

[54] **TELEMETERING DRILL STRING WITH SELF-CLEANING CONNECTORS** 2,748,358 5/1956 Johnston.....340/18 LD

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[51] **Int. Cl.**G01v 1/16

[58] **Field of Search**73/151; 175/104; 340/18 LD

[56] **References Cited**

UNITED STATES PATENTS

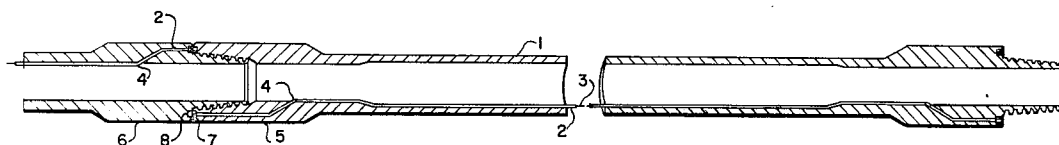
2,096,359 10/1951 Hawthorn.....340/18 LD

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[57] **ABSTRACT**

A telemetering drill string in which segments of an insulated electrical conductor are joined by connectors in the pipe joints is improved by electrical connectors having generally ring-shaped contact-making surfaces which are wiped together as the pipe joints are interconnected. A process of telemetering while drilling in a deep borehole is improved by installing a wire line telemetering system between the drill bit and a section of the above type of segmented electrical conductor-containing telemetering drill string.

4 Claims, 5 Drawing Figures



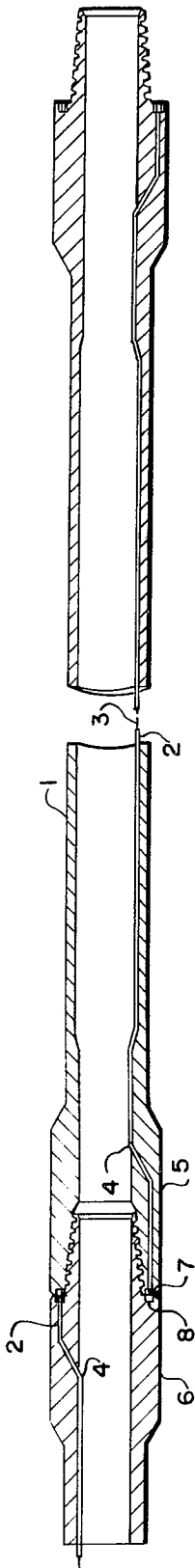


FIG. 1

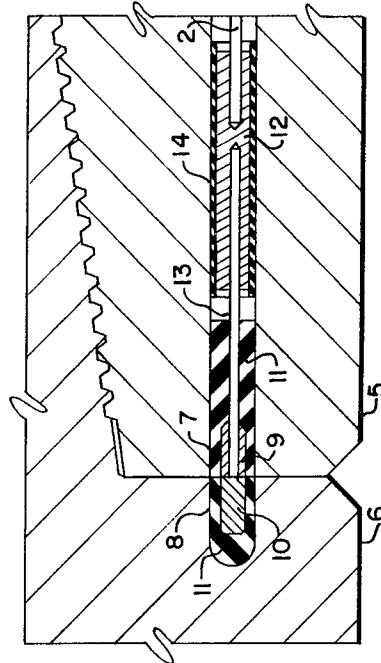


FIG. 2

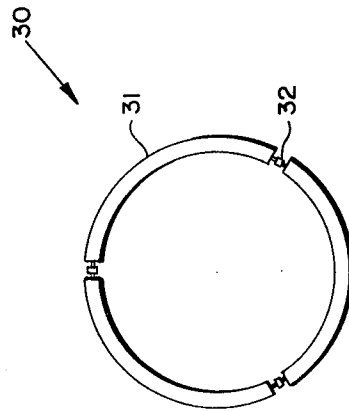


FIG. 5

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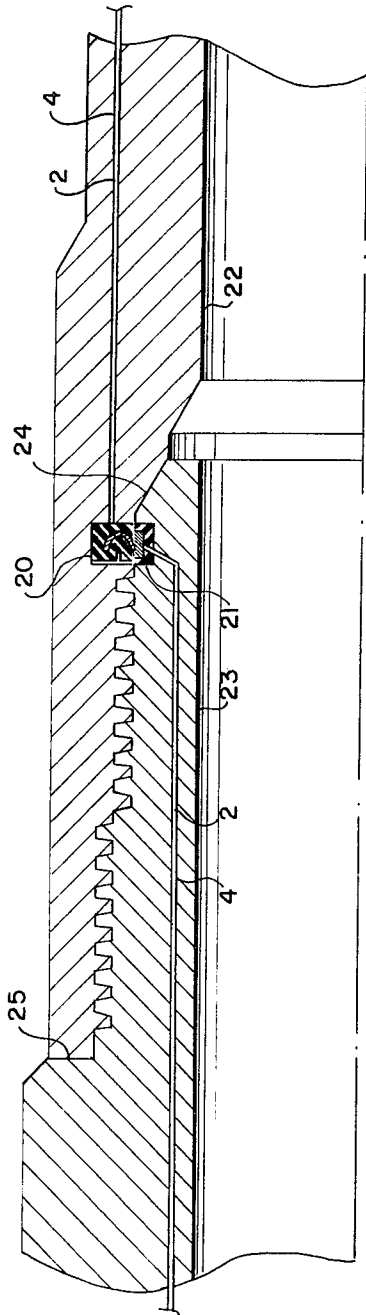


FIG. 3

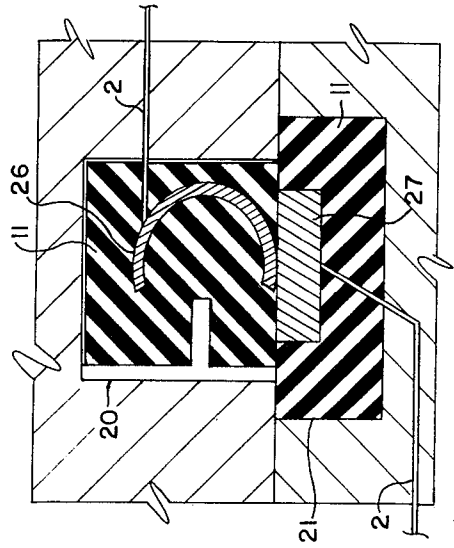


FIG. 4

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TELEMETERING DRILL STRING WITH SELF-CLEANING CONNECTORS

BACKGROUND OF THE INVENTION

This invention relates to transmitting an electrical signal along a drill string while it is in the borehole of a well. More particularly, the invention relates to an information telemetering drill string which can be assembled and used without special drill string manufacturing and/or drilling techniques or precautions.

The desirability of transmitting an electrical signal along a drill string was recognized over 30 years ago. Numerous systems have been proposed. Typical earlier proposals required specially constructed drill pipe sections, such as those described in U.S. Pat. No. 2,178,931, or required internally mounted electrical connector arrangements that cause a significant reduction in the internal diameter of the drill pipe, such as those described in U.S. Pat. No. 2,301,783 or 3,253,245.

U.S. Pat. No. 2,531,120 describes a system for transmitting electrical power along a drill string to drive an electrical drilling motor. It uses ring and contact-pin electrical connectors that are mounted within mating portions of the pipe joints and avoids the need for specially constructed drill pipe sections or restrictions of drilling fluid passageway. But, the ring and contact-pin arrangement is disadvantageous with respect to transmitting an electrical information signal. In an information signal connector-introduced noise may mask the information or provide misleading information.

In the procedures that are usually employed for assembling and disassembling or "round tripping" a drill string, the mating portions of the pipe joints become coated with fluids having various degrees of electrical conductivity. Any electrical connectors which are mounted in such portions of the pipe joints are almost inevitably smeared with various nonconductive fluids such as oils, greases, pipe thread lubricants, or the like. An information-conveying electrical signal tends to become noisy and relatively severely attenuated when it is conveyed across a plurality of pipe joints containing electrical connectors in which the contacting elements are rings and contact-pins. In such a situation each metal-to-metal contact area is relatively small and the effective contact resistance tends to vary widely due to the presence of differing amounts of nonconductive fluids that tend to remain between the contact-pins and rings.

The contacting faces of the pins and rings tend to become smooth and flat. Any minute particle between such metal surfaces tends to have a large effect on the conductivity across the metal-to-metal junction.

SUMMARY OF THE INVENTION

This invention provides an improved telemetering drill string of a type in which segments of an insulated electrical conductor are joined by electrical connectors located in mating portions of the drill string pipe joints. In the improved drill string each electrical connector contains a generally ring-shaped and substantially full-circle contact-making conductive metal portion that is: located in an annular groove within a pipe joint element; electrically insulated from the groove walls; and is electrically connected to a segment of the insulated electrical conductor. At least one member of each pair

of mating contact-making rings is mounted adjacent to a resilient biasing means that is arranged to urge the contact-making ring toward a position from which it is displaced, with a wiping action, by the mating contact-making ring, as the elements of the pipe joint are screwed together.

DESCRIPTION OF THE DRAWING

FIG. 1 is a cross-sectional illustration of a portion of an assembled telemetering drill string of the invention.

FIG. 2 is an enlargement of the broken line-encircled portion of FIG. 1.

FIG. 3 is a cross-sectional illustration of an alternative drill string pipe joint arrangement.

FIG. 4 is an enlargement of the broken line-encircled portion of FIG. 3.

FIG. 5 illustrates an alternative type of electrically conductive ring-shaped contact-making element for use in the present invention.

DESCRIPTION OF THE INVENTION

As shown in FIG. 1, the present invention relates to a drill string composed of pipe sections 1 that contain a segmented electrical conductor 2. Within the conductor 2 a conductive wire 3 is surrounded by an electrical insulating material. The electrical conductor is extended along the interior of each pipe section 1 and run through holes 4 in the box 5 and pin 6 elements of the pipe joint-forming portions of each pipe section. Annular grooves 7 and 8 are formed within mating portions of the box and pin elements.

In the embodiment shown in FIGS. 1 and 2, solid annular metal contact-making rings 9 and 10 are disposed within the grooves 7 and 8 and insulated from the groove walls by rubber or other resilient insulating material 11. The segments of the insulated electrical conductor 2 are connected to the contact-making rings by means such as the connector 12, pin 13 and insulating sleeve 14, as shown with respect to contact making ring 9 in FIG. 2.

The dimensions and properties of the contact-making rings 9 and 10 and associated resilient insulating material 11 are adjusted so that at least one of the rings is resiliently urged toward a position from which it is displaced, with a wiping action, by the mating contact-making ring as the box and pin elements of the adjoining pipe sections are screwed together. For example, ring 9 is mounted so that the surrounding resilient insulating material 11 displaces it at least several thousandths of an inch beyond the end face of box 5 when the pin 6 is removed from the box 5.

In a telemetering operation the upper and lower ends of the segmented electrical conductor 2 are electrically connected to, respectively, a downhole measuring unit and a surface located means (not shown) for obtaining and utilizing an electrical signal. Suitable devices and techniques for conducting such operations are known to those skilled in the art.

FIG. 3 illustrates a pipe joint arrangement of a type, such as a Hydril tool joint arrangement which contains a multiplicity of sealing shoulders. In this embodiment, annular grooves 20 and 21 are formed within mating portions of the box and pin elements 22 and 23 that are disposed between the sealing shoulder portions 24 and 25 of the tool joint. Groove 20 in box 22 contains a

resilient, conductive, contact-making ring 26 which is insulated from the groove walls by resilient insulating material 11 and is connected to a segment of the insulated electrical conductor 2. Groove 21 in pin 23 contains a solid annular conductive metal contact-making ring 27 which is similarly insulated by material 11 and connected to a segment of the insulated electrical conductor 2.

In the embodiment shown in FIGS. 3 and 4, the contact-making ring 26 is arranged so that it expands radially inward when freed of contact with contact-making ring 27 by the removal of the pin element 23 from the box element 22. As the box and pin elements are screwed together the outer surfaces of the contact-making rings are wiped together. The sealing of the pipe joint sealing shoulders 24 and 25 isolates the contact-making elements from fluids inside or outside the drill pipe.

FIG. 5 illustrates an alternative arrangement for an electrically conductive contact-making ring 30 which can be used in place of, for example, the contact-making ring 27, shown in FIG. 4. Contact-making ring 30 comprises arcuate conductive metal sections 31 and interconnecting flexible conductive metal sections 32 which combine to form a substantially full-circle generally ring-shaped structure that is adapted to collapse and expand along a radial direction. Such a radially flexible contact-making ring structure is advantageous in allowing both members of a pair of mating contact-making rings to be radially urged toward positions from which they are each displaced with a wiping action when the box and pin elements of a pipe joint are screwed together.

In a preferred arrangement, the contact-making surfaces of one member of each pair of mating contact-making rings, such as the rings 9 and 10 in FIG. 2, is roughened by means of grooves or knurls and the mating surface of the other contact-making ring is made generally smooth and flat. Such an arrangement tends to increase the extent of effective metal-to-metal contact area between the rings while they are resiliently pressed together within the assembled tool joint. As the tool joint elements are screwed together the mating contact-making rings are wiped together and the valleys between the ridges of the grooves or knurls provides space that can accept the pipe dope or other contaminate that is being wiped away by the rubbing together of the metal surfaces.

The insulating material which isolates the contact-making portions from the walls of the grooves in the pipe joint elements can be substantially any type of electrical insulating material which is resistant to the temperatures and fluids that are normally encountered in the drilling of a well. Where desirable, for example where the insulating material is not significantly resilient, at least one resilient member such as a spring is preferably arranged to urge at least one member of each pair of mating contact-making rings into a position from which it is displaced when the pipe joint is connected. Particularly suitable insulating materials are resilient materials such as rubber, especially a silicone rubber-like resin, plastic or the like materials.

In telemetering while drilling into a deep zone within the earth, the present type of telemetering drill string can advantageously be used in conjunction with a wire

line system for obtaining and transmitting downhole measurement information. The wire line system is installed within a section of drill string with its upper end connected to a pipe joint electrical connector of a segmented electrical conductor containing telemetering drill string. The composite assembly is used for telemetering information while drilling into the deep zone with sections of the telemetering drill string being added as required in order to increase the depth of the borehole. In this process the running-in of the wire line system is required only once during each round tripping of the drill string, for example when it is desirable to change the drill bit. In addition, the number of sections of segmented electrical conductor containing telemetering drill string that is needed is only the number required to extend along the distance by which the borehole is advanced between the round trips. This advantageously avoids both (a) the time required to install a wire line system each time an additional stand of drill pipe is added and (b) the expense of stocking and maintaining sufficient segments of electrical conductor-containing telemetering drill string to reach the total depth to which a borehole is to be drilled.

The wire line portion of such a composite system can be either partially or totally retrievable by means of the wire line. In a totally retrievable system the wire line is electrically connected to a measuring instrument package that can be lowered into and remotely latched to or unlatched from a position within the drill collar or near the bit end of the drill string. In a partially retrievable system, at least part of the instrument package is adapted to stay within the drill string when the wire line and/or some of the instrumentation is removed by withdrawing the wire line. Such systems are known to those skilled in the art and substantially any type can be used in the present invention.

What is claimed is:

1. In a telemetering drill string in which segments of an insulated electrical conductor are joined by electrical connectors in mating portions of drill string pipe joints that contain mating sealing shoulders, an improvement in the arrangement of electrical connectors which comprises:

in each electrical connector, a generally ring-shaped substantially full-circle contact-making ring of conductive metal that is mounted within an annular groove in a pipe joint element, is electrically insulated from the wall of the groove, and is electrically connected to a segment of said insulated electrical conductor;

within each assembled pipe joint, at least one resilient biasing means operatively associated with at least one of said contact-making rings to urge the ring toward a position from which it is displaced with a wiping action by the adjacent contact-making ring as the pipe joint elements are screwed together; and,

a location of said grooves and contact-making rings in said drill string pipe joints between the innermost and outermost portions of the mating sealing shoulders such that said grooves and rings are located beyond the inner diameter of the drill string and are isolated from the fluid in and around the drill string by the metal to metal joining of said innermost and outermost portions of the mating sealing shoulders.

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2. The system of claim 1 in which, within each pair of said contact-making rings, the contact-making surface of one ring is substantially flat and smooth while the contact-making surface of the other ring is roughened to provide wiping contours for wiping the flat surface of the mating contact-making ring.

3. In a process for drilling into a relatively deep zone and telemetering downhole measurement information along a drill string within a borehole, the improvement which comprises:

extending a drill string within a borehole to a selected relatively deep depth;

installing a system for obtaining downhole measurement information and transmitting it along an extended continuous length of wire line within said drill string and connecting the wire line to a pipe joint electrical connector of a segmented electrical conductor-containing telemetering drill string; and,

adding additional drill string sections of said segmented electrical conductor-containing telemetering drill string as required in order to drill into and telemeter downhole measurement information

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from said deep zone.

4. In a process for drilling into a relatively deep zone and telemetering downhole measurement information along a drill string within a borehole, the improvement which comprises:

extending a drill string containing a measuring device near the drill bit within the borehole to a selected relatively deep depth;

inserting a wire line measurement information telemetering means having an extended continuous length of wire line into said drill string;

connecting said wire line telemetering means with the lower end being connected remotely to said measuring device and the upper end being connected to a pipe joint electrical connector of a segmented electrical conductor-containing telemetering drill string; and

adding additional drill string sections of said segmented electrical conductor-containing telemetering drill string as required in order to drill into and telemeter downhole measurement information from said deep zone.

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