Jan. 21, 1958 J. D. MARTINEZ 2,820,610

MULTIPLE MAGNETIZATION DEVICE FOR WELL CORES

Filed Aug. 3, 1955 3 Sheets-Sheet 1

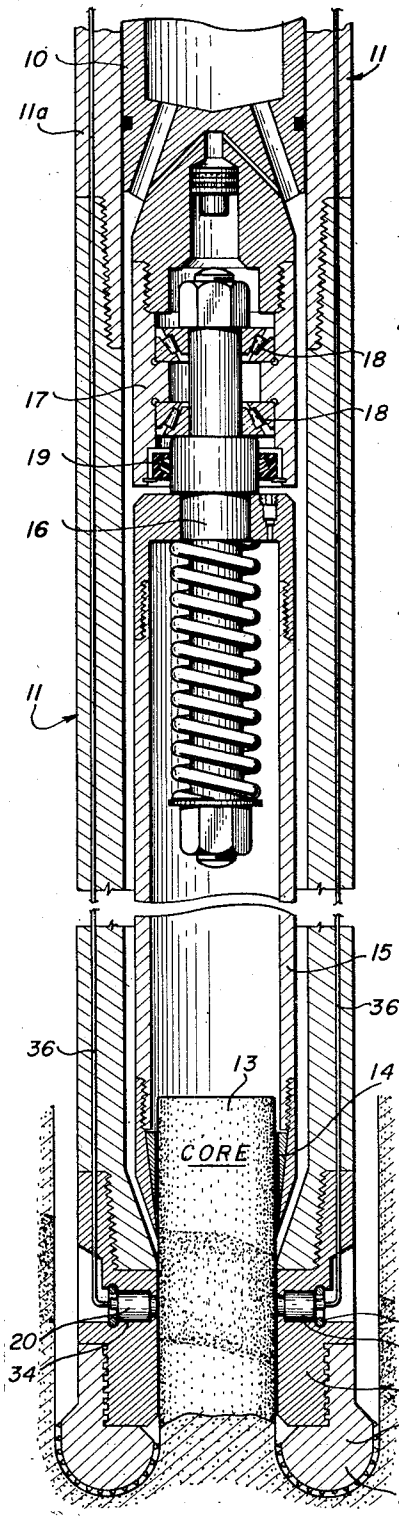


FIG. 1A.

FIG. 1.

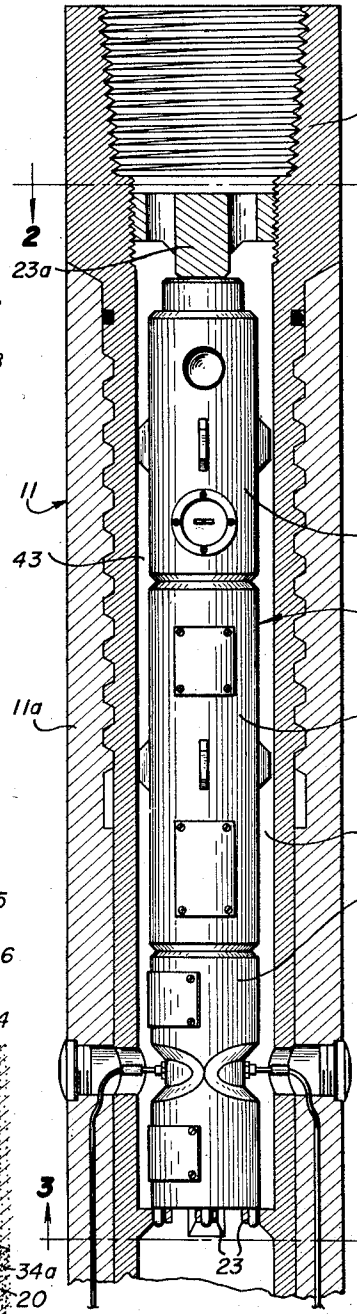


FIG. 2.

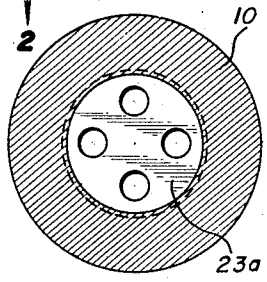
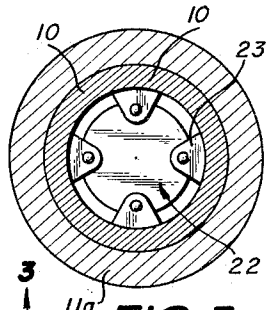


FIG. 3.



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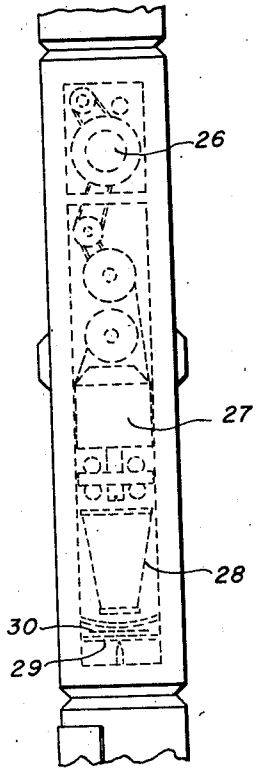


FIG. 4.

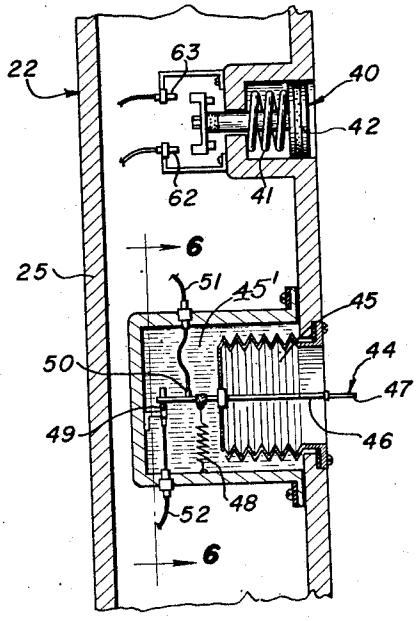


FIG. 5.

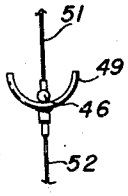


FIG. 6.

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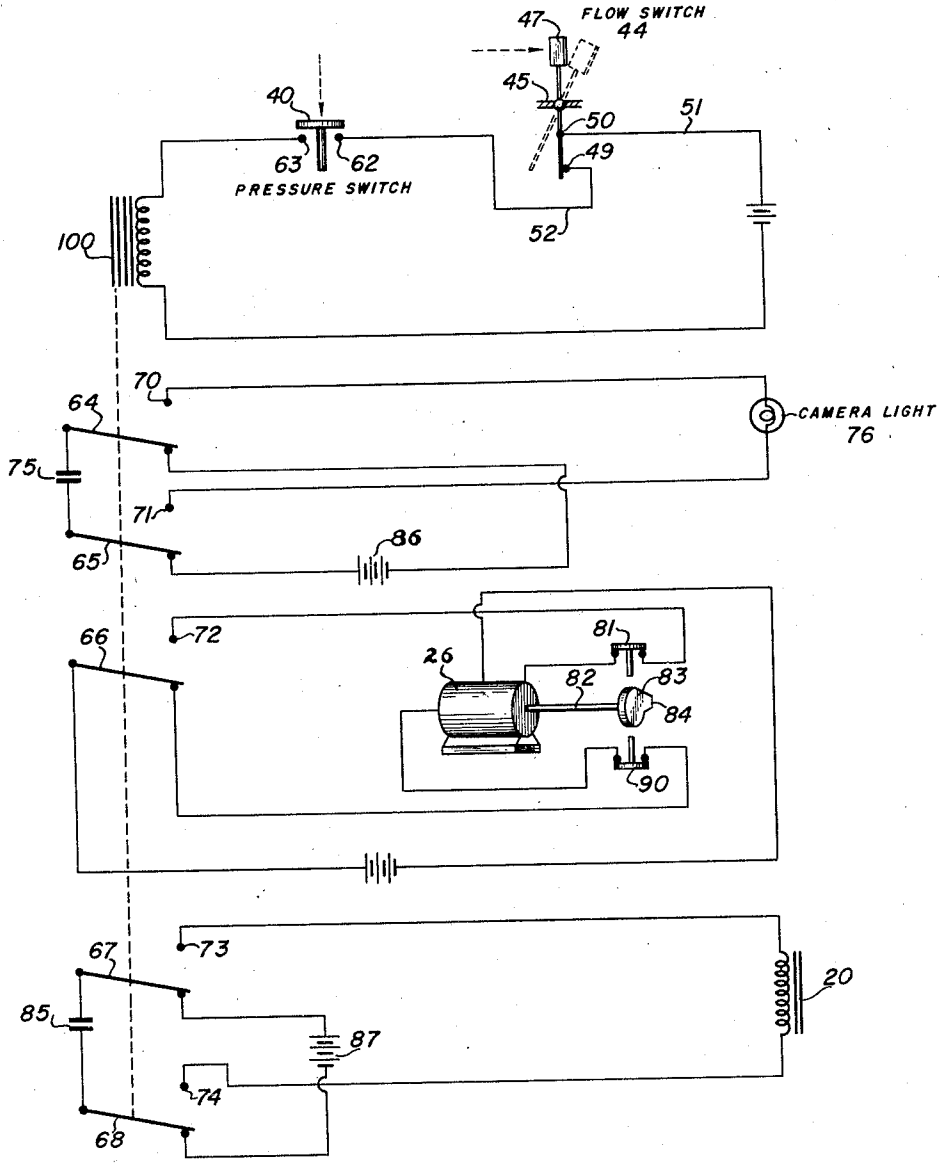


FIG. 7.

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2,820,610

MULTIPLE MAGNETIZATION DEVICE FOR WELL CORES

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8 Claims. (Cl. 255—1.4)

This invention relates to the taking of a subsurface core and the orienting of the subsurface core. More particularly, this invention relates to a novel apparatus for obtaining an oriented subsurface core including means for magnetizing said core at a plurality of points on the core.

During the drilling of a borehole in the search for oil or other minerals, core samples are cut from the formations being traversed and are removed to the earth's surface for examination. Various important information can be obtained from such a core. For example, if any bedding planes are observable in the core, the strike and dip of these planes (and hence of the formation from which the core was obtained) can be determined. The true directions of strike and dip, however, can be determined only if the core can be oriented (in space) in the same way that it was oriented in its original place in the formation. In one method of core orientation, a physical mark or scratch of known orientation is first applied to the formation at the bottom of the borehole, which is the formation to be cored. After the core is subsequently drilled and removed to the earth's surface, it can be oriented by reference to this mark. However, often the core breaks into many pieces while being drilled and removed, and it is then possible to orient only the topmost portion of the core, that is, the portion which possesses the aforesaid orienting mark. The other pieces of the core cannot be oriented. In another method of core orientation, a plug of ferromagnetic material is inserted into the top of the core, which ferromagnetic material is then magnetized by the earth's magnetic field and hence serves in the subsequent orientation of the core. In this method also, complete orientation of all sections of the core is not possible if the core is broken during its drilling or removal. Any method which depends upon inducing a physical property on the top portion of the core is subject to the same disadvantages. Hence, in order to be able to orient any separate individual section of the core, it is necessary that the physical property which is utilized in orienting the core, be present along the entire length of the core.

My new apparatus is a new apparatus for magnetizing the core, during coring operations, at a plurality of points along the length of the core. Hence, if the core should be broken during its removal from the borehole, the broken pieces will each be magnetized and hence each piece can be properly oriented.

Briefly described, my new apparatus for cutting a core from the bottom of a borehole includes a drill string having attached thereto a coring bit and a core catcher for taking the core to be studied. Means are provided, within the drill string, for magnetizing the core along a particular plane thereof. Means are also provided for continuing the drilling of the core after it has been once magnetized, discontinuing the drilling at will, and magnetizing said core along a second plane thereof. By this procedure, the core may be magnetized any number of times as desired, before it is removed to the earth's surface. Means are also provided within the drill string for measuring the inclination and the direction of inclination of the apparatus during each magnetization of the core.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings in which:

Figs. 1 and 1A are longitudinal sectional views showing the general arrangement of my new apparatus with Fig. 1A being a continuation of Fig. 1;

Fig. 2 is a view taken along the line 2—2 of Fig. 1;

Fig. 3 is a view taken along the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary schematic view showing the location of the surveying means in my new instrument;

Fig. 5 is a fragmentary sectional view of the control switch unit of Fig. 1 showing the pressure and flow switch incorporated in my new instrument;

Fig. 6 is a fragmentary view taken along the line 6—6 of Fig. 5; and

Fig. 7 is an electrical circuit diagram showing the electrical operation of my new apparatus.

Referring to the drawings and more particularly to Figs. 1 and 1A, numeral 10 refers to a sub on the lower section of a drill string which is lowered into the borehole. This sub is made of non-magnetic material. Threadedly connected to the portion or sub 10 of the drill string is an outer core barrel 11. A portion 11*a* of outer barrel 11 is made of a non-magnetic material. Threadedly connected to the outer barrel 11 is a core bit 12 used in drilling the core 13. As the core bit 12 is rotated, the core 13 is forced upwardly into a core catcher 14, which is attached to the lower extremity of an inner barrel 15. The upper portion of the inner barrel 15 is connected to a rod 16. The rod 16 extends to the lower portion of the drill string 10. Connected to the lower portion of the drill string 10 and forming an integral part thereof is a sleeve member 17. It can be seen from an examination of Fig. 1, that the sub 10, the outer barrel 11 and the sleeve 17 rotate with the core bit 12 when the drill string is rotated to take the core 13. The rod member 16, to which the inner barrel 15 is attached, remains stationary as the core 13 is forced into the inner barrel 15. Suitable bearings 18 are positioned between the rod 16 and the sleeve 17 to provide for the rotation of the rotating members about the stationary members. To prevent any of the circulating fluids from getting into the bearings 18, suitable packing means 19 are provided. Located in the outer core barrel 11 are diametric magnetizing means 20 such as the electromagnets shown in Fig. 1A.

The means for surveying the borehole are located within the non-magnetic sub 10. The housing generally designated as 22 containing the surveying instruments and controls is held in the sub 10 by means of brackets 23 and spider 23*a*. An annulus 43 shown in Fig. 1 is provided to permit the passing of drilling fluids around the housing 22. Located within the housing 22 is a power source such as the batterys 24, the switch controls 25, a motor 26, a multi-shot photographic camera 27, an inclinometer 28 and a compass 29 (see Fig. 1 and Fig. 4). A lubber line 30 is provided for the purpose of orienting the position of the electromagnets 20 with respect to magnetic north. In the embodiment shown the lubber line 30 and the line extending between electromagnets 20 along which the core is magnetized are parallel and lie in a plane taken along the longitudinal axis of housing 22.

Fig. 1A being a continuation of Fig. 1 and showing the lower portion of the present device, illustrates the location of the magnetizing means 20 within the outer

barrel 11. As shown in Fig. 1A the electromagnets 20 are located in recesses 34 of a non-magnetic sub portion 35 connected into the outer barrel 11. The electromagnets 20 are held in place by snap rings 34a. Although not shown the electromagnets consist of a magnetic case and wrap around coils which are connected to leads 36 which are channeled in the outer barrel and which in turn connect into the housing 22. The magnetizing means 20 are positioned in the outer barrel 11 below the lower most extremity of the core catcher 14 and above the drill bit 12. Hence, it can be seen that while drilling the core, the core may be magnetized at any desired location along its length.

Fig. 5 shows a sectional elevational view of the controlling means 25 which is included in the housing 22 containing the surveying instruments. Located within a recess in housing 22 is a hydrostatic switching means 40, which is spring biased by means of a coil spring 41. The coil spring 41 biases the piston 42 toward the fluid passage 43. Also included in a second recess in housing 22 is a flow switch 44. The flow switch 44 includes a bellows 45 to which is attached a lever arm 46. One end of the arm 46 has attached thereto a paddle 47 which is moved downwardly in response to the flow of circulating fluids during drilling operations. The spring 48, which is attached to the other end of the arm 46, biases the other extremity of the arm 46 against a semi-circular conducting means 49 when the circulation of fluid is ceased. Connected to the arm 46 at point 50 is a conductor 51. Connected to the semi-circular conducting member 49 is a second conductor 52. That part of the lever arm 46 which extends inwardly from point 50 is of electrically conducting material, whereas that part extending outward from point 50 is not. Hence, it can be seen that when the flow of circulating fluid is discontinued, the arm 46 will be biased against the semi-circular conductor 49 by spring 48 thereby closing an electrical circuit between conductors 51 and 52, without electrically grounding this point to the mud outside the instrument. The purpose of the bellows 45 is to allow pressure equalization between the oil-filled portion of the recess 45' and the borehole outside. Any contraction or expansion of the bellows necessary to equalize pressure will not interfere with the operation of the flow switch.

Fig. 7 shows an electrical diagram utilized in my new core orienting apparatus. The hydrostatic switch is indicated by reference numeral 40 and the spring biased flow switch by reference numeral 44 (as in Fig. 5). A relay 100 having movable contact arms 64, 65, 66, 67 and 68 is also included within the electrical circuit. The positions of the hydrostatic switch 40, the flow switch 44 and the relay contact arms 64 through 68, as shown in Fig. 7, are the positions of the switches and contact arms prior to the lowering of the apparatus into the borehole. The spring in hydrostatic switch 40 is selected to be of such strength so that when the instrument is lowered into the hole, the switch will be moved against the bias of this spring to engage contacts 62 and 63 only when the instrument is exposed to the predetermined hydrostatic pressure at the depth at which the core is to be taken. However, as long as the drilling is continued the flow of mud will prevent flow switch 44 from completing the circuit through contacts 49 and 50 thereby keeping the electrical circuit open during drilling operations. When it is desired to magnetize the core, the drilling is stopped, resulting in the movement of flow switch 44 against contacts 49 and 50. The movement of the flow switch 44 against contacts 49 and 50 energizes the relay 100 to move contact arms 64 and 65 against contacts 70 and 71, respectively. Contact arm 66 engages contact 72 and contact arms 67 and 68 engage contacts 73 and 74, respectively. Voltage is then supplied from condenser 75 through contact 70 to the incandescent light bulb 76. The supply of voltage to incandescent light bulb 76 and the lighting of the light bulb 76 result in the taking of

a picture of the compass and inclinometer contained in the surveying instrument. When contact arm 66 engages contact 72, voltage is supplied to the electric motor 26 through a limit switch 81. Motor 26 may possess two field windings and can run in either direction depending on which field is energized. Motor 26 rotates a shaft 82 which advances the film contained in the camera. Shaft 82 has connected thereto a disk 83 including a protruding portion 84. The protruding portion 84 engages the limit switch 81, after the film contained in the camera is moved a predetermined distance. When contact arms 67 and 68 engage contacts 73 and 74, respectively, electromagnets 20 are energized to magnetize the core. The voltage is supplied from condenser 85.

After the core has been magnetized, the flow of mud fluid may be resumed to continue the coring of the core. The mud pressure moves the flow switch 44 to open the electrical circuit thereby de-energizing relay 100. The contact arms of relay 100 are then returned to the position, as shown in Fig. 7, resulting in the recharging of condenser 75 by battery 86 and the recharging of condenser 85 by battery 87. Also, the other field winding of motor 26 is then energized, which reverses motor 26 and causes the shaft 82 to return to its previous position preparatory to again advancing the film after the next picture is taken. When the shaft attains this previous position, motor 26 is cut off by the contact of protrusion 84 with limit switch 90. When after further coring it is desired to magnetize the core at another location on the core, the drilling is again discontinued and the cycle of operation is repeated. Later in the laboratory, any section of the core can be oriented by determining the direction of its induced magnetization by means of a suitable magnetometer such as, for example, the type described by Johnson, Murphy and Michelsen in "Review of Scientific Instruments," volume 20, page 429 (June 1949) and correlating this with the orientation of the lubber line of the compass as recorded in the corresponding photograph. Since the direction of the lubber line relative to magnetic north has been photographically recorded and since the direction of the lubber line and the direction of induced magnetization extend in the same direction, the direction of induced magnetization relative to magnetic north is readily ascertained.

Although I have described my invention with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.

I claim:

1. In an apparatus for cutting a core from the bottom of an earth bore including a drill string: an outer barrel having a drill bit attached thereto and connected to said drill string; an inner barrel having a core catcher at its lowermost extremity disposed within said outer barrel, said core catcher being located within said outer barrel upwardly from said drill bit; diametric electromagnets in said outer barrel adapted to magnetize said core located below said core catcher and above said drill bit; means for energizing said electromagnets to thereby magnetize said core; means for de-energizing said electromagnets after said core has been magnetized; and surveying means positioned in said outer barrel for recording the azimuthal direction of said electromagnets at the time said core is magnetized, whereby the azimuthal direction of each of the magnetizations may be ascertained.

2. An apparatus in accordance with claim 1 wherein said means for energizing and de-energizing said electromagnets includes an electrical circuit having a flow switch exposed to the circulating fluid pressure which is biased to activate said electrical circuit when no fluid flow pressure is exerted against said flow switch, said flow

switch being opened by the application of fluid flow pressure to de-activate said electrical circuit.

3. An apparatus in accordance with claim 2 wherein said surveying means includes means for ascertaining the amount and direction of inclination of said apparatus at the time said core is magnetized.

4. An apparatus in accordance with claim 3 wherein said electrical circuit includes a spring biased pressure switch adapted to close to activate said electrical circuit at a selected fluid pressure and to open to deactivate said circuit at fluid pressures below said selected pressure.

5. An apparatus for obtaining a magnetized core from a borehole comprising a drill string having a drill bit positioned on the lower end thereof, means in said drill string for receiving said core, means in said drill string positioned above said drill bit for magnetizing said core, means in said drill string for energizing and de-energizing said magnetizing means, said core being movable past said magnetizing means whereby said core may be magnetized at selected portions of said core, and surveying means in said drill string for recording the azimuthal direction of said magnetizing means each time said core is magnetized whereby the azimuthal direction of each of the magnetizations may be ascertained.

6. An apparatus in accordance with claim 5 wherein said means for energizing and de-energizing said electro-

magnets includes an electrical circuit having a flow switch exposed to the circulating fluid pressure which is biased to activate said electrical circuit when no fluid flow pressure is exerted against said flow switch, said flow switch being opened by the application of fluid flow pressure to de-activate said electrical circuit.

7. An apparatus in accordance with claim 6 wherein said surveying means includes means for ascertaining the amount and direction of inclination of said apparatus at the time said core is magnetized.

8. An apparatus in accordance with claim 7 wherein said electrical circuit includes a spring biased pressure switch adapted to close to activate said electrical circuit at a selected fluid pressure and to open to deactivate said circuit at fluid pressure below said selected pressure.

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