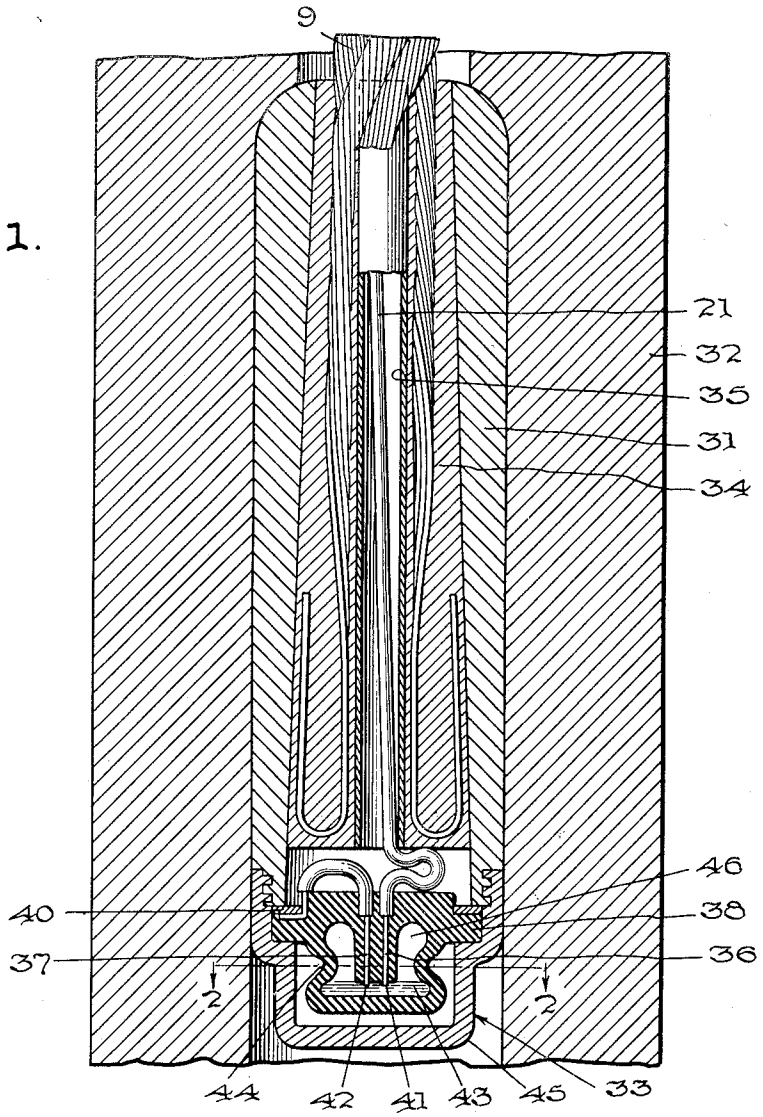
Jan. 29, 1952 J. F. KENDRICK 2,584,028

IMPACT SWITCH

Filed Oct. 31, 1949 2 SHEETS—SHEET 1

FIG. 1.



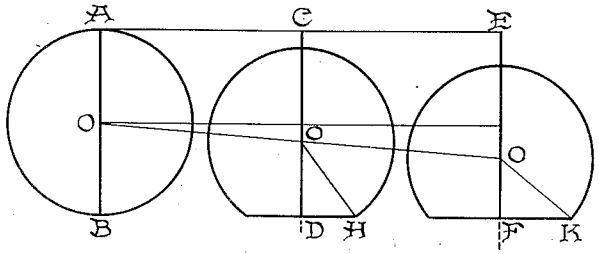


FIG. 6. FIG. 6a. FIG. 6b.

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FIG. 2.

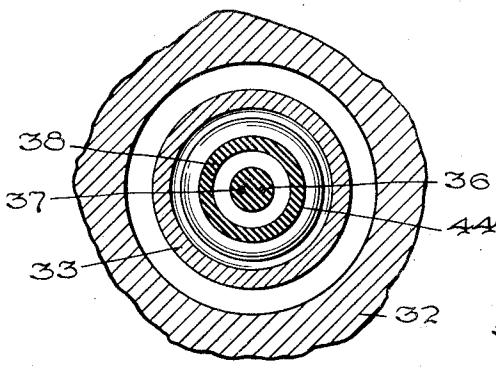


FIG. 3.

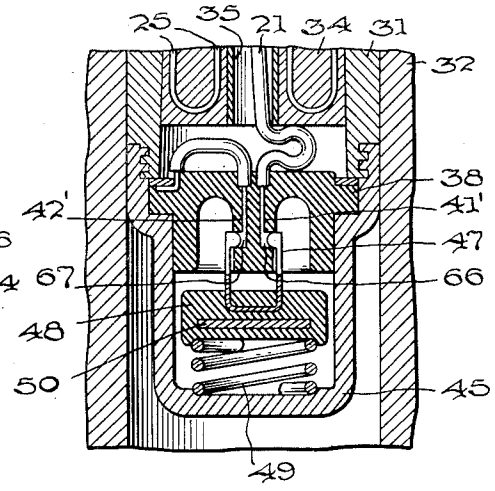


FIG. 4.

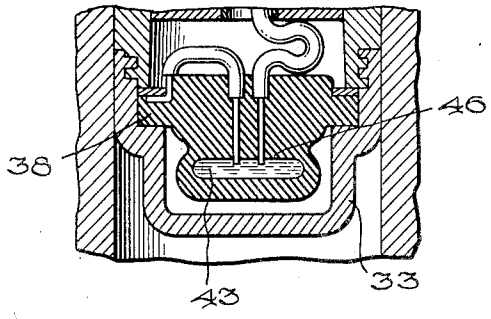
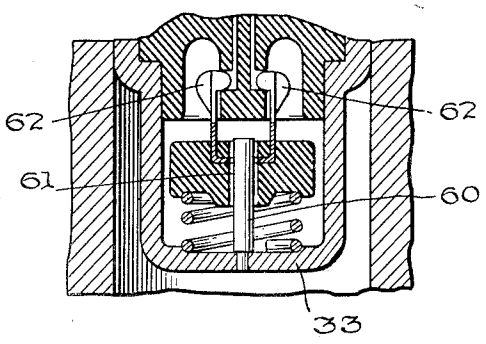


FIG. 5



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IMPACT SWITCH

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Application October 31, 1949, Serial No. 124,563

5 Claims. (Cl. 200—52)

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This application is a continuation-in-part of application Ser. No. 782,876, filed October 29, 1947, Impact Switch, now abandoned, which was a continuation-in-part of parent application Ser. No. 590,498, filed April 26, 1945, Drilling Motion Indicator for Cable-Tool Drills, also abandoned, which has been replaced by a continuation-in-part parent application Ser. No. 121,919, filed October 18, 1949, Method and Apparatus for Drilling Motion Indicator. Also pending as a continuation-in-part of the above parent application is application Ser. No. 123,353, filed October 25, 1949, Drilling Cable With Insulated Conductor.

This invention pertains to the construction of an impact switch, suitable for use with a drilling motion indicator for a cable-tool drill, as disclosed in the parent application. The construction of a drilling cable for similar use is disclosed in the parent application and in the first continuation-in-part application.

In cable-tool drilling, a bit, as part of a string of tools, is attached to the lower end of a drilling cable, which is reciprocated and manipulated at the surface, so that the bit strikes the bottom of the well or bore hole with impact, to effect the drilling. The motions of the string of tools are likewise used to operate the drilling motion indicator, as this eliminates a number of elements of uncertainty such as time lag and phase difference between the motion of the tools and the reciprocating motion at the surface. However, a number of structural difficulties result from controlling the operation of the indicator from the bottom of the hole.

The reciprocation of the bit, during normal drilling, subjects any electrical device, positioned in the string of tools, to cyclic impacts of relatively large magnitude, which may average around 40,000 per day. The impacts set the string of tools to vibrating violently, in a very complex manner, inasmuch as a typical string may have an average diameter of about 4 inches and an overall length of about 60 feet. Structural considerations dictate locating such a device at the upper end of the string, where it will be subject to the full destructive effect of the vibrations. Then, any electrical signal the device may initiate has to be transmitted to the surface, through an external circuit, which has high impedance. The present record depth with cable-tools is slightly over 10,000 feet. To be effective, the drilling motion indicator must reveal the signal with no significant time lag.

Under favorable conditions, the swivel rope socket keeps the drilling cable twisted up and relatively relaxed. However, scratches on the

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surface of the tools indicate that the tension on the drilling cable, during the latter part of the down-stroke and the up-stroke reacts on its helical structure to untwist the cable a few turns. Due to high contact pressures, the swiveling element of the rope socket works only when the tension is reduced, generally at the beginning of the down stroke of the tools, when the cable retwists very rapidly. For this reason, the electrical element, responsive to the motion of the tools, will be subject cyclically to large centrifugal forces of short duration.

During drilling operations, a loose link called a jar, is placed between the rope socket and the stem. Should the string of tools become stuck, the driller adjusts his hitch, so that the reciprocation of the upper end of the drilling cable will cause the jar to deliver an upwardly directed impact on the stuck tools. When drilling, the magnitude of the downwardly directed impact has to be limited to what the tools will withstand, but, when jarring, the objective is to increase the magnitude of the upwardly directed impact progressively. Frequently, it is difficult to determine whether the jars are working or whether the rig is just making a lot of miscellaneous noises. The electrical device will not only have to withstand the cyclic impact of jarring, but it is desirable that it indicate that the jars are working. These exacting requirements should be met by a device that is dependable, easily installed and inexpensive.

It is an object of this invention to provide an electrical device that can be mounted in a string of cable tools easily, and will be responsive at least to the significant motions thereof. Another object is to provide a device that is capable of withstanding great axial impact stresses, upwardly, downwardly and cyclically applied. A further objective is to provide a means that will withstand cyclic centrifugal forces and indicate their occurrence to the driller. Again, it is an object to provide a simple electrical device that will record its action at the surface end of the bore hole or well with a minimum of time lag, due to impedance in the external circuit.

Other objects and advantages of my invention, together with a further understanding of its nature and the detailed features of construction thereof, will be apparent from the detailed illustrations and specifications that follow, wherein:

Figure 1 is a fragmentary central vertical sectional view through the spindle of a swivel socket, showing the details of a mercury type impact switch;

Figure 2 is a fragmentary horizontal sectional

view thereof taken on the line 2—2 of Figure 1;

Figure 3 is a fragmentary central vertical sectional view through the spindle of a swivel socket, showing the details of a mechanical type impact switch;

Figure 4 is a fragmentary central vertical sectional view of a modified form of the impact switch of Figure 1 in which the auxiliary reservoir is eliminated;

Figure 5 is a fragmentary central vertical sectional view of another modification of the switch of Figure 3;

Figure 6 is a diagram showing the effect of a "high" or "tight" hitch;

Figure 6*a* is a diagram showing the effect of an intermediate hitch; and

Figure 6*b* is a diagram showing the effect of a "low" or "loose" hitch.

Referring to the drawings, the drilling cable 9 is babbitted into the spindle 31 which is free to turn inside the swivel socket 32. Its function is to permit the drilling cable to retwist, instead of to kink or "dog-leg," whenever the tension in the drilling cable is reduced.

Figure 1 shows the application of the invention to the swivel socket, when the internal conductor drilling cable 9 is used. 33 is the switch and its general design will be apparent from an inspection wherein 32 is the swivel housing, 9 is the drilling cable, 31 is the spindle of the swivel socket, into which the stranded drilling cable is babbitted as shown at 34, and which is free to spin about the axis of the rope socket 32 whenever the tension of the drilling cable is reduced.

A tube 35, with external ridges to key it to the babbitt may be inserted to afford a passage for the electrical conductor. The insulation of the electrical conductor may be protected from the heat of babbitting the drilling cable in a number of ways. The preferred way is to pull the electrical conductor out from the center of the drilling cable, between any pair of strands, until the babbitting is completed, whereupon it is rethreaded through the tube.

Figures 1 and 2 show the preferred embodiment of the switch, which is the part of this invention claimed in this continuation-in-part application, wherein 36 and 37 are two insulated conductors molded into the main body 38 of the switch, which is made from an oil-resisting, suitably elastic material such as synthetic rubber or a plastic. Conductor 36 is joined with centrally located conductor 21, of the drilling cable 9, with a fluid-tight splice. Conductor 37 is grounded by means of gripping its insulation stripped end under the adapting and reinforcing disk 40. When it is desired to use two centrally located conductors in the drilling cable, conductor 37 will be joined to this second conductor with a fluid-tight splice. The lower stripped ends of conductors 36 and 37 protrude slightly through the main body of the switch, as at 41 and 42, and are normally submerged in mercury 43, which completes the electrical circuit. The mercury is contained in a suitably elastic reservoir, formed by a circumferentially pleated extension 44 of the main body of the switch 38. The switch is held in fixed relation to a receptacle formed by the spindle 31 of the swivel socket 32 and a housing 45 threadedly connected to the lower end of the spindle 31.

In operation, the inertia of the mercury 43, under the influence of a downwardly directed impact, forces the reservoir 44 downwardly, until its movement is checked through contact with

the housing 45. This removes the mercury 43 from contact with the conductors 41 and 42 and interrupts the flow of current through the circuit, causing a signal in the indicator at the surface. With the termination of the impact, the elastic construction of the longitudinal walls of the reservoir 44 raise the bottom of the reservoir, bringing the mercury 44 again into contact with the conductors 41 and 42, thereby closing the circuit and permitting the flow of electrical energy. The switch will be proportioned with a sufficiently stiff walled reservoir, so that the terminals 41 and 42 will not be uncovered by the reaction to ordinary inertia.

In the event of an upwardly directed impact, which would be the case if the jars should operate, intentionally or otherwise, the inertia of the mercury 43 would force it into the upper section 46 of the reservoir, again opening the circuit and interrupting the flow of elertrical energy, resulting in a signal at the surface. In the event this indication of upward impact is not desired, it is only necessary to modify the design to eliminate the upper section 46 of the reservoir, as shown in Figure 4.

When the spindle 34 of the swivel socket pins, as is the case when the tension in the drilling cable is lessened, the centrifugal force thus created will cause the surface of the mercury to assume a curve, which will remove it from contact with the conductors 41 and 42, open the circuit, stopping the flow of electrical energy and giving a signal on the surface. Should such an indication be undesirable, it is only necessary to shorten the diameter of the reservoir and increase the thickness of the mercury used to eliminate it. As illustrated in Figures 1 and 2, therefore, the switch will indicate downward impact, upward impact and spinning of the swivel spindle, and the occurence of the signal in relation to the surface stroke will give the operator definite advice of the proper functioning of the tools at the bottom of the well bore. However, a slight modification of the design of the switch will effectively eliminate the indication of upward impact or the functioning of the swivel, or both, as has been fully described above.

A mechanical modification of the switch is shown in Fig. 3 in which like reference numbers designate like parts having the same function as in Fig. 1. The switch is held in fixed relation to the spindle 31 of the swivel socket 32 by means of a housing 45 threadedly connected to the lower end of the spindle 31. The conductors 41′ and 42′ are molded into a cylindrical projection of the main body 38 of the switch. Diametrically opposite sides of this cylindrical projection are flattened to receive the terminal plates of conductors 41 and 42, which are slightly concave inward to mate with the terminals of the U-shaped connector 47, which is mounted on the floating base 48, the latter being supported on the housing 45 by means of the open coil helical spring 49. The inertia of floating base 48 is built up by means of the mass 50 molded in said base. When in its neutral position, connector 47 short circuits the conductors 41 and 42 thereby completing the circuit. Under the influence of a downwardly directed impact, floating base 48 compresses the spring 49 and connector 47 is moved downwardly out of contact with connectors 41 and 42. The flow of current is interrupted, resulting in a suitable signal being driven at the surface of the well bore. When the downward impact is expended, spring 49 returns the float-

ing base 48 to its neutral position, again bringing connector 47 into contact with conductors 41 and 42.

Under the influence of an upwardly directed impact, floating base moves upward under the influence of its inertia and the thrust of spring 49. Connector 47 is thereby removed from contact with conductors 41 and 42, resulting in the interruption of the current, which gives a suitable signal at the top of the well bore. When the impact is dissipated, the mass of floating base 48 returns it to its neutral position, which brings connector 47 into contact with connectors 41 and 42 and the cycle is completed. Where the indication of the upward impact is undesirable, it may be eliminated from this design either by providing shoulders on the cylindrical projection, which will check the upward movement of connector 47 or increase the length of the cylindrical projection, so that contact with floating base 48 will check the upward movement of the connector 47. The design as shown does not permit the indication of the spinning of the spindle 31. However, if the floating base 48 be guided by the cylindrical projection 60, Fig. 5, slidingly engaging a hole 61, provided in the floating base 48 and the mass of the terminals of connector 47 be increased as indicated at 62, the centrifugal force, as the spindle spins will separate the ends of the connector 47, thereby stopping the flow of current, and giving a signal at the top of the well bore. When the spindle 31 ceases to spin, the elasticity of connector 47 will cause its terminals to return to their neutral position, permitting a resumption of the flow of current, thereby completing the cycle.

Just what the effect of letting more line into the well bore is shown in the diagrams of Figs. 6 to 6b inclusive. These assume that the movement of the string of tools is simple harmonic motion, which is only a rough approximation. It will be remembered that this motion is the projection, on a straight line, of a point following a circular path with a uniform velocity. In simple harmonic motion, the velocity at any instant is proportional to line DH of Fig. 6a and line FK of Fig. 6b. As the bit cannot go any farther than the bottom of the hole, the effect of letting more line into the hole is to increase the velocity at the instant of impact. As the magnitude of the impact varies as the square of the velocity at impact, a loose hitch, when it does not cause an impact that needlessly batters the bit, generally drills the fastest. The reason the surface signals are more pronounced, when a tight or high hitch is use, is that the line is under greater tension at the instant of impact. The signal is, therefore, a summation of vibrations with higher frequencies, as is fully explained in the parent application and has a higher pitch and the amplitude of the natural vibration is increased by the greater stretch of the drilling cable, and the jiggle is, therefore, intensified.

To summarize, I have disclosed herein an impact switch for use with a drilling motion indicator for a cable-tool drill, which will be highly dependable, easily installed and relatively inexpensive. It will signal, from the bottom of the well bore, to the driller at the surface the significant motions of the string of tools, enabling him to make and maintain the same hitch, whether he is drilling in a wet or dry hole, straight or crooked hole with fast or slow motion or with a tight or loose hitch. The construction is such that it will withstand cyclic impact and centrifugal forces. Obviously, it is the "heart" of such a drilling motion indicator, which will be an important advance in the art of cable-tool drilling.

What I claim as new and desire to secure by Letters Patent is:

1. An inertia type electrical switch comprising a body adapted to be mounted in a reciprocatable receptacle and constrained to parallel the motions thereof, a reservoir with an elastically deformable enclosure dependent from the body, a dense electrically conductive fluid in the reservoir, electrical conductors disposed axially within and through the body with outer ends adapted to be connected to an external circuit and with inner ends exposed and normally projecting into the fluid to complete an associated circuit, the fluid being displaceable in response to the movements of the body to uncover the exposed ends of the conductors and interrupt the flow of electricity.

2. An inertia type electrical switch comprising a body disposed at right angles to a vertical axis adapted to be mounted axially in a receptacle reciprocatable along the axis and constrained to parallel the motions of the receptacle, the central portion of the lower surface of the body being a plane at right angles to the axis, a reservoir formed by the lower surface of the body and an elastically deformable enclosure dependent from the outer edge of the central portion thereof, a dense electrically conductive fluid in the reservoir, electrical conductors disposed through the body with outer ends adapted to be connected to an external circuit and with inner ends exposed and normally projecting into the fluid to complete an associated circuit, the fluid being displaceable in response to a downwardly directed impact to uncover the exposed ends of the conductors and interrupt the flow of electricity.

3. An inertia type electrical switch comprising a body disposed at right angles to a vertical axis adapted to be mounted axially in a receptacle reciprocatable along the axis and constrained to parallel the motions of the receptacle, the central portion of the lower surface of the body projecting axially beyond the lower plane of the body, a main reservoir formed by the lower surface of the body and an elastically deformable enclosure dependent from the body, an auxiliary reservoir formed by the axial projection of the body and the encircling enclosure of the main resorvoir, a dense electrically conductive fluid in the main reservoir, electrical conductors disposed through the body with outer ends adapted to be connected to an external circuit and with inner ends exposed and normally projecting from the axial projection of the body into the fluid to complete an associated circuit, the fluid being displaceable in response to a downwardly directed impact and to an upwardly directed impact to uncover the exposed ends of the conductors and interrupt the flow of electricity.

4. An inertia type electrical switch comprising a receptacle with a vertical axis reciprocatable along the axis, a body positioned in the receptacle in fixed relation thereto and constrained to parallel the movements thereof, a reservoir with an elastically deformable enclosure dependent from the body, a closure enveloping the reservoir detachably joined to the receptacle and proportioned to limit the deformation of the en-

closure of the reservoir, a dense electrically conductive fluid in the reservoir, electrical conductors disposed through the body with outer ends adapted to be connected to an external circuit and with inner ends exposed and normally projecting into the fluid to complete an associated circuit, the fluid being displaceable in response to the movements of the receptacle to uncover the exposed ends of the conductors and interrupt the flow of electricity.

5. An inertia type electrical switch comprising a unitary hollow body adapted to be fixed in a reciprocatable receptacle, a solid body portion depending centrally from the top of said body and dividing the interior thereof into upper and lower reservoirs, a dense electrically conductive fluid in said lower reservoir, electrical conductors mounted in said body portion and having

outer ends adapted to be connected to an external circuit and inner ends exposed and projecting into said fluid to complete an associated circuit, said fluid being displaceable from one reservoir toward the other to uncover said exposed ends and interrupt the flow of electricity in response to reciprocation of the receptacle.

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