 1A and 1B illustrate a drilling rig 12 and an electromagnetic telemetry system 10 according to one or more exemplary embodiments of the present invention. As understood in the art, electromagnetic telemetry system 10 generates and/or receives electromagnetic waves downhole. Electromagnetic telemetry system 10 includes a bottom hole assembly 14, current launching device 16 (gap sub assembly, for example) and tubular section 18 (referred to in combination as a well string, for example), all extending down through casing 20 of well 22. The term "well string," as used herein, may refer to a variety of deployment strings such as, for example, drill string, coiled tubing, production tubing, etc. In the exemplary embodiment of FIGS. 1A and 1B, the well string is a drill string.

[0011] In addition, electromagnetic telemetry system 10 includes a receiver 24 electrically coupled to a ground reference 26, and may also have one or more repeaters (not shown) along tubular 18 as necessary. In general, electromagnetic telemetry system 10 communicates by launching a low fre-
frequency current (between about 1 and 30 Hz, for example) along tubular 18. Signals associated with the current are then detected at the surface by receiver 24 where a potential difference is measured between drilling rig 12 and ground 26. In this exemplary embodiment, electromagnetic telemetry system 10 may operate in, for example, a phase modulated carrier mode, pulse position modulation mode or orthogonal frequency-division multiplexing mode, or a number of other modulation modes, as will be understood by those ordinarily skilled in the art having the benefit of this disclosure.

[0012] In order to produce the current transmitted by electromagnetic telemetry system 10, electrical current launching device 16 is provided adjacent bottom hole assembly 14 (or may form part of bottom hole assembly 14). In a first exemplary embodiment, electrical current launching device 16 is provided as an electrical break between bottom hole assembly 14 and tubular 18 which effectively turns the well string into a large antenna. In the exemplary embodiment of FIG. 1A, a gap sub assembly serves as the electrical break or antenna. An electrical potential difference is thereby created between bottom hole assembly 14 and tubular 18, thus creating the transmitted current. As understood in the art, the gap sub assembly is an electrical isolation joint designed to withstand the high torsional, bending, tensile and compression loads of electromagnetic telemetry system 10. However, in other embodiments, electrical current launching device 16 may instead be a toroid assembly, as understood in the art. These and other aspects of electromagnetic telemetry system 10 will be readily understood by those ordinarily skilled in the art having the benefit of this disclosure.

[0013] Still referring to FIGS. 1A and 1B, tubular 18 has been lowered through blow out preventer 28 down into well 22, and through casing 20. As previously mentioned, in this exemplary embodiment, tubular 18 is drill pipe forming part of a drill string; however, in other embodiments, tubular 18 may be, for example, coiled or production tubing utilized for some other operation. Nevertheless, tubular 18 extends down to current launching device 16 which is coupled to bottom hole assembly 14. A drill bit 30 is positioned at the distal end of bottom hole assembly 14. Drill bit 30 may be rotated by a variety of methods including, for example, tubular 18 or a mud motor. In this exemplary embodiment, bottom hole assembly 14 comprises a CPU (not shown) and electromagnetic telemetry transmitter 32 that includes electronics necessary to sense, detect and transmit electromagnetic signals via current launching device 16, in addition to handling other operations of bottom hole assembly 14, as understood in the art.

[0014] In certain exemplary embodiments of electromagnetic telemetry system 10, an electrically insulating material 34 is applied around one or more portions of a drill string (tubular 18 or bottom hole assembly 14) above and/or below current launching device 16. In one embodiment, the electrically insulating material 34 need not be a perfect insulator; rather, the resistivity of electrically insulating material 34 is no less than two orders of magnitude higher than that of the fluid (drilling mud, for example) used during the downhole operation. Moreover, in certain embodiments, it is also not necessary that electrically insulating material 34 be without break along tubular 18 or bottom hole assembly 14. Nevertheless, electrically insulating material 34 may be a variety of materials, such as, for example, a swellable material, injection-molded coating, bands, sleeves, stabilizers, high oxygen fuel spray coating, anodized layers, etc. The swellable material may be, for example, such materials as used in the Swell Technology™ Systems, commercially available through the Assignee of the present invention, Halliburton Energy Services, Co. or Houston, Tex. In addition, the swellable material may be selected based upon the mud type (oil or water based, for example) such that, once contact has been made with the drilling mud, the swellable material swells onto bottom hole assembly 14 and/or tubular 18 and adheres to it.

[0015] As previously described, electrically insulating material 34 is applied to one or more portions of the well string (i.e., tubular 18 and bottom hole assembly 14) above and/or below the current launching device 16. In one embodiment, electrically insulating material 34 is applied immediately above and/or below current launching device 16, as shown in FIGS. 1A and 1B. However, in other embodiments, electrically insulating material 34 may also be placed all along tubular 18 as desired. In certain exemplary embodiments, electrically insulating material 34 may be applied as a tape that is wrapped around one or more portions of bottom hole assembly 14 as it is tripped into well 22. The electrically insulating tape may be adhered along the well string by wetting it with the same fluid (drilling mud, for example) that will be utilized to cause it to swell. However, in other embodiments, an adhesive backing may also be utilized on the tape to adhere it to the well string. Exemplary insulating tapes may be, for example, swellable materials, adhesive-backed rubber, silicone rubber, Teflon, polyester films, polyimide tapes, polymer sheets (polyethylene, for example). In certain embodiments, however, the use of polyethylene would be limited to about 115° C. since a typical melting point for a polyethylene plastic is around 120° C. Moreover, the tape may be one to several feet wide and a fraction of an inch thick (½ inch, for example).

[0016] In an alternate embodiment, electrically insulating material 34 may be formed into a sleeve having an inner diameter somewhat larger than that of the box-pin outer diameter of bottom hole assembly 14 or tubular 18. In one example, the electrically insulating sleeve would be applied along the well string as it is tripped into well 22. The electrically insulating sleeve may be held in place during deployment in a variety of ways such as, for example, by applying clamps or tape to hold the electrically insulating sleeve in place until the swellable material begins to swell. In the alternative, the electrically insulating sleeve may be snug enough around the well string portion to hold itself in place until swelling begins. In addition, portions of the electrically insulating sleeve may be wetted with drilling mud, thus causing that portion of the sleeve to swell and adhere to the well string. Nevertheless, after deployment, as the electrically insulating sleeve comes into the contact with the drilling fluid, the swellable material is then activated to swell against the surface of bottom hole assembly 14 or tubular 18, thus adhering to it. The swellable material may be selected, for example, based upon the type of drilling mud utilized, as will be understood by those ordinarily skilled in the art having the benefit of this disclosure.

[0017] Moreover, still referring to FIGS. 1A and 1B, electrically insulating material 34 may also be applied to one or more sections of tubular 18 using any of the methods described herein. Such an embodiment will minimize current loss during transmission along tubular 18. In prior art telemetry systems, the current traveling up the well string and casing tends to migrate off the well string/casing and go to ground, thus resulting in signal loss. However, through use of
this alternate embodiment of the present invention whereby one or more portions of tubular 18 are insulated above current launching device 16, the amount of current going to ground along tubular 18 is then reduced, which increases the amount of current traveling back up the well string and reaching the surface, thus resulting in a larger amplitude signal. In certain embodiments, electrically insulating material 34 may be utilized along bottom hole assembly 14 only, tubular 18 only, or in combination along both bottom hole assembly 14 and tubular 18.

[0018] Additionally, in yet another alternative embodiment, an electrically resistive fluid may be pumped into well 22 to assist in electrically isolating electromagnetic telemetry system from casing 22. Such fluid may be drill mud and or fluid additives added to the fluid. In another embodiment, the electrically resistive fluid may be utilized without electrically insulating material 34, as will be understood by those ordinarily skilled in the art having the benefit of this disclosure.

[0019] Although not shown in FIGS. 1A and 1B, exemplary embodiments of present invention may also be utilized in downhole telemetry systems which may only utilize a downhole receiver. As understood in the art, electromagnetic telemetry system 10 may comprise a receiver in place of current launching device 16 which is used to receive signals transmitted from the surface via tubular 18. Such an embodiment may or may not include electromagnetic telemetry transmitter 32. In such embodiments, the receiver may be, for example, a gap sub assembly or toroid as previously described. However, unlike the previous embodiments described herein, the receiver will instead receive and decode the signal in order to perform some operation within bottom hole assembly 14. In such embodiments, placement of electrically insulating material 34 around one or more portions of tubular 18 will reduce and/or eliminate current leakage from tubular 18 into casing 20 or the open hole formation, as will be understood by those ordinarily skilled in the art having the benefit of this disclosure.

[0020] Now with reference to the graphs of FIGS. 2A-2C, the signal improvement effects of adding electrically insulating material 34 above and/or below current launching device 16 will be described. The graphs plot the current along tubular 18 and casing 20 along various depths of well 22 wherein various lengths of electrically insulating material 34 have been applied. FIG. 2A is a plot of the current on tubular 18 and casing 20 in a 2,800 foot well with 2,500 feet of drill pipe, 2,500 feet of casing, a 1 inch gap sub assembly, at a depth of 1,400 feet and using 0.25 ohm meter mud. As can be seen, the current very rapidly bleeds off of the pipe into casing 20 in such a way that a significant portion of the current is no longer available as a signal, but instead has been effectively shorted out by casing 20.

[0021] FIG. 2B is a plot of the current on tubular 18 and casing 20 in the same well as FIG. 2A, but with 400 feet of electrically insulating material 34 along bottom hole assembly 14 below the 1 inch gap sub assembly. The mud resistivity is again 0.25 ohm meters. As illustrated, current still quickly bleeds to casing 20 as soon as there is no electrically insulating material 34, but the overall signal level is significantly improved. FIG. 2C is yet another plot of the current along the well, but with 400 feet of insulation above and 400 feet of insulation below a 1 inch gap sub assembly. The mud resistivity is again 0.25 ohm meters. As before, the current quickly leaks to casing 20 where the electrically insulating material 34 ends, but the overall signal level is again improved. Chart 1 below is a summary of these and other signal levels that may be observed at the surface.

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>dBm</th>
<th>R (Ohm m)</th>
<th>Insulation (inches/feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.21972</td>
<td>73.1624</td>
<td>0.25</td>
<td>1&quot;</td>
</tr>
<tr>
<td>0.33617</td>
<td>69.4688</td>
<td>0.25</td>
<td>100 feet below gap</td>
</tr>
<tr>
<td>0.61561</td>
<td>64.2139</td>
<td>0.25</td>
<td>400 feet below gap</td>
</tr>
<tr>
<td>1.3439</td>
<td>57.433</td>
<td>0.25</td>
<td>800 feet centered on gap</td>
</tr>
<tr>
<td>0.36888</td>
<td>69.4505</td>
<td>2.5</td>
<td>1&quot;</td>
</tr>
<tr>
<td>0.43331</td>
<td>67.2641</td>
<td>2.5</td>
<td>100 feet below gap</td>
</tr>
<tr>
<td>0.71538</td>
<td>62.0932</td>
<td>2.5</td>
<td>400 feet below gap</td>
</tr>
<tr>
<td>1.4828</td>
<td>56.5782</td>
<td>2.5</td>
<td>800 feet centered on gap</td>
</tr>
</tbody>
</table>

As shown, the signal level in millivolts appears in the first column, the signal level expressed as decibel millivolts appears in the second column, and a summary of the insulation appears in the fourth column. Although the foregoing examples address embodiments utilizing transmitters, the same types of gains in signal to noise ratio will be present in embodiments utilizing downhole receivers, as will be understood by those ordinarily skilled in the art having the benefit of this disclosure.

[0022] In view of the foregoing, electrically insulating material 34 may be applied to the well string in a variety of ways. For example, electrically insulating material 34 may be applied to one or more portions of the well string as the well string is being made up. In the alternative, one or more portions of the well string may be insulated before the well string is made up. Moreover, exemplary embodiments of the present invention may be utilized in open and cased wells. In cased sections of the well, electrical insulating material 34 reduces or prevents short circuits from current launching device 16 into casing 20. In open sections of the well, electrical insulating material 34 reduces or prevents current leakage from the well string into the formation. Accordingly, the up hole or down hole telemetry range of electromagnetic telemetry system 10 is increased by a distance roughly equal to the length of insulation applied and downhole power requirements are reduced. Therefore, electromagnetic telemetry is efficiently provided while drilling (or performing other operations) with the telemetry transmitter inside and outside the casing.

[0023] In addition, in those embodiments of the present invention utilizing insulating cased wells, the portion of the well string below current launching device 16 (or the receiver) may be insulated. However, in those embodiments utilized along portions of wells that are open to the formation, portions of the well string above current launching device 16 (or the receiver) may be insulated. In the latter embodiment, the length of one or more electrically conductive portions of the formation along the open well may be determined, and the length of electrically insulating material 34 is determined based upon the length of the conductive formation. As understood in the art, the location of the electrically conductive formations may be determined based upon, for example, resistivity logs of other wells near the well under construction, as will be understood by those ordinarily skilled in the art having the benefit of this disclosure. Based upon the logged data, as well as the planned well trajectory and how far the bit will be beyond the conductive formation at a given time.
(in those embodiments utilized in a drill string), those same skilled persons can readily determine the length of electrically conductive material necessary to be applied above current launching device 16 (or the receiver). For example, if the well is a vertical well and the bit run is planned to extend to a depth of 12,000 feet, the electromagnetic transmitter is 200 feet above the drill bit, and a very conductive formation extends from 10,000 to 11,000 feet, then 1,800 feet of electrically insulating material 34 may be positioned above the current launching device 16 so that once current launching device 16 passed the bottom of the conductive formation (i.e., once it was beyond a depth of 11,000 feet), there would always be electrically insulating material 34 between tubular 18 and the formation. Nevertheless, in either embodiment, one or more portions of the well string above and/or below current launching device 16 or the receiver (not shown) may also be insulated.

[0024] An exemplary methodology of the present invention provides a method for utilizing an electromagnetic telemetry system in a downhole well, the method comprising providing a well string comprising one or more tubulars attached to a bottom hole assembly, the bottom hole assembly comprising at least one of an electrical current launching device or a receiver; applying electrically insulating material around one or more portions of the well string; deploying the bottom hole assembly into the well, conducting an electromagnetic telemetry operation using the bottom hole assembly; and utilizing the electrically insulating material to reduce at least one of short circuits from the current launching device to casing or current leakage from the well string into the casing or formation along the well. The conducted electromagnetic telemetry operation may be, for example, transmitting and/or receiving electromagnetic signals along the system. Another method further comprises applying the electrically insulating material around one or more portions of the well string immediately above or below the current launching device or receiver. In another method, applying the electrically insulating material around the one or more portions of the well string comprises wrapping the one or more portions of the well string with one or more sheets of electrically insulating material.

[0025] In yet another, applying the electrically insulating material around the one or more portions of the well string comprises positioning an insulation sleeve around the one or more portions of the well string, the insulation sleeve being comprised of electrically insulating swellable material. In another, applying the electrically insulating material around the one or more portions of the well string comprises applying at least one of: an electrically insulating swellable material; an electrically insulating injection-molded coating; an electrically insulating spray coating; or an electrically insulating anodized layer. In yet another, applying the electrically insulating material around the one or more portions of the well string comprises: determining a length of an electrically conductive portion of the formation along the well; and applying the electrically insulating material based upon the determined length.

[0026] An exemplary embodiment of the present invention provides an electromagnetic telemetry system for use in a downhole well, the system comprising a well string comprising one or more tubulars attached to a bottom hole assembly, the bottom hole assembly comprising at least one of an electrical current launching device or a receiver; and electrically insulating material positioned around one or more portions of the well string to reduce at least one of short circuits from the current launching device to casing; or current leakage from the well string into the casing or formation along the well. In another embodiment, the electrically insulating material is positioned immediately above or below the current launching device or receiver. In yet another, the electrical current launching device is a gap sub assembly or a toroid. In another, the receiver is a gap sub assembly or a toroid. In another, the electrically insulating material is one or more sheets of electrically insulating material. In yet another, the electrically insulating material is an insulation sleeve. In another, the electrically insulating material is at least one of: an electrically insulating swellable material; an electrically insulating injection-molded coating; an electrically insulating spray coating; or an electrically insulating anodized layer.

[0027] Yet another exemplary methodology of the present invention provides a method for utilizing an electromagnetic telemetry system in a downhole well, the method comprising: applying electrically insulating material around one or more portions of a well string comprising at least one of an electrical current launching device or a receiver; deploying the well string into the well; and utilizing the electrically insulating material to reduce at least one of short circuits from the current launching device to casing or current leakage from the well string into the casing formation along the well. Another method further comprises applying the electrically insulating material around one or more portions of the well string immediately above or below the current launching device or receiver. In another, applying the electrically insulating material around the one or more portions of the well string comprises applying at least one of an electrically insulating swellable material; an electrically insulating injection-molded coating; an electrically insulating spray coating; or an electrically insulating anodized layer. In yet another, applying the electrically insulating material around the one or more portions of the well string comprises determining a length of an electrically conductive portion of the formation along the well; and applying the electrically insulating material based upon the determined length.

[0028] The foregoing disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed. Further, spatially relative terms, such as “beneath,” “below,” “lower,” “above,” “upper” and the like, may be used herein for ease of description to describe one element or feature’s relationship to another element(s) or feature(s) as illustrated in the figures. The spatially relative terms are intended to encompass different orientations of the apparatus in use or operation in addition to the orientation depicted in the figures. For example, if the apparatus is turned over, elements described as being “below” or “beneath” other elements or features would then be oriented “above” the other elements or features. Thus, the exemplary term “below” can encompass both an orientation of above and below. The apparatus may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein may likewise be interpreted accordingly.

[0029] Although various embodiments and methodologies have been shown and described, the invention is not limited to such embodiments and methodologies and will be understood to include all modifications and variations as would be apparent to one ordinarily skilled in the art having the benefit of this disclosure. For example, one or more repeaters may also form
part of the telemetry systems described herein and, in such cases, the same inventive principles would be applicable, as will be understood by those same ordinarily skilled persons. Therefore, it should be understood that the invention is not intended to be limited to the particular forms disclosed. Rather, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A method for utilizing an electromagnetic telemetry system in a downhole well, the method comprising:
   - providing a well string comprising one or more tubulars attached to a bottom hole assembly, the bottom hole assembly comprising at least one of an electrical current launching device or a receiver;
   - applying electrically insulating material around one or more portions of the well string;
   - deploying the bottom hole assembly into the well;
   - conducting an electromagnetic telemetry operation using the bottom hole assembly; and
   - utilizing the electrically insulating material to reduce at least one of:
     - short circuits from the current launching device to casing;
     - current leakage from the well string into the casing or formation along the well.

2. A method as defined in claim 1, further comprising applying the electrically insulating material around one or more portions of the well string immediately above or below the current launching device or receiver.

3. A method as defined in claim 1, wherein applying the electrically insulating material around one or more portions of the well string comprises wrapping the one or more portions of the well string with one or more sheets of electrically insulating material.

4. A method as defined in claim 1, wherein applying the electrically insulating material around one or more portions of the well string comprises positioning an insulation sleeve around the one or more portions of the well string, the insulation sleeve being comprised of electrically insulating swellable material.

5. A method as defined in claim 1, wherein applying the electrically insulating material around one or more portions of the well string comprises applying at least one of:
   - an electrically insulating swellable material;
   - an electrically insulating injection-molded coating;
   - an electrically insulating spray coating; or
   - an electrically insulating anodized layer.

6. A method as defined in claim 1, wherein applying the electrically insulating material around one or more portions of the well string comprises:
   - determining a length of an electrically conductive portion of the formation along the well; and
   - applying the electrically insulating material based upon the determined length.

7. An electromagnetic telemetry system for use in a downhole well, the system comprising:
   - a well string comprising one or more tubulars attached to a bottom hole assembly, the bottom hole assembly comprising at least one of an electrical current launching device or a receiver; and
   - electrically insulating material positioned around one or more portions of the well string to reduce at least one of:
     - short circuits from the current launching device to casing;
     - current leakage from the well string into the casing or formation along the well.

8. A system as defined in claim 7, wherein the electrically insulating material is positioned immediately above or below the current launching device or receiver.

9. A system as defined in claim 7, wherein the electromagnetic current launching device is a gap sub assembly or a toroid.

10. A system as defined in claim 7, wherein the receiver is a gap sub assembly or a toroid.

11. A system as defined in claim 7, wherein the electrically insulating material is one or more sheets of electrically insulating material.

12. A system as defined in claim 7, wherein the electrically insulating material is an insulation sleeve.

13. A system as defined in claim 7, wherein the electrically insulating material is at least one of:
   - an electrically insulating swellable material;
   - an electrically insulating injection-molded coating;
   - an electrically insulating spray coating; or
   - an electrically insulating anodized layer.

14. A method for utilizing an electromagnetic telemetry system in a downhole well, the method comprising:
   - applying electrically insulating material around one or more portions of a well string comprising at least one of an electrical current launching device or a receiver;
   - deploying the well string into the well; and
   - utilizing the electrically insulating material to reduce at least one of:
     - short circuits from the current launching device to casing;
     - current leakage from the well string into the casing or formation along the well.

15. A method as defined in claim 14, further comprising applying the electrically insulating material around one or more portions of the well string immediately above or below the current launching device or receiver.

16. A method as defined in claim 14, wherein applying the electrically insulating material around one or more portions of the well string comprises applying at least one of:
   - an electrically insulating swellable material;
   - an electrically insulating injection-molded coating;
   - an electrically insulating spray coating; or
   - an electrically insulating anodized layer.

17. A method as defined in claim 14, wherein applying the electrically insulating material around one or more portions of the well string comprises:
   - determining a length of an electrically conductive portion of the formation along the well; and
   - applying the electrically insulating material based upon the determined length.

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