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TELEMETRY DRILL PIPE WITH RING-CONTROL ELECTRODE MEANS

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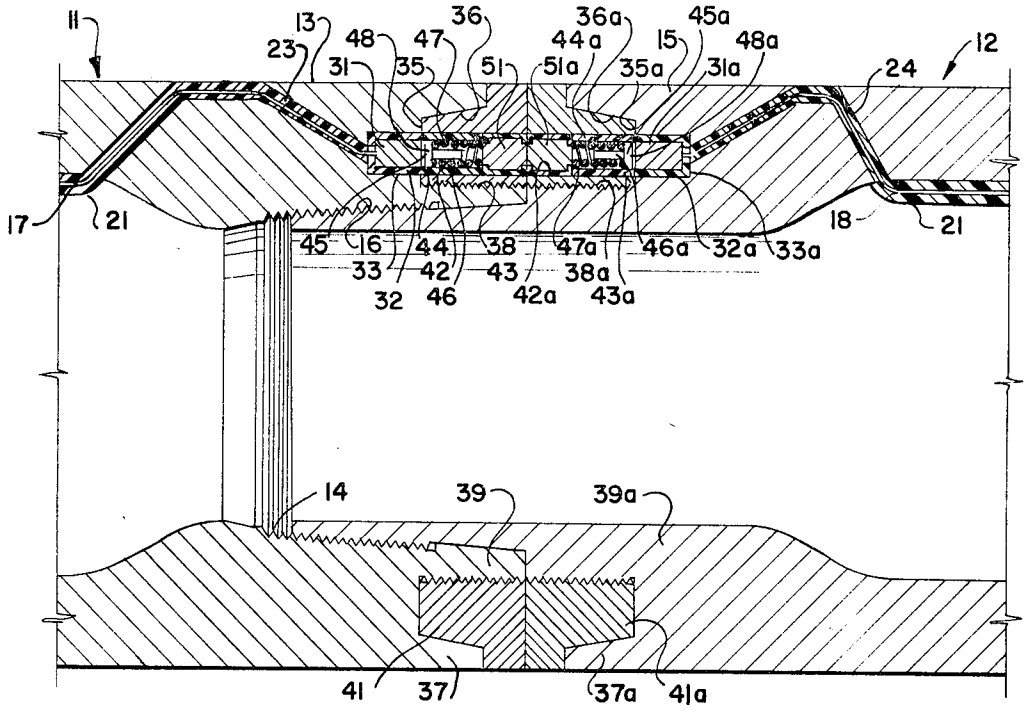

FIG. 1

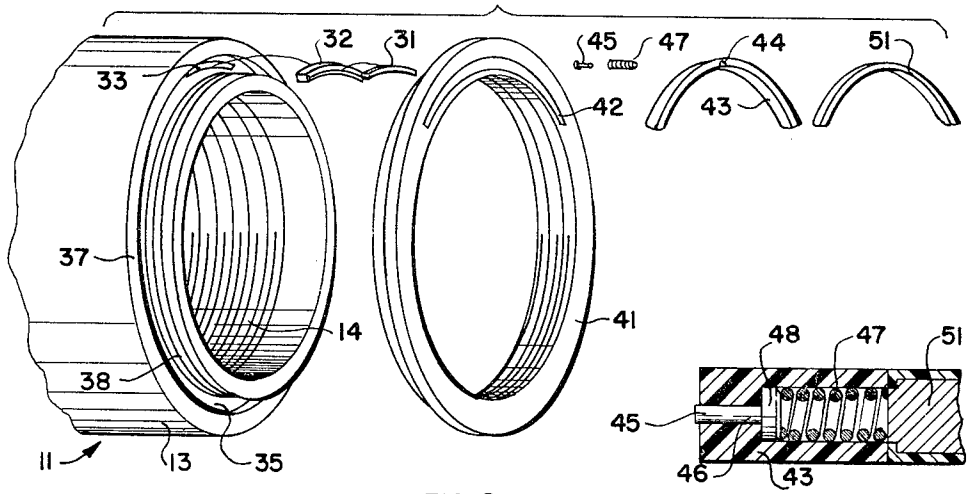

FIG. 2

FIG. 3

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TELEMETRY DRILL PIPE WITH RING-CONTROL ELECTRODE MEANS

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ABSTRACT OF THE DISCLOSURE

Drill pipe is constructed of a plurality of pipe sections attachable to one another in an end-to-end manner by means of cooperating threaded connector means. Each section has associated therewith insulated electrical conductor means running along substantially the full length thereof and operatively associated at each end with electrode means which comprise electrically insulated inserts positioned in operative association with contact rings threadedly engaged to the remainder of the pipe section at the box and pin ends thereof. When the pipe sections are attached together the electrode means of adjacent sections are in cooperative engagement, thereby providing an electrical path along the full length of the drill pipe string.

This invention relates to apparatus for use in drilling oil and gas wells while at the same time being utilized to transmit telemetric data from the hole being drilled. More particularly, the present invention relates to a drill pipe construction which incorporates electrical conductor means and cooperating electrode means to provide an electrical path along the full length of the drill pipe string.

When drilling a bore hole or otherwise carrying out operations with respect to a well through the use of a pipe string, it is often desirable to send or receive electrical signals between the surface and downhole. It is a known practice in the art to incorporate transducer or other devices at selected locations downhole, such as on the drill bit, to detect such operating conditions as drilling pressure, temperature, resistivity, and the like, and relay such information to the surface by means of electrical signals. In addition, it is often desirable to send signals from the surface to a downhole location for various purposes.

Numerous arrangements have been employed in the past for transmitting these electrical signals between downhole and the surface. One approach has been to incorporate in each pipe section an individual electrical conductor, such as an insulated wire or conduit, with some means for electrically connecting the conductors together as the pipe sections are joined during the course of operations. Such arrangements have been characterized by the fact that they are often complex and prone to mechanical failure after repeated usage. In addition, many arrangements of the prior art type require the use of specially designed drill pipe at great cost and expense to the operator.

SUMMARY OF THE INVENTION

It is therefore a primary object of the present invention to provide an improved telemetry apparatus of simple construction which incorporates conventional drill pipe and which is exceedingly rugged in construction whereby it may be used repeatedly without substantially diminishing the effectiveness thereof.

This and other objects have been attained in the present invention by providing a drill pipe constructed of a plurality of conventional pipe sections attachable to one another in an end-to-end manner by means of cooperating threaded connector means. Each pipe section is modified by running lengthwise therealong electrical conductor means which is operatively associated at the terminal ends thereof to electrode means comprising electrically insulated inserts positioned in operative association with contact rings threadedly engaged to the remainder of the pipe section at the box and pin ends thereof. More particularly, at each end of the pipe section an outwardly facing channel is formed in which is positioned in an insulated manner a contact element secured to the end of the conductor means. The contact element is maintained in position by means of a contact ring threadedly fastened at the end of the pipe section and housing therein an outer contact member in electrical communication with the contact element. As adjoining pipe sections are secured together, the outer contact members thereof are placed in engagement, thereby providing an electrical path along the full length of the pipe string.

DESCRIPTION OF THE DRAWING

Other objects, purposes, and characteristic features of the present invention will be obvious from the accompanying drawing and from the following description of the invention. In describing the invention in detail, reference will be made to the accompanying drawing in which the like reference characters designate corresponding parts throughout several views, and in which:

FIG. 1 is a cross-sectional, longitudinal view illustrating the end portions of two adjacent pipe sections according to the present invention in operative engagement with an electrical path being provided therebetween;

FIG. 2 is an exploded view of the female or box end of a pipe section according to the present invention and illustrating the constituent elements associated therewith; and

FIG. 3 is an enlarged cross-sectional view illustrating a portion of an alternative embodiment of the present invention.

Referring now to FIG. 1, two pipe sections incorporating the teachings of the present invention are indicated generally by means of reference numerals **11** and **12**, respectively, with the sections being shown in the relative positions assumed thereby when in operative engagement during drilling or other downhole activities. As is clearly shown in that figure, pipe section **11** has a box or female end **13** provided with internal threads **14** in the conventional manner. Pipe section **12**, on the other hand, has a pin or male end **15** incorporating external threads **16**. The internal and external threads cooperate to releasably maintain the pipe sections **11** and **12** together in an obvious manner. It is of course to be understood that drill pipe sections **11** and **12** are provided at their other ends (not shown) with a pin end and a box end respectively so that the sections may be joined in an end-to-end manner with other pipe sections (not shown) as the entire pipe string is made up in the usual manner.

Running lengthwise along pipe sections **11** and **12** are electrical conductor means comprising copper wires **17** and **18**, respectively. For the majority of the length thereof, copper wires **17** and **18** run within the throughbores of the pipe sections and are maintained in a fixed position relative to the inner peripheral walls thereof by means of an electrically insulating material **21** such as epoxy cement or resin. Insulation material **21** serves to protect wires **17** and **18** from drilling fluid abrasion and/or from possible impact damage from wire-line or other tools which may be utilized during operations.

Drill pipe section **11** is drilled in the vicinity of box end **13** to provide a throughbore **23** through which wire **17** extends. In like manner, a throughbore **24** is provided in pipe section **12** in the vicinity of pin end **15** to accommo-

date wire 18. It should be noted that wires 17 and 18 are substantially centrally disposed in the throughbores in an insulated manner by the same above-described electrically insulating material 21 utilized to bond the wires to the inner peripheral walls of the pipe sections. While the paths of throughbores 23 and 24 may be varied in accordance with the requirements of practice and the exigencies of any given situation, it is of course desirable that the overall strength of the pipe not be compromised. Accordingly, the throughbores should be maintained at a relatively small cross-section and drilled in regions of considerable pipe thickness. The throughbore paths shown in FIG. 1 therefore are merely by way of example and illustrative of paths which may be selected.

Wires 17 and 18 are connected at their respective illustrated ends to contact elements 31 and 31*a* such as by means of solder or other securing means. Contact elements 31 and 31*a* are constructed of any electrically conducting material and each comprises a bent bar segment as shown most clearly in FIG. 2 with respect to contact element 31. Contact elements 31 and 31*a* are housed in insulating pocket elements 32 and 32*a* which are constructed of ethyl cellulose or other similar material. As may be seen most clearly with reference to FIG. 1, insulating pocket elements 32 and 32*a* bound contact elements 31 and 31*a* on three sides thereof with wires 17 and 18 passing through aperture means formed in one of the bounding sides of the pocket elements. Pocket elements 32 and 32*a* are disposed in arc-shaped grooves 33 and 33*a*, respectively, which are formed in box end 18 and pin end 15.

With reference to both FIGS. 1 and 2, it may be seen that arc-shaped grooves 33 and 33*a* are formed in the pipe sections in such a manner that the grooves communicate with open-faced channels 35 and 35*a* also formed in the sections. Open-faced channel 35 is defined on the one side thereof by the sloping wall 36 of box end outer shoulder portion 37 and on the other side thereof by the threaded wall 38 of box end inner shoulder portion 39. Open-faced channel 35*a*, which is disposed at the pin end 15 of pipe section 12, is defined on the one side thereof by the sloping wall 36*a* of pin end outer shoulder portion 37*a* and on the other side thereof by the threaded wall 38*a* of pin end inner shoulder portion 39*a*.

Open-faced channels 35 and 35*a* are adapted to accommodate contact rings 41 and 41*a*, respectively. The contact rings are provided on the inner peripheral surfaces thereof with threads which cooperate with threaded walls 38 and 38*a* so that the rings may be screwed into the positions illustrated in FIG. 1. It should be noted that the external shape of the contact rings substantially conforms to the configuration of the open-faced channels.

The contact rings are provided with arc-shaped passageways 42 and 42*a* which, as may be seen with specific reference to passageway 42 in FIG. 2, form an arc greater in length than arc-shaped grooves 33 and 33*a*. Arc-shaped passageways 42 and 42*a* are positioned in contact rings 41 and 41*a* in such a manner that they will communicate at least partially with arc-shaped grooves 33 and 33*a* when the contact rings 41 and 41*a* are screwed into position within open-faced channels 35 and 35*a*.

Arc-shaped passageways 42 and 42*a* accommodate therein insulation inserts 43 and 43*a*, respectively, which are formed for example of ethyl cellulose material. The insulation inserts are in the form of a solid bar with apertures 44 and 44*a* being formed therein at a substantially centralized location as shown most clearly with respect to insulation insert 43 in FIG. 2. The contact rings 41 and 41*a* and cooperating open-faced channels 35 and 35*a* are so dimensioned that the apertures 44 and 44*a* overlie at least a portion of contact elements 31 and 31*a* when the contact rings are in the position illustrated, i.e. after the rings have been threaded into cooperative engagement with open-faced channels 35 and 35*a*.

Apertures 44 and 44*a* accommodate therein contact pin members 45 and 45*a*, respectively, said pin members being

constructed of an electrically conducting material. The pin members may be surrounded about the shaft portions 46 and 46*a* thereof by means of compression springs 47 and 47*a* with the compression springs engaging enlarged head elements 48 and 48*a* of the contact pin members. The compression springs are constructed of electrically conducting material. Alternatively, the contact pin members may have the respective head elements thereof bearing against the springs as shown, for example, in FIG. 3. In this embodiment, the shaft portion of the pin members pass through apertures formed in the respective insulation inserts, as shown, to engage the associated contact elements 31 and 31*a*, the latter elements not being illustrated in FIG. 3 but shown in FIGS. 1 and 2.

Also disposed within arc-shaped passageways 42 and 42*a* are ring conductor inserts 51 and 51*a* (FIGS. 1 and 2). The ring conductor inserts may be constructed of any electrical conducting material and are situated in the passageways with one side thereof in contact with compression springs 47 and 47*a*. The ring conductor inserts 51 and 51*a* are slidably positioned in arc-shaped passageways 42 and 42*a*. When in the position illustrated in FIG. 1, the ring conductor inserts are thus biased into contact with one another thereby providing an electrical flow path therebetween. As stated above, the ring conductor inserts may be constructed of any suitable electrically conducting material. To provide a better wear resisting surface it may be desirable to coat the abutting surfaces with tungsten carbide. The inner and outer circumferential surfaces of the arc-shaped passageways 42 and 42*a* are coated with a thin layer of epoxy-phenolic material in the vicinity of inserts 51 and 51*a* so that the inserts are electrically insulated from the main bodies of the contact rings 41 and 41*a*.

It may thus be seen that with the above-described arrangement a completed electrical path is provided between wires 17 and 18 when pipe sections 11 and 12 are joined in the manner illustrated. More particularly, an electrical flow path may be traced through wire 17, contact element 31 and thence through the arrangement of contact pin member 45 and compresion spring 47 to ring conductor insert 51. Current then flows from insert 51 to insert 51*a* and thence to the compression spring 47*a*, contact pin member 45 and compression spring 47 to ring conductor

While this invention has been described with particular reference to preferred embodiments thereof, it should be understood that the particular form disclosed has been selected to facilitate explanation of the invention rather than to limit the number of forms which it may assume. Further, it should be understood that various modifications, alterations and adaptations may be applied to the specific form described to meet the requirements of practice without in any manner departing from the spirit of the invention or the scope of the subjoined claims.

I claim as my invention:

1. Apparatus for transmitting electrical signals along a drill string disposed in a well borehole, said apparatus comprising:

a plurality of drill pipe sections, each having a box end and a pin end, said sections being adapted to be detachably interconnected in an end-to-end manner, each pipe section including:

an inner wall defining a throughbore;

electrical conductor means extending within said throughbore substantially along the length of said inner wall;

electrically insulating material bonding said electrical conductor means to said inner wall;

electrical contact means disposed at the box end and the pin end of the pipe section with the ends of the electrical conductor being connected to the contact means;

contact ring means releasably secured to the box end and the pin end of the pipe section;

electrically conductive ring conductor insert means operatively associated with said contact ring means and adapted to be placed in communication with ring conductor insert means of an adjoining pipe section; and

means adapted to complete an electrical flow path between said electrical contact means and said ring conductor insert means when said contact ring means are releasably secured at the box end and the pin end of said pipe section.

2. The apparatus according to claim **1** wherein said contact means are disposed in groove means at the box end and the pin end of said pipe section, said contact means being maintained in an insulated manner from the rest of said pipe section by insulation means.

3. The apparatus according to claim **2** wherein said insulation means is ethyl cellulose material.

4. The apparatus according to claim **1** wherein said means adapted to complete an electrical flow path between said electrical contact means and said ring conductor insert means includes spring biasing means constructed of electrically conductive material, said spring biasing means at one end thereof being yieldably maintained against an electrically conducting pin contacting said electrical contact means and at the other end thereof being yieldably maintained against said ring conductor insert means.

5. The apparatus according to claim **1** wherein said ring conductor insert means is slidably positioned in an arc-shaped passageway formed in said contact ring means.

6. The apparatus according to claim **5** wherein a portion of the outer surface of the ring conductor insert means is coated with tungsten carbide.

7. The apparatus according to claim **5** wherein a portion of the ring conductor insert means is coated with epoxy-phenolic material.

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