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METHOD AND APPARATUS FOR INSULATING A DRILL STEM IN  
CONTINUOUS EXPLORATION OF A BORE HOLE  
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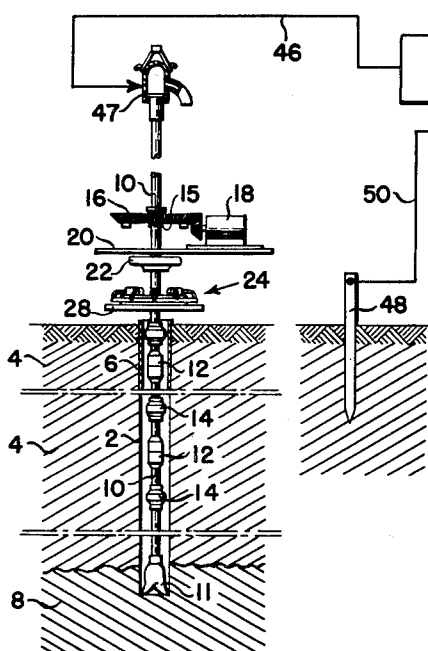


FIG. 1.

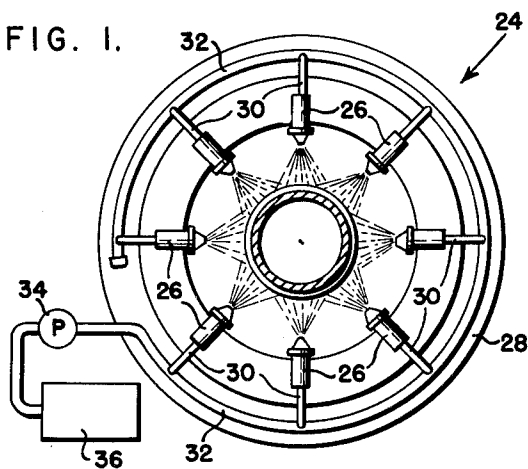


FIG. 3.

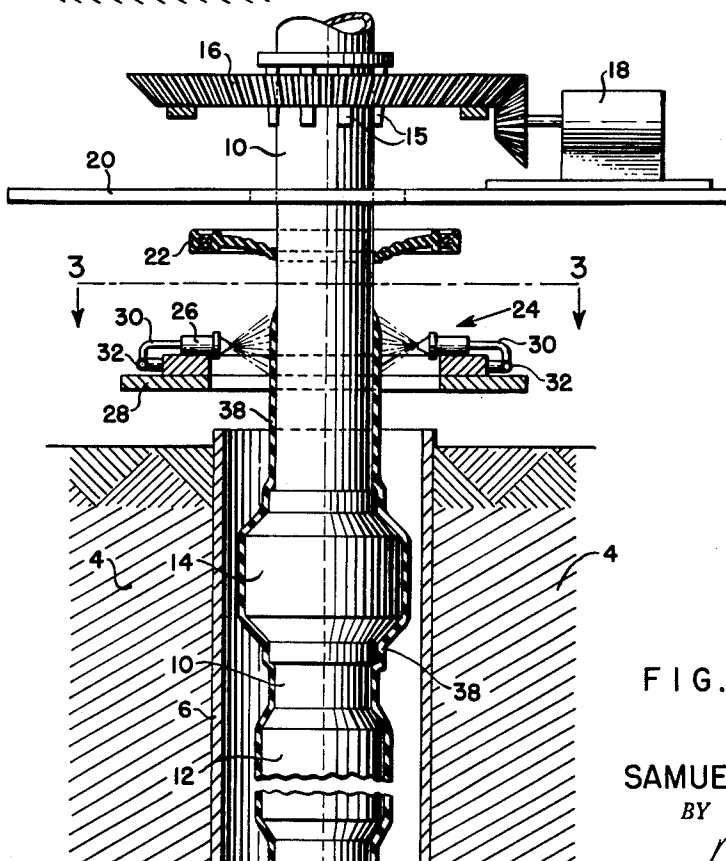


FIG. 2.

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## METHOD AND APPARATUS FOR INSULATING A DRILL STEM IN CONTINUOUS EXPLORATION OF A BORE HOLE

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8 Claims. (Cl. 255—1.8)

This invention relates to a method and apparatus for insulating a drill stem to permit the use of the drill stem in a bore hole as an insulated conductor for electric current used in making measurements to determine the characteristics of the strata encountered by a drill bit in the bore hole.

It has long been considered desirable to determine characteristics of the strata encountered by a drill bit in a bore hole as the drilling is done. The simplest way of accomplishing this end would be to pass a current through the drill bit into the earth in such fashion that the local resistance about the bit could be measured. Leading the current to the bit, however, presented a problem inasmuch as, if the drill stem was part of the current circuit, there would be loss of current all along the drill stem which would constitute an extensive short circuit with the wall of the hole.

Various devices have, therefore, been proposed for providing an insulated conductor extending downwardly through the drill stem. Such devices include coupling means attached to the ends of the conductors extending through the drill stem sections, which coupling means required coupling or uncoupling as the drill stem sections were assembled or disassembled on inserting the drill stem into the hole or removing the drill stem therefrom. The arrangements require special drill stem sections with consequent considerable expense.

It has been proposed to provide insulated sleeves permanently affixed to the drill stem accompanied by the use of insulated couplings for the drill stem sections. This approach has also proven to be impractical in that the abrasive effect of the walls of the bore hole upon the insulating coating in the bore hole is such that the insulating coating is worn away after a short period of use, thus necessitating the use of a great many sections of pipe as replacements in order that the insulating coating on the drill stem be maintained during the drilling of a well. It will be apparent that the problem of delivery of the pipe required in the drilling of a well to the location where the well is being drilled is frequently a very difficult problem, and once sufficient pipe has been delivered to that location, it is highly undesirable to replace that pipe frequently with other pipe during the drilling operation.

It is an object of the present invention to provide for substantially continuous exploration of a bore hole as the bore hole is drilled.

It is another object of the present invention to provide a method of providing an insulating coating on the exterior of the drill stem which will last for a sufficient period of time to permit accurate measurements to be made indicating the nature of the strata encountered by the drill bit.

It is a further object of the present invention to provide for the replacement of the insulating coating on the drill stem each time the drill stem is lowered into the bore hole.

These and other objects of the invention will become apparent from the following description when read in conjunction with the accompanying drawing, in which:

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Figure 1 is a diagrammatic showing of apparatus embodying the present invention;

Figure 2 is an enlarged showing of the portion of the apparatus shown in Figure 1 adjacent to the surface of the earth involved in applying the insulating coating to the drill stem; and

Figure 3 is a plan view taken on the plane 3—3 shown in Figure 2.

Referring to the figures there is shown a bore hole 2 extending into the earth 4, the upper portion of the bore hole wall being supported by casing 6 and the lower portion of the bore hole terminating in a strata 8. Extending within the bore hole is a drill stem 10 having couplings 12 between its various sections and being provided with insulating pipe protectors 14. The drill bit 11 is affixed to the lower end of the drill stem.

The pipe protectors are heavy collars of rubber, rubber bonded on other suitable wear resistant material which may be slipped over the ends of the drill stem section and are of greater diameter than the couplings between successive drill pipe lengths. The protectors are preferably positioned relatively close to the couplings to protect the couplings from abrasive contact with the wall of the bore hole. Additional protectors may be provided between successive couplings if desired.

The drill stem is supported by slips 15 mounted within a gear 16 which is driven by a motor 18 and is supported on a gear mounting table 20. The supporting framework for the table 20 is not shown to avoid unduly complicating the drawing. The structure of the slips, the gear and the gear driving means is entirely conventional and, being well known in the art, is not described in detail herein.

In accordance with my invention however, the gear mounting table 20 is mounted a sufficient distance above the surface of the earth to permit the installation of a pipe wiper 22 and the assembly of spray nozzles shown generally at 24 between the table 20 and the surface of the earth.

The pipe wiper 22 is provided to clean the outer surface of the drill stem as the drill stem sections are lowered into the bore hole. Pipe wipers are generally made of rubber or other suitable rubber material and by squeezing action remove water, grease, dirt, etc. from the wall of the pipe passing therethrough. The pipe wiper may be supported by a suitable frame work, not shown, which may be mounted, for example, on either the underside of the table 20 or mounted above the spray nozzle base plate 28. It will be apparent that brush scrubbers or degreasing solvent applicators may additionally be employed in order to further clean the surface of the pipe if they should be required.

There is shown generally at 24 an arrangement of spray nozzles 26 which are mounted on the base plate 28. The base plate is supported, by suitable supporting means not shown, in a position below the slips and the pipe wiper. The spray nozzles 26 are connected by means of the pipe lines 30 to the supply line 32. The pump 34 delivers to the supply line 32 liquid material from the reservoir 36. The nozzles are arranged so that their spray patterns overlap to provide complete coverage of the drill stem with the insulating material. This liquid material may be a rubber composition carried by a suitable solvent, a synthetic plastic material carried by a suitable solvent, a molten plastic material or other liquid which may be sprayed upon the drill stem and which, when sprayed thereupon, will dry quickly and form a wear resistant insulating coating thereon. It will be apparent that a great variety of types of spray nozzles may be employed in place of those disclosed herein. It will also be apparent that brushes or rollers could be substituted for the spray nozzles disclosed herein for applying the insulating coating to the drill stem.

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Thus, as the drill stem is lowered into the bore hole, the various sections of pipe as they are assembled and successively lowered into the bore hole are coated with an insulation material. The pipe protectors 14 are of greater diameter than the drill stem 10 or the pipe couplings 12 and thus, most of the abrasive contact between the drill stem and the wall of the bore hole will occur on the surface of the insulating pipe protectors. The amount of abrasion which occurs between the wall of the bore hole or the fluid in the bore hole and the drill stem between successive pipe protectors is not sufficient to destroy the insulating coating before a considerable amount of drilling has been accomplished. Thus there is provided an expendable insulating coating which is replaced each time the drill stem is rebuilt and lowered into the bore hole after having been removed therefrom.

Referring to Figure 1 there is shown in diagrammatic form the electrical circuit employed in connection with the present invention. This circuit includes a suitable source of current 40 which is connected by means of conductor 42 to suitable measuring and recording apparatus 44 as will be hereinafter described. The measuring and recording apparatus is connected by conductor 46 to the drill stem through a suitable swivel connection 47 at the top of the drill stem 10. The current passes from the current source 40 through the measuring and recording apparatus 44 and the drill stem 10 into the strata 8 engaged by the drill bit 11, back through the earth 4 to the grounding electrode 48, and through the conductor 50 to the current source.

The current source may be a battery, generator, or other suitable current source depending upon the type of current flow (direct, low frequency alternating or high frequency alternating) desired. The measuring and recording apparatus may be adapted to measure current flow, and may vary in type depending upon the particular type of exploration measurement employed. There are a great variety of measuring arrangements well known in the art. Alternatively, the drill stem could be used as a conductor for high frequency currents generated at the lower end of the drill stem by a current source which has been lowered into the drill stem. In general, the drill stem forms an insulated conductor which may conduct current to or from the surface of the earth to the bit or the vicinity thereof.

It will be apparent that various modifications may be made in the embodiment of the invention disclosed herein, and that a variety of electrical measuring apparatus may be employed with the present invention without departing from the scope of the invention as set forth in the following claims.

What is claimed is:

1. The method of exploring a bore hole during drilling thereof comprising lowering a rotatable drill stem into the bore hole, said drill stem having a drill bit attached to the lower end thereof, applying an insulating coating to the outer surface of the drill stem as it is lowered into the bore hole, and employing the insulated drill stem in the measurement of an electrical condition existing in the vicinity of the drill bit.

2. The method of exploring a bore hole during drilling thereof comprising a rotatable drill stem into the bore hole, said drill stem having a drill bit attached to the lower end thereof, applying an insulating coating to the outer surface of the drill stem as it is lowered into the bore hole, and providing for a flow of current through the drill stem and between the drill stem and earth strata in the vicinity of the drill bit to determine characteristics of the earth strata, the current being prevented from passing between the drill stem and surrounding earth

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strata other than those in the vicinity of the drill bit by the insulating coating on the drill stem.

3. The method of exploring a bore hole during drilling thereof comprising lowering a rotatable drill stem into the bore hole, said drill stem having a drill bit attached to the lower end thereof, cleaning the outer surface of the drill stem, applying an insulating coating to the outer surface of the drill stem as it is lowered into the bore hole, and employing the insulated drill stem in the measurement of an electrical condition existing in the vicinity of the drill bit.

4. The method of exploring a bore hole during drilling thereof comprising lowering a rotatable drill stem into the bore hole, said drill stem having a drill bit attached to the lower end thereof, mounting insulating pipe protectors on the drill stem, applying an insulating coating to the outer surface of the drill stem as it is lowered into the bore hole, and employing the insulating drill stem in the measurement of an electrical condition existing in the vicinity of the drill bit.

5. Apparatus for exploring a bore hole during drilling thereof comprising a rotatable drill stem, a drill bit attached to the drill stem, means for lowering the drill stem into the bore hole, means for applying an insulating coating to the drill stem as it is lowered into the bore hole, and means including the insulated drill stem for measuring an electrical condition existing in the vicinity of the drill bit.

6. Apparatus for exploring a bore hole during drilling thereof comprising a rotatable drill stem, a drill bit attached to the drill stem, means for lowering the drill stem into the bore hole, means for applying an insulating coating to the drill stem as it is lowered into the bore hole, and means providing for a flow of current through the drill stem and between the drill stem and earth strata in the vicinity of the drill bit and for determining characteristics of the earth strata, the current being prevented from passing between the drill stem and surrounding earth strata other than those in the vicinity of the drill bit by the insulating coating on the drill stem.

7. Apparatus for exploring a bore hole during drilling thereof comprising a rotatable drill stem, a drill bit attached to the drill stem, means for lowering the drill stem into the bore hole, means for cleaning the drill stem as it is lowered into the bore hole, means for applying an insulating coating to the drill stem as it is lowered into the bore hole, and means including the insulated drill stem for measuring an electrical condition existing in the vicinity of the drill bit.

8. Apparatus for exploring a bore hole during drilling thereof comprising a rotatable drill stem, a drill bit attached to the drill stem, means for lowering the drill stem into the bore hole, insulating means mounted at intervals along the drill stem for spacing the drill stem away from the wall of the bore hole, means for applying an insulating coating to the drill stem as it is lowered into the bore hole, and means including the insulated drill stem for measuring an electrical condition existing in the vicinity of the drill bit.

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