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2,300,823

INDICATING DEVICE FOR WELL DRILLS

Filed Dec. 18, 1939

2 Sheets-Sheet 1

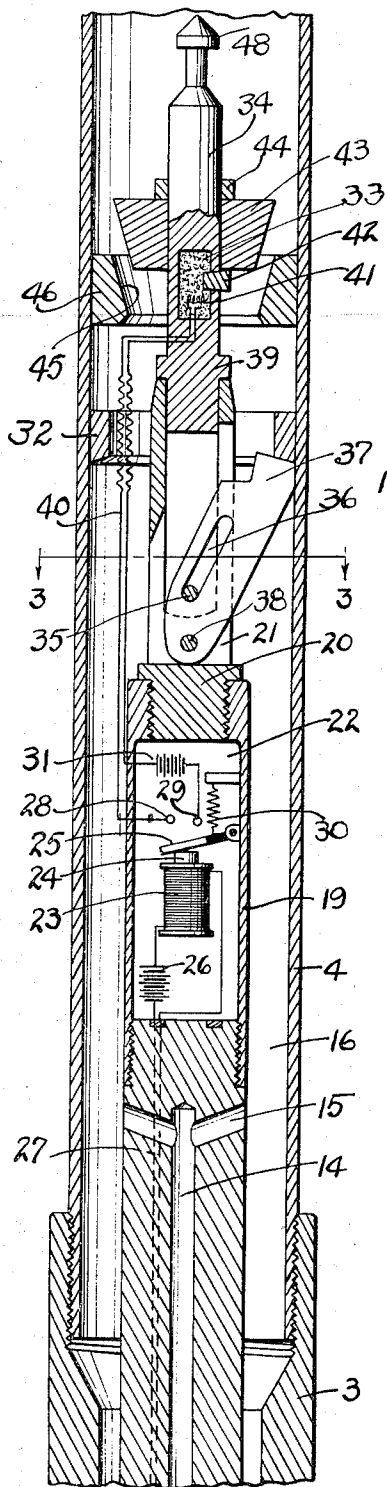


Fig. 1.

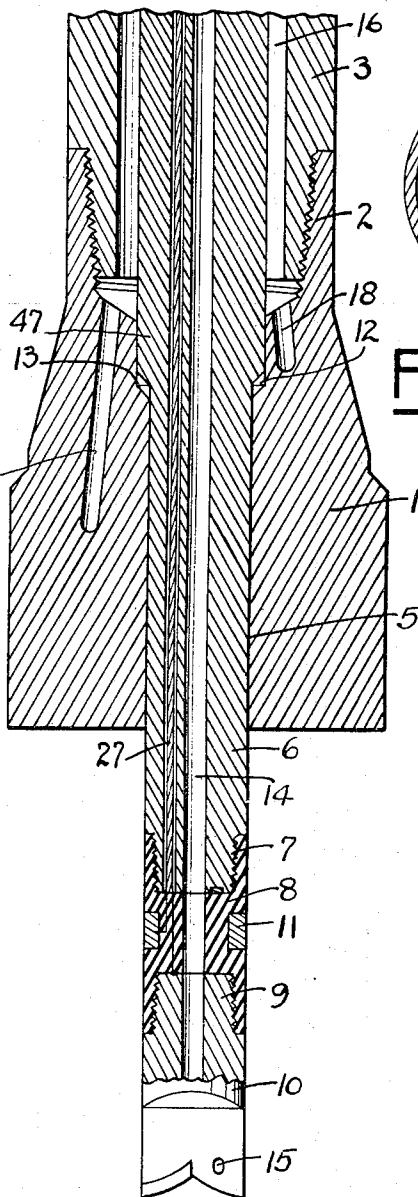


Fig. 2.

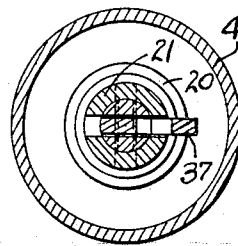


Fig. 3.

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2 Sheets-Sheet 2

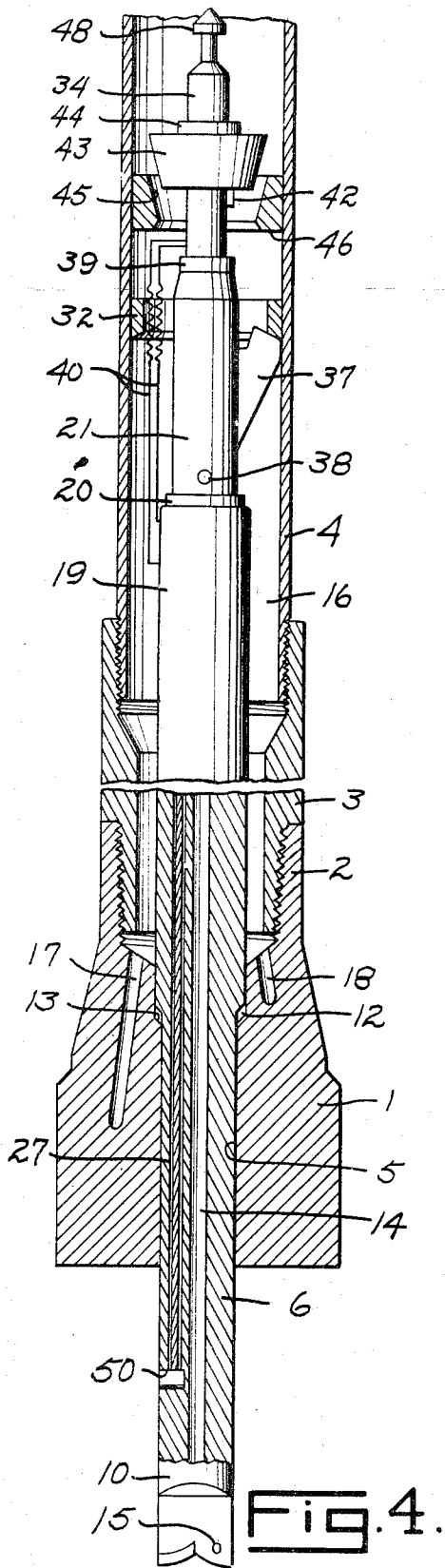


Fig. 4.

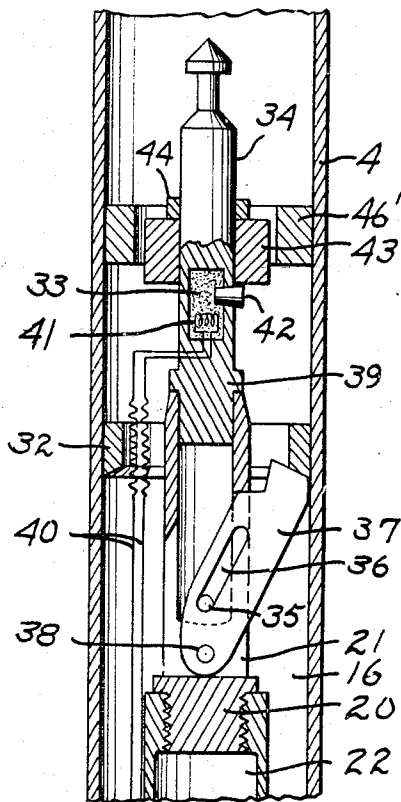


Fig. 6.

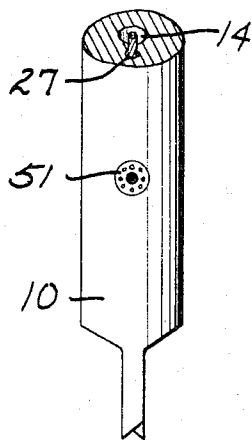


Fig. 5.

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INDICATING DEVICE FOR WELL DRILLS

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10 Claims. (Cl. 255—1)

This invention relates to devices for indicating the nature of formations encountered by the drill in the process of well drilling.

In the drilling of deep wells it is desirable to provide means in connection with the drill which will indicate the nature of the formation which is being drilled and particularly those containing oil or indications of the proximity to oil. The common method of determining the character of the formation is to employ a core drill which may be lowered down through the drill stem and the drill bit and employed to take a sample of the formation, which sample is withdrawn to the surface for examination. Such a method is time consuming and expensive and it is an object of this invention to provide means employed in connection with the well drill which will indicate the nature of the formations encountered in the well without the necessity of withdrawing the drill for examination of the sample.

It is a further object of the invention to provide a device which may be employed in combination with the well drill which may be lowered into position through the well drill and employed during the continuous operation of drilling to furnish an indication to the driller of the presence of oil or gas in the hole.

The invention preferably employs an electrically actuated device for altering the passage for fluid circulation through the drill stem in response to the encounter, or penetration, of certain types of formations in the lower end of the hole.

The invention will be better understood from a consideration of an illustrative embodiment in the drawings accompanying this specification and wherein:

Fig. 1 is a central longitudinal section through the upper portion of the mechanism embodying the invention;

Fig. 2 is a similar view showing the lower end of the drill bit and signaling mechanism;

Fig. 3 is a transverse section on the plane 3—3 of Fig. 1;

Fig. 4 is a central longitudinal section through a modified form of the invention, portions of the structure being shown in elevation;

Fig. 5 is an enlarged detail showing the pilot bit construction;

Fig. 6 is a sectional detail showing a modified valve construction.

In Figs. 2 and 4 there is indicated at 1 a drill bit of the fish tail type which may be employed in drilling the well. It will be understood that

the particular construction of the drill 1 is not important. The upper end of the drill is provided with a shank 2 which is threaded on the interior to engage with a drill collar 3. The upper end of the drill collar may be connected with a drill stem 4 of the usual construction.

The drill bit itself is formed with an axial passage longitudinally thereof at 5 of the proper size to receive therein a mandrel 6. Said mandrel has a pin member 7 at its lower end threaded to engage with a sub 8 of some insulating material such as Bakelite. The lower end of the sub is threaded to engage with the shank 3 of a pilot bit 10. In the outer periphery of the sub 8 is a collar 11, which is fitted within a circumferential recess in the periphery of the insulating sub.

Adjacent the upper end of the mandrel 6 the outer diameter is increased somewhat to provide a shoulder at 12 which may engage with a stop shoulder 13 in the head of the bit. The mandrel is provided with a longitudinal passage 14 for the fluid circulation. This passage is connected for discharge at the lower end with openings 15 in the opposite faces of the pilot bit 10. At the upper end of the mandrel the passage 14 diverges at 16 to connect with the space 16 within the drill collar.

The space 16 accommodates the downward circulation through the drill stem of the flushing fluid for the main drill bit 1. It connects at the upper end of the drill with passages 17 and 18, which carry the fluid onto the bottom of the hole in front of the advancing faces of the drill.

Above the mandrel is a housing 19, which is screwed over the upper end of the mandrel to thereby close the lower end of the housing, the upper end of the housing being closed by a plug 20, which serves as a mounting for the latch housing 21. It will be noted that the housing 19 has a chamber 22 therein which is closed against the access of liquid to the interior during the operation of the tool. The housing has therein an electromagnet 23, the core 24 of which cooperates with the switch arm 25. The coil 23 of the electromagnet is connected with a battery or other source of electricity 26. The electric circuit including the coil and the battery also includes wires which are extended from the chamber downwardly, through an opening indicated at 27, connecting at its lower end with the sub 8. The passage allows the connection of one of the wires of the circuit with the collar 11 of conducting material. The other wire of

the circuit is connected with the upper end of the bit shank 9.

It will be understood that the usual drilling mud ordinarily employed in drilling furnishes an electrolyte which is sufficiently potent to cause the flow of electricity by way of the drilling mud and the surrounding formation between the drill bit and the collar 11 of the sub. Thus, a small current will normally pass through the coil of the magnet so that the energizing of the magnet will hold the switch arm 25 away from two terminals 28 and 29 of the second electric circuit.

The arm 25 in this embodiment is normally urged into position to close the circuit through the two terminals 28 and 29 by a spring 30. The circuit including the terminals 28 and 29 has therein a battery 31 and the wires leading from these terminals extend outwardly through the wall of the housing and are extended upwardly through a latch collar 32 and into a chamber 33 in the latch stem 34.

The latch stem 34 has its lower end slidable within the latch housing 21 and has at its lower end a transverse pin 35 which engages within a slot 36 of a latch arm 37 pivoted at 38 in the lower end of the housing 21. The upper end of the latch dog 37 is adapted to engage below the ring 32 when the pin 35 is in its lower position. It will be obvious that when the latch stem 34 is moved upwardly the movement of the pin 35 in the slot 36 will unlatch the dog. There is a radial flange 39 on the latch stem which is adapted to engage the upper end of the housing 21 to limit the downward movement of the stem.

The chamber 33 within the latch stem is adapted to be filled with explosives and the circuit 40 which includes the terminals 28 and 29 is extended into the latch stem and has in the circuit an igniting element 41 which, when energized, will act to explode the charge of powder within the chamber 33 and force a plug 42 laterally from an opening in the chamber which is normally closed by said plug.

The plug 42 serves as a stop for a valve member 43 slidable upon the latch stem and limited in its upward movement by a collar 44 on the stem. When the plug 42 is removed from below the valve said valve will drop and engage within a seat 45 within a ring 46 fixed upon the interior of the drill stem to close the drill pipe and signal the driller by the resultant increase in pressure.

In the modified form of the invention as shown in Figs. 4, 5 and 6, the mandrel 8 and the pilot bit 10 are made unitary. In this embodiment a minute current normally passes thru the electromagnet 23 for reasons that will be more fully apparent. This current is insufficient to magnetize the core 24 sufficiently that the arm 25 will be drawn downwardly against the tension of the spring 30. The arm 25 is therefore normally held upwardly away from terminals 28—29 which in this embodiment are placed below the normal position of the arm 25. In this manner the circuit from the battery 29 thru the conductors 40 to the igniting element 41 will normally remain open as in the previously described embodiment.

It is known that certain frequencies of a limited range are set up in a drill bit and stem when the bit is operating within a stratum having particular characteristics. In order to take advantage of this fact a vibration responsive element 51 is mounted within a chamber 50 in the pilot bit 10. The element 51 is so constructed that only a minute current normally flows thru the

electromagnet 23 as above indicated. The element 51 is, however, responsive to a predetermined band of frequencies to permit a greater current to pass therethru, such current being sufficient to pull the arm 25 downwardly whereby the circuit thru the igniting element 41 is closed whereby desired indications are produced.

In Fig. 6 there is shown a further modification in which the member 43' corresponds to the valve member 43 in Fig. 1. This member is smaller than the internal diameter of the ring 46' fixed in position within the drill stem 4. There is therefore normally a throttling of the fluid between the elements 43' and 46'. If, however, the electromagnet 23 is deenergized and the plug 42 is forced from its normal position, the member 43' will move downwardly upon the latch stem 34 and the throttling action upon the pumped drilling fluid will be immediately decreased. Again the change in pumping conditions indicates that the plug 42 has been removed, such condition also indicating that the pilot bit has entered into a stratum of predetermined character.

In the operation of the device of the invention the pilot bit together with the housing 19, latching device 37 and valve member 43 are lowered downwardly through the drill bit. When the device is thus seated the valve 43 will be held in a fixed position relative to the valve seat 45 by the plug 42. In the normal operation of the drill the pilot bit will be rotated by means of the main drill through connection of any preferred form between the two members and preferably from the mandrel adjacent the shoulder 12 at the point 47 of polygonal shape so that the two parts will be held against relative rotation.

The latch 37 engaging below the ring 32 will permit the exertion of a downward thrust upon the pilot bit as the drill is operated. If a formation of relatively high electrical resistance such as one containing oil or gas is encountered in the hole when using the embodiment shown in Figs. 1 to 3 such formation will act as an insulating material and will reduce the passing of current between the ring 11 and the shank 9 of the pilot bit whereupon the arm 25 will be moved upwardly by the spring 30 to bring about the functioning already described.

Similar actuation will take place when the vibration responsive element 51 of the embodiment of Figs. 4 and 5 is affected by vibrations within a predetermined band of frequencies. When the passage of the current through this circuit is thus increased the pull of the electromagnet 23 will be sufficiently changed that the arm 25 will be drawn downwardly to close the circuit across the two terminals 28 and 29. When this is done the current will flow through the circuit 40 heating up the igniter element 41 and by the firing of the explosive within the latching stem the plug 42 will be removed from its position and the downward circulation of the flushing fluid will force the valve 43 downwardly and thus alter the circulation of fluid from the pumps. This will indicate at once to the operator that a significant formation has been encountered. It will then be possible for the operator to lower an overshot engaging over the upper end 48 of the latch stem. A pull may then be exerted on the latch stem to withdraw the latch 37 and allow the tool to be withdrawn from the well. A well tester or other sampling device may then be lowered through the drill stem so as to obtain an accurate sample of the fluid and formation at the bottom of the well.

It will be obvious that when the device of the invention is used the running of a well tester or sample taking bit frequently into the well will be avoided. The device may be employed during the ordinary drilling and will tend to inform the driller when it is desirable to make a test of the formation. The advantages of this structure will be obvious to those skilled in the art.

What is claimed is:

1. A drill stem, a well drill thereon having an axial passage, an upwardly presented shoulder in said passage, a mandrel adapted to fit through said passage and rest upon said shoulder, a pilot drill, an insulating sub connecting said pilot drill to said mandrel, a latch, a housing connecting said latch and said mandrel, a source of electricity in said housing, conducting wires in circuit with said source, an electrode in said circuit connected with the outside of said insulating sub, another electrode on said drill, there being drilling fluid in the well outside said drill stem whereby an electric current is conducted between said electrodes through the adjacent formation, a magnet in said circuit normally energized by said battery and said electrolyte, a second circuit, a switch in said second circuit normally urged to closed position by a spring, but positioned to be held open by said magnet, a latch stem to operate said latch, a valve on said stem, a seat therefor in said drill stem, a chamber for explosives in said stem, a plug closing said chamber and also acting to hold said valve from its seat, an igniting element in said chamber connected in said second circuit to explode the charge in said chamber when said second circuit is closed by said switch and thus remove said plug and release said valve to alter the passage through said drill stem.

2. A well drill, a drill stem connected therewith, a mandrel supported for rotation with said drill, a pilot bit on said mandrel, a battery housed in said mandrel, wires in circuit with said battery and having spaced terminals insulated from each other at the lower end of said mandrel, a chamber for explosives above said mandrel, a plug closing one side of said chamber, a valve supported on said plug, a seat for said valve in said drill stem below said valve, a normally energized electro-magnet in said circuit, and means actuated in response to the deenergizing of said magnet to displace said plug and allow said valve to move toward said seat.

3. A well drill, a drill stem connected therewith, a mandrel, a pilot drill on said mandrel projecting below said drill, means to insulate said pilot drill from said mandrel, a battery housed in said mandrel, wires connected in circuit with said battery and having spaced terminals on said pilot drill and said insulating means, the flushing fluid between said terminals forming an electrolyte, a valve seat in said drill stem above said mandrel, a valve, means supporting said valve above said seat, and means responsive to the breaking of said circuit to release said support and allow said valve to seat and close off the passage of fluid.

4. A well drill, a drill stem connected therewith, a mandrel, a pilot drill on said mandrel projecting below said drill, means to insulate said pilot drill from said mandrel, a battery housed in said mandrel, wires connected in circuit with said battery and having spaced terminals on said pilot drill and said insulating means, the flushing fluid between said terminals forming an electrolyte, a valve seat in said drill stem above said mandrel, a valve, means supporting said

valve above said seat, a charge of explosives behind said support, an electric igniter in said charge, a second electric circuit including said igniter, and means responsive to the breaking of said first named circuit to close said second circuit to explode said charge to release said support and allow said valve to move to restrict the passage of fluid.

5. In a device of the character described, a drill stem, a drill thereon, a mandrel supported axially of said drill, a pilot drill on said mandrel, an electric circuit including an electromagnet, terminals in said circuit insulated from each other at the lower end of said mandrel, flushing fluid about said drill stem and drill adapted to conduct an electric current between said terminals through the surrounding formation and to normally maintain said electromagnet energized, and signalling means operating in response to the interrupting of current through said circuit and the deenergizing of said electromagnet when a formation of high electrical resistance is encountered.

6. In a device of the character described, a drill stem, a drill thereon, a mandrel supported axially of said drill, a pilot drill on said mandrel, an electric circuit, terminals in said circuit insulated from each other at the lower end of said mandrel, flushing fluid about said drill stem and drill adapted to conduct an electric current from the terminal to the surrounding formation, an electromagnet in said circuit ordinarily energized when said electrolyte and a conductive formation are present, but deenergized when an insulating formation reduces the flow of electricity between said terminals, a valve in said drill stem above said mandrel, a seat therefor, means to support said valve above said seat, said supporting means being rendered ineffective to support said valve in response to the reduction of current in said circuit.

7. In a device of the character described the combination of, a well drill, a drill stem connected thereto, a pilot bit removably mounted in said drill and adapted to rotate therewith, said drill stem providing a passage for drilling fluid downwardly to the well drill, a valve seat in said stem, a valve, means supporting said valve adjacent the seat, and means responsive to the penetration of a formation of predetermined nature for releasing the valve for movement relative to the seat, whereby a signal is transmitted to the surface through the fluid in the drill stem.

8. In a device of the character described the combination of, a well drill, a drill stem connected thereto and providing a passage for drilling fluid downwardly to the well drill, a valve seat in said stem, a valve, means supporting said valve in spaced relation with said seat, and means responsive to the penetration of a formation of predetermined nature for releasing said valve for movement relative to said seat, whereby a signal is transmitted to the surface through the fluid in the drill stem.

9. A device for signalling the surface that a formation having predetermined characteristics has been penetrated during the drilling operation including means to pump a drilling fluid downwardly through a drill string during the drilling operation, means carried by the drill string to apply a difference in potential to spaced terminals on the exterior of the device during drilling, and means for automatically varying the rate of flow of the drilling fluid when the resistivity conductivity of the formation being

penetrated by the drilling changes sufficiently to affect the potential between the terminals.

10. A device for signalling the surface that a formation having predetermined characteristics has been penetrated during the drilling operation including means to pump a drilling fluid downwardly through a drill string during the drilling operation, means carried by the drill string to apply a difference in potential to spaced teri-

nals on the exterior of the device during drilling, and means for automatically varying the rate of flow of the drilling fluid when the resistivity conductivity of the formation being penetrated by the drilling changes sufficiently to affect the potential between the terminals so that the variation in flow caused by said last means will be effective at the surface.

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