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B. W. SEWELL

2,569,390

WELL LOGGING

Filed Aug. 20, 1946

2 Sheets-Sheet 1

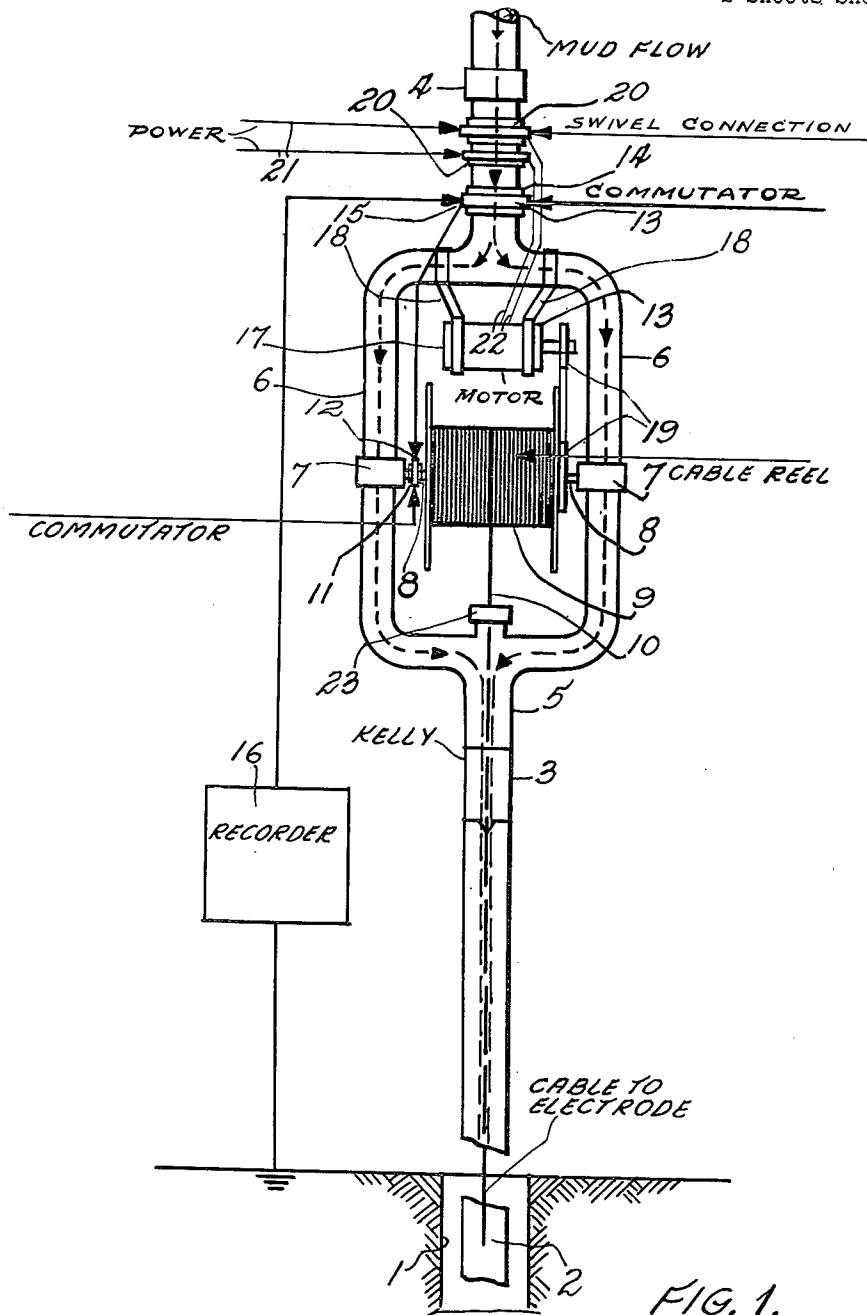


FIG. 1.

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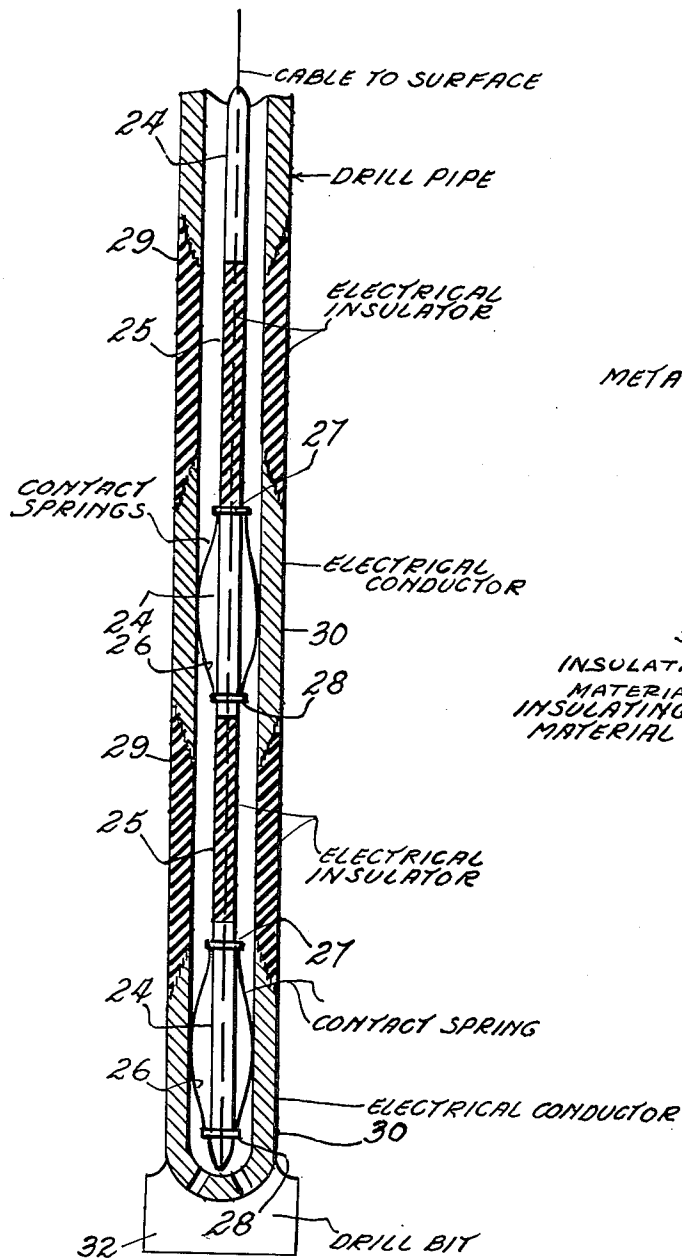


FIG. 2.

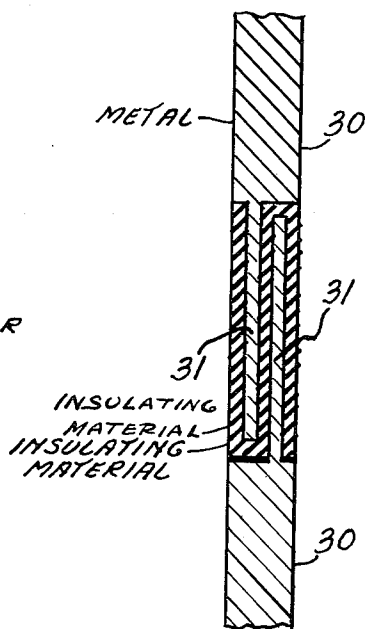


FIG. 3.

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## UNITED STATES PATENT OFFICE

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## WELL LOGGING

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3 Claims. (Cl. 255—1)

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The present invention is directed to a method and apparatus for logging wells while drilling.

The principal object of the present invention is the provision of an apparatus and method for logging wells while drilling.

An additional object of the present invention is to provide in an apparatus of the aforesaid type an arrangement whereby electrical conductors may be lowered in the drill stem without twisting due to rotation of the drill stem.

A further object is to provide in an apparatus of the aforesaid type novel means for making contact between an isolated conductive section near the drill bit and a conductor lowered through the drill stem so as to utilize said section as an electrode.

Another object of the present invention is the provision of a method and apparatus of the aforesaid type with which any type of logging requiring the use of electrical conductors, such as conductivity measurements or radioactivity measurements or the like, may be carried out during drilling.

Still another object of the present invention is the provision of a novel means and method type in which the probing means may be housed in the kelly of a drill stem during drilling and used intermittently, as desired, for logging purposes.

Yet another object of the present invention is the provision of a novel means and method for taking a signal off a conductor carried inside a rotating drill stem.

Other objects and advantages of the present invention will appear from the accompanying drawing in which,

Fig. 1 is a front elevation of the upper part of a drill stem embodying part of the apparatus of the present invention;

Fig. 2 is a vertical section through the lower portion of the same drill stem embodying the remainder of the apparatus of the present invention; and

Fig. 3 is a vertical section showing a modified wall construction for the lower part of the drill stem.

Referring to the drawing in detail, numeral 1 designates a bore hole in which is arranged a drill stem 2, the upper end of which is connected in the usual manner to a key 3. Between the kelly and the swivel joint 4 is arranged a conduit 5 having separated arms 6 which, in the embodiment shown, assume the form of a rectangle, the conduit 5 being connected at its upper

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end to the swivel and at its lower end to the kelly.

Suitably fixed to each of the arms 6 at a mid point thereof is a bearing 7 in which is journaled the shaft 8 of a reel 9 on which is wound a cable 10 carrying one or more conductors. The inner end of each conductor is connected in the usual manner with a slip ring 11 fixed to the shaft 8 on which is carried the usual spring contact member 12 electrically connected to another slip ring or commutator 13 mounted on the upper end of conduit 5 and suitably insulated therefrom by an insulating sleeve 14 mounted thereon. To frictionally engage slip ring 13 is a second spring contact 15 connected to recorder 16 which, as is common in well-logging equipment, contains a source of power to supply the probes or electrodes.

The reel 9 is driven by a motor 17 rigidly suspended from the arms 6 by suitable brackets 18 so as to rotate with the arms as a unit and geared to shaft 8 by a suitable gearing 19. To supply power to the motor, the upper end of conduit 5 carries suitable slip rings or commutators 20 connected to a source of power by leads 21 and to the motor by leads 22.

The cable 10 passes through a packing gland 23 arranged on the bottom connecting piece of the arms 6 centrally with respect to the conduit 5. Above the swivel 4 is the usual connection with a mud hose, not shown. The mud enters the upper part of the conduit 5, passes through the arms 6, the lower part of the conduit 5, and the kelly 3, into the drill stem 2. Leakage of mud or drilling fluid to the outside around the cable is prevented by suitable packing. Suspended from the cable is an electrode assembly composed of alternate sections of metal tubing 24 and tubing of insulated material, such as Bakelite 25. In the embodiment shown, the sheath of the cable is anchored in the upper metal section 24 in the manner well known in devices of this type. Each of the other metal sections 24 constitutes an electrode. Mounted on each electrode is an assembly of spring arms 26 having their ends connected to suitable collars 27 and 28. One of these collars is fixed to the tube 24 and the other is slidable thereon. Where two electrodes are employed and two conductors, each of the conductors is connected to the interior of one of the tubular members 24 so as to provide electrical contact between said tubular member and the recording apparatus at the surface as well as with the source of power at the surface.

The lower end of the drill stem is likewise made up of conductive and insulating sections corresponding in number and spacing to those on the electrode assembly. In the embodiment shown, there are two insulating sections 29 and two conductive sections 30, the lower one of which carries the drill bit 32. These insulating sections may be fabricated in any desired manner but in order to impart strength to the assembly to withstand the torque of drilling, a suitable construction for these insulating sections is shown in Fig. 3. In this construction, each metal section 30 has a thinner extension 31 on its end. These thinner extensions are arranged so as to be concentric with each other and have a different diameter so that an annular space is formed between them. Insulating material is molded into place around these extensions in the manner shown so as to form a continuous inner and outer surface with the metal sections 30 to produce, in effect, an integral structure. These insulating sections have high shearing strengths, and, together with the extensions 31, are able to withstand the torque and other stresses imposed upon the assembly during the drilling operation.

The spring arms 26 are sufficiently bowed so that when the electrode assembly is in the drilling stem, these arms make good frictional contact with their adjacent metal sections 30. The conductors carried by the cable being directly connected to the metal sections 24, there is provided a complete electric circuit, including the electrodes, the earth between the electrodes, the conductors, and the recorder. It will be understood that in conventional electric logging the source of power for passing current through the earth formations is included in the recorder unit. It will be apparent, of course, that if a different source of power is required, it will be connected to the commutator 13. Where it is desired only to measure the self-potential of the formations transversed, no source of power is required and only one electrode is employed. Likewise, only one electrode and a single conductor are necessary when the source of power supplies alternating current and it is desired to measure both the self-potential of the earth and the impedance thereof.

Various modifications of the specific arrangement shown will occur to those skilled in the art. Such modifications are embraced within the scope of the present invention in so far as they embody the principles underlying the present invention. It will be observed that the arrangement shown makes possible the transmission of electric signals between a point in the bore hole and the surface while drilling without incurring the difficulty of twisting of the transmission cable about its axis.

The nature and objects of the present invention having thus been set forth and a specific illustrative embodiment of the same given, what is claimed and desired to be secured by Letters Patent is:

1. In an apparatus for the rotary drilling and simultaneous logging of a bore hole, a rotatable drill stem, a head on said drill stem comprising a pair of spaced hollow arms in fluid communication with the interior of said drill stem, a reel journaled in said arms with its longitudinal axis perpendicular to the longitudinal axis of said

drill stem, a cable wound on said reel, signal producing means carried by said cable, signal conducting means carried by said cable, signal receiving means mounted on said drill stem for rotation therewith and independent of said reel, signal transmitting means connecting said signal conducting means with said signal receiving means and means for taking off a signal from said conducting means.

2. An apparatus for drilling a well by the rotary method and simultaneously logging it comprising a hollow drill stem mounted for rotation, at least one electrically conductive section arranged adjacent the lower end of said drill stem and insulated therefrom, an elongated probing device having at least one conductive section, spring contacting means carried by said probing device adapted to make electrical contact between the electrically conductive section thereof and the electrically conductive section of said drill stem, a cable carrying said probing device, at least one conductor in said cable connected to an electrically conductive section of said probing device, a reel mounted on the upper end of said drill stem for carrying said cable, said reel being mounted for rotation about its transverse axis with said drill stem and for rotation about its longitudinal axis, the longitudinal axis of said reel being disposed in perpendicular relation to the longitudinal axis of the drill pipe, at least one slip ring carried by said reel and connected to one of said conductors, at least one slip ring carried by said drill stem and rotatable therewith, an electrical connection between said reel slip ring and said drill stem slip ring and a recorder at the surface electrically connected to said drill stem slip ring.

3. An apparatus for drilling a bore hole by the rotary method and simultaneously logging it which comprises a hollow drill stem mounted for rotation, a head carried by said drill stem comprising spaced hollow arms in fluid connection with said drill stem, a swivel connection between said head and a conduit for supplying a fluid medium to said drill stem, a reel journaled in said arms with its longitudinal axis vertical to the longitudinal axis of said drill stem whereby said reel is capable of rotation about its transverse axis with said drill stem and of rotation about its longitudinal axis, means for rotating said reel about its longitudinal axis, an electrical recorder adapted to be arranged at the surface, sliding electrical contacts between said recorder and said reel, a cable carrying an electrical conductor wound on said reel, a probing device carried by the free end of said cable, said conductor being connected to said probing device and said sliding connections, and means at the upper end of said drill stem for passing said cable into said drill stem.

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