March 21, 1944. W. L. CHURCH 2,344,598

WALL SCRAPER AND WELL LOGGING TOOL

Filed Jan. 6, 1942 3 Sheets-Sheet 1

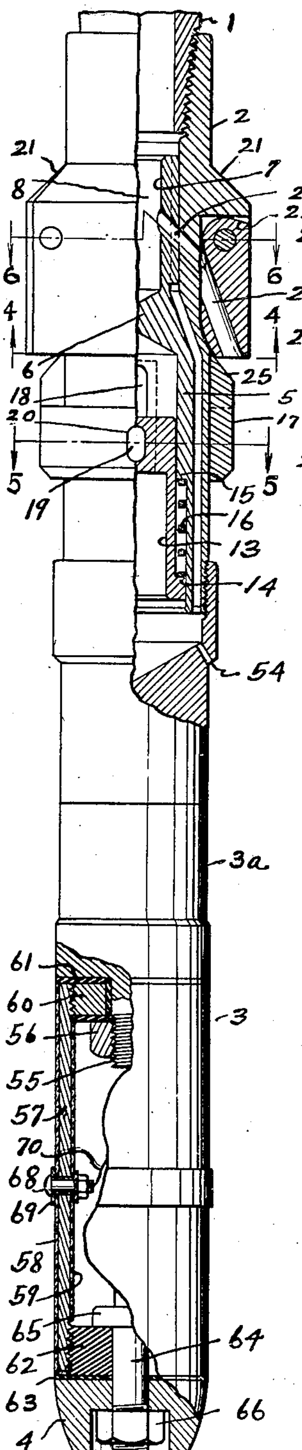

Fig.1.

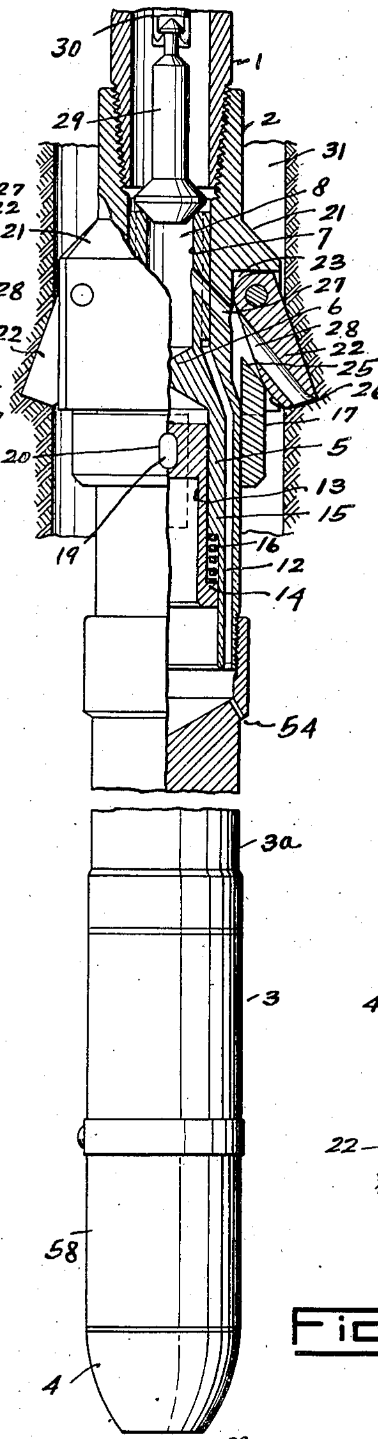

Fig.2.

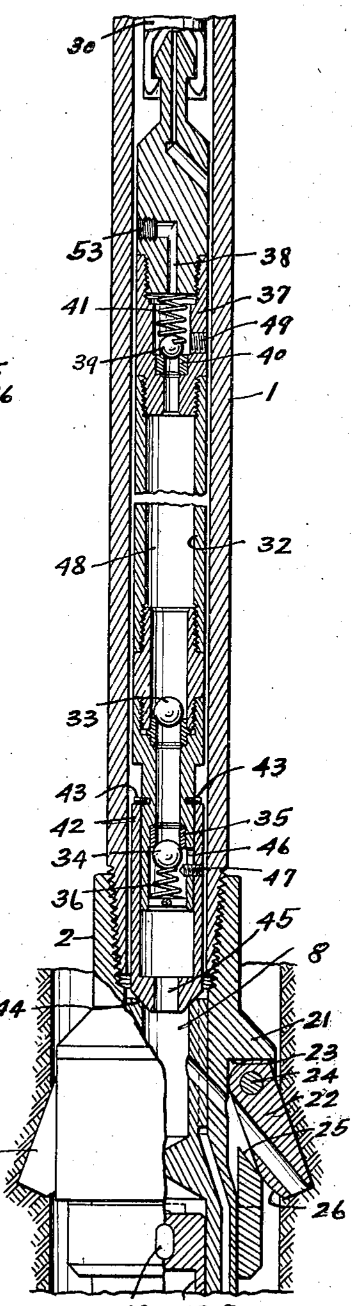

Fig.3.

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WALL SCRAPER AND WELL LOGGING TOOL

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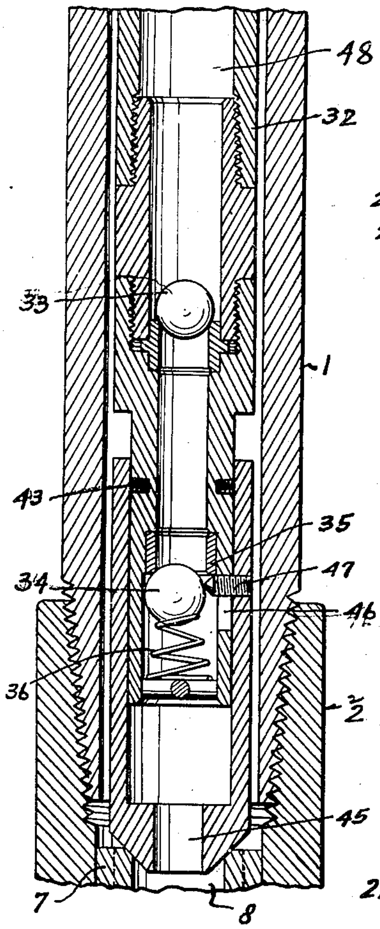

Fig. 7.

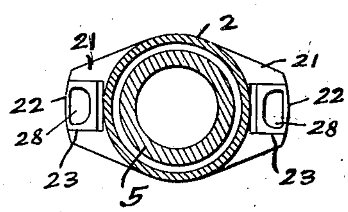

Fig. 4.

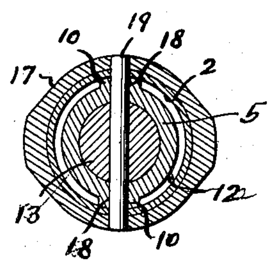

Fig. 5.

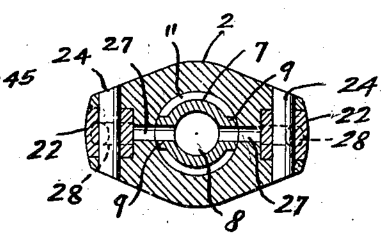

Fig. 6.

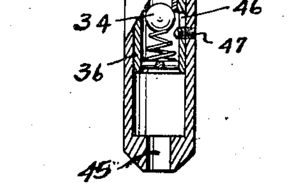

Fig. 8.

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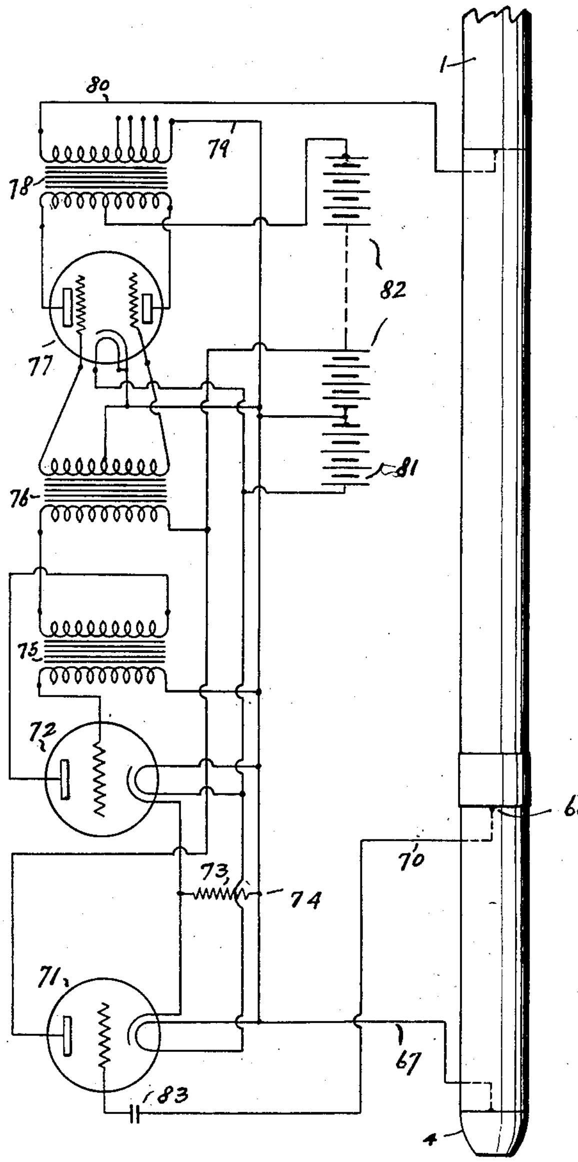

Fig. 9.

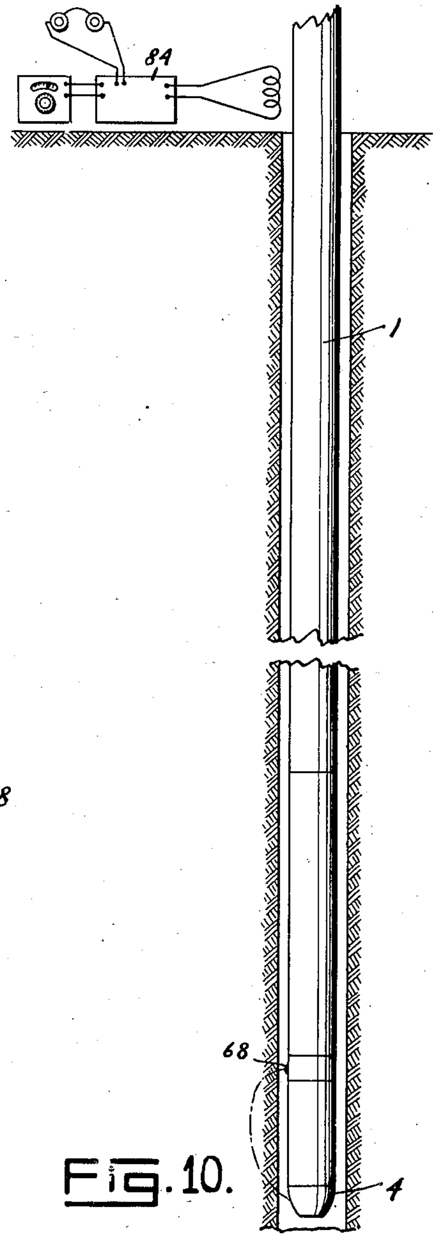

Fig. 10.

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2,344,598

WALL SCRAPER AND WELL LOGGING TOOL

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Application January 6, 1942, Serial No. 425,726

8 Claims. (Cl. 255—1.4)

This invention relates to a tool for use in a well bore designed to take samples of the side wall formation and to bring the samples to the ground surface for inspection.

An object of the invention is to provide a tool of the character described that may be lowered into the well bore while in inactive position and then actuated to active position whereby a sample of the formation may be taken from the side walls of the bore to be withdrawn to the ground surface.

A further object of the invention is to provide a tool of the character described so designed that the material which may have been deposited on the walls of the bore by the drilling fluid may be scraped off and removed so as to expose the natural formation to the end that an electrical well logging apparatus may be used to test the natural wall formation as thus exposed.

Another object of the invention is to provide in combination an electrical well logging device and side wall sample taking device. At the present time, it is common practice to run a well logging tool on a wire line into the well so as to locate different formations and to thereafter run a side wall sample taking tool on a string of drill stem to obtain samples of the various formations thus located. This method is not entirely satisfactory as wire line measurements vary, to a considerable degree, from measurements taken with the drill stem. By the use of the tool herein described, the well may be logged and the side wall sample taken during the same operation and in that manner the sample will be taken from the same stratum of wall formation which has been logged by the electrical well logging device.

In carrying on well logging operations at the present time, the electrical instrument is lowered into a well after the well has been drilled and wherein the walls of the well are covered with deposits from the drilling fluid. These deposits come from different formations and differ widely in conductivity. They cover the natural formation and consequently it is difficult if not impossible to obtain a true reading of the natural formations, so covered by an electrical well logging device. By the use of the apparatus herein described, the foreign deposits may be first removed from the wall of the well and the natural formation exposed and a true potential gradient of the formation may be obtained by the use of the well logging apparatus forming a part of this invention.

The invention herein disclosed constitutes an improvement over that disclosed in Patent No. 1,998,075, issued to applicant on April 16, 1935, and in Patent No. 2,053,698, issued to applicant on September 8, 1936. Other objects will be apparent from the following specification as illustrated by the accompanying drawings, wherein—

Figure 1 shows a side elevation, partly in section, showing the sample taking device in inactive position.

Figure 2 shows a similar view showing the sample taking device in active position.

Figure 3 shows a fragmentary, vertical sectional view showing the sample taking device in active position with the recovery device lowered into the drill stem.

Figure 4 shows a cross-sectional view taken on the line 4—4 of Figure 1.

Figure 5 shows a cross-sectional view taken on the line 5—5 of Figure 1.

Figure 6 shows a cross-sectional view taken on the line 6—6 of Figure 1.

Figure 7 shows a fragmentary, vertical, sectional view of the sample recovery apparatus in position to receive the sample from the sample taking device.

Figure 8 shows a side elevational view of the recovery device shown partly in section.

Figure 9 shows a side elevation of the lower end of the tool showing also a wiring diagram, and

Figure 10 shows a side elevation of the drill stem showing the tool connected to the lower end thereof partly broken away, showing also the amplifier and frequency measuring device at the ground surface.

Referring more particularly to the drawings, the numeral 1 designates a tubular drill stem to the lower end of which there is connected a special coupling 2 which is slightly flared at its lower end and to the lower end of which there is connected a housing 3 for the well logging device more particularly hereinafter described. At the lower end of this housing, there is a guide plug 4, said housing and plug forming also a guide for the tool.

Within the coupling 2 there is a downwardly opening cylinder 5 which is closed at its upper end by the transverse web 6 and, above the web the cylinder has a tubular extension 7, preferably formed integrally therewith and which is spaced from the inner wall of the coupling. This extension contains the sample receiving chamber 8 and on opposite sides has the relatively wide vertical ribs 9, 9, which fit closely against the inside wall of the coupling 2, as more accurately shown in Figure 6. The cylinder 5 is spaced from the coupling 2 and at opposite sides has the relatively wide vertical ribs 10, 10, which fit closely against the inside walls of said coupling as shown in Figure 5. The ribs 9 are staggered with respect to the ribs 10 and connecting upper and lower channels 11 and 12 are thus provided through which drilling fluid may flow downwardly from the drill stem 1 into the lower end of the cylinder 5.

Within the cylinder 5, there is a plunger 13 of a general tubular form whose upper end is formed solid, as shown in Figures 2 and 5 and whose lower end is open. The lower end of the plunger has an external annular upwardly facing shoulder 14 and above the shoulder the cylinder is provided with an internal annular downwardly facing shoulder 15.

Surrounding the plunger and interposed between said shoulders 14 and 15, there is a strong coil spring 16 which normally holds the plunger in its lower position as shown in Figure 1.

Around the lower flared end of the coupling 2, there is an annular expander 17 as shown in Figures 1, 2 and 5.

The cylinder 5 and the surrounding coupling 2 have the oppositely disposed vertical slots 18, said slots on said opposite sides registering and said slots being cut through the ribs 10 of the cylinder 5 as shown in Figure 5. A pin 19 extends transversely through the solid end of the plunger 13, as shown in Figure 5, with its ends extended through the slots 18 on each side. This pin limits the movement of the plunger in each direction and its outer ends are fitted into bearings 20 of the expander whereby the expander will be moved with the plunger.

As will be noted, more particularly in Figures 4 and 5, the coupling 2 is widened, on each side, intermediate its ends thus providing housings 21, 21 wherein are housed the relatively wide probes 22, 22 terminating in downwardly directed scraping edges.

Each housing 21 is provided with a downwardly facing recess 23 wherein the corresponding probe 22 is fitted closely and the upper end of each probe is pinned in the housing by the transverse pin 24. The lower ends of the probes, therefore, may be swung outwardly into position shown in Figures 2 and 3, by the expander 17, upon upward movement of said expander. The upper end of the expander has the inwardly tapering face 25 which works in contact with the outwardly tapering inside faces 26 of the probes, so that upon upward movement of the expander, the lower ends of the probes will be forced outwardly.

The tool, as assembled in Figure 1, may be lowered into the well. The spring 16 will hold the plunger 13 and the expander 17 in their lowermost position while the tool is being lowered. Circulation may be maintained in the bore by the flow of drilling fluid downwardly through the drill stem and out through the aligned passageways 27 and 28. The passageways 27 lead outwardly through the ribs 8 and coupling 2 and the passageways 28 continue on outwardly through the probes. When it is desired to take a sample of the wall formation or to remove the wall coating, hereinabove referred to, a plug 29 may be dropped through the drill stem and it will land upon and close the upper end of the sample receiving chamber 8. The drilling fluid will thereafter be forced under pressure through the passageways 11 and 12 and will enter the lower end of the cylinder 5 and will operate to move the plunger 13 upwardly into the position shown in Figure 3 and the expander 17 will be carried upwardly with the plunger and will engage behind the probes 22 and will force them outwardly. The plug 29 may then be engaged by a grappling tool of conventional design, such as indicated by the numeral 30, which is lowered into a drill stem by a wire line and engaged with the plug and the plug removed.

The tool may then be lowered and as it is lowered, the wall formation will be scraped, by the scrapers 22, off of the wall of the bore and portions of it will pass upwardly through the passageways 28 and 27, and will enter and fill the chamber 8. This chamber may be made of any desired capacity so as to receive a substantial sample.

It is to be understood that at this time the drill stem 1 as well as the well bore 31, are filled with drilling fluid so that the static pressure will be the same.

When a sufficient sample has been collected in the chamber 8, a sample removing tool, such as shown in Figure 8, may then be lowered through the drill stem and will land on the upper end of the chamber 8 as illustrated in Figure 3.

This sample removing tool will now be described. It embodies a tubular barrel 32 having the upwardly opening valve 33 near its lower end and beneath it the downwardly opening ball valve 34 which is normally held against its seat 35 by a strong coil spring 36 beneath it. Screwed onto the upper end of the barrel 32, there is a head 37 having an outlet passageway 38 extending upwardly therethrough and turned outwardly through the side of the head as shown in Figure 3. This passageway is normally closed by an upwardly opening valve 39 which is held against its seat 40 beneath by means of a strong coil spring 41 above.

Fitted over the lower end of the barrel 32, there is a sleeve 42 which is held in its lower position, temporarily by means of the frangible pins 43 which are carried by the barrel and engage the upper end of the sleeve. The lower end of this sleeve is tapered to land on the tapering seat 44 at the upper end of chamber 8 and also has an inlet passageway 45. When this tool lands on the seat 44, it is empty and upon the application of pump pressure to the drilling fluid above, the barrel will be forced further downwardly shearing the pins 43. The lower end of the barrel has a vertically elongated side slot 46 and a pin 47 is anchored to the sleeve 42 and extends through said slot and upon said further downward movement of the barrel, the inner end of the pin 47 will engage the ball valve 34 and force it over to one side of its seat 35. The tool should now be moved upwardly so that the free ends of the probes 22 will not be embedded in the wall formation and the pressure of the fluid in the bore 31 will force the contents of the chamber 8 up through the passageway 45 and on up past the valves 34, 33 and into the sample receiving chamber 48 above said last mentioned valve. The grappling tool, as 30, may now again be lowered and engaged with the head 37 as shown in Figure 3 and the sample removing tool removed from the drill stem with the sample therein and trapped between the valves 33, 39. When this tool is removed from the well, an unseating tool may be screwed through the tapped hole 49 opposite the valve 39. This unseating tool is designated generally by the numeral 50 and its inner end has a reduced release finger 51 which will engage the valve 39, when the unseating tool is screwed into place, and unseat said valve from its seat 40 thus allowing the sample to escape through the channel or duct 38 for inspection. However, if desired, before unseating the valve 39, a pressure gauge as 52 may be screwed into the laterally turned internally threaded end 53 of the passageway 38 and the valve 39 then unseated and the pressure of the sample contained in the chamber 38, thus ascertained before said sample is released from said chamber. Any solid sample which may accumulate in the chamber 48 may be rendered accessible by unscrewing the head 37 from the barrel 32.

The upper end of the housing 2 is preferably formed of a solid connection 3a whose upper end is provided with one or more discharge ports 54 through which circulation of the drilling fluid may be maintained while the upper end of the chamber 8 is closed.

The lower end of the solid coupling 3a is reduced forming an outwardly threaded stud 55 designated to receive the nut 56. Beneath the solid connection 3a the housing is formed of a cylindrical case 57 which is covered on the outside and lined on the inside with the insulating coatings 58, 59.

Threaded into the upper end of the case 57 there is a ring 60, which is insulated from the connection 3a by the insulating material 61. The stud 55 extends through the ring 60 and is maintained in assembled relation therewith by means of the nut 56 which is also insulated from the ring 60, as more clearly shown in Figure 1.

Screwed into the lower end of the case 57 there is a ring 62 formed of insulating material. The guide plug 4 is fitted against the lower end of the case 57 and insulated therefrom by the insulating material 63. A stem 64 is fitted downwardly through the ring 62 and through the plug 4. This stem is formed with a head 65 which engages the inner end of the ring 62 and its lower end is externally threaded to receive a nut 66 which is countersunk into the lower end of the plug and which serves to clamp the plug to the lower end of the case 57. The stem 64 is not insulated from the plug 4 and they form an electrode to which the conductor 67 is connected.

Extended through the wall of the case 57 there is an electrode 68 which is insulated from the case by the insulation 69. A conductor 70 is connected to the electrode 68.

A voltage generating and measuring circuit is illustrated diagrammatically in Figure 9 and housed within the case 57 and includes a vacuum tube voltage measuring circuit 71 which measures the voltage between the electrodes 4 and 68. The numeral 72 designates an audio-frequency signal generator. A change in voltage across the electrodes 4 and 68 causes a change in the cathode current of the measuring current 71 through the resistor 73. This resistor 73 connects the cathodes of the circuit 71 and generator 72 to the common amplifier ground 74. The audio-frequency of the signal generated by generator 72 is determined by the voltage drop across the resistor 73. Thus a voltage change across the electrodes 4 and 68 causes a voltage change across the resistor 73. The transformer 75 forms the tank circuit of signal generator 72. The signal generated by the generating circuit is coupled through the transformer 76 into the voltage amplifier tube 77. The numeral 78 designates the output transformer, one side of its secondary winding being connected through the conductor 79 to the common amplifier ground 74 and in turn through the connector 67 to electrode 4. The other side of the secondary winding of transformer 78 is connected through the conductor 80 through the coupling 3a to the drill stem which forms the third electrode. The voltage produced by the signal generating circuit is thus amplified by the tube 77 and fed into the drill stem and electrode 4. The out-put circuit is completed by the generated current passing through the bore hole side wall formation between the electrode 4 and the drill stem. A portion of this voltage is measured by the vacuum tube measuring circuit 71 between the electrodes 4 and 68. The battery 81 supplies the filament voltage for the tube of circuit 71 and the tubes of generator 72 and amplifier 77 and the battery 82 is the high voltage plate supply for the tubes of 71, 72 and 77. The condenser 83 is a direct current blocking condenser to the vacuum tube 71. The signal to be received at the ground surface is carried up by means of the drill stem 1. As shown by Figure 10, a suitable frequency measuring device 84 is set up at the ground surface. The device 84 may be loosely coupled to the drill stem 1 by means of an induction coil, or under certain conditions, it might be found most practical to use a direct connection to said drill stem. Said frequency measuring device 84 also includes an audio-frequency amplifier and a suitable means for measuring the frequency of the signal that is conducted to the surface by the drill stem.

When the device has been lowered into the well and the foreign deposits have been removed by the scrapers 22 to expose the natural formation, the drill stem is then elevated so as to bring the electrodes 4 and 68 opposite the natural stratum thus exposed in order to measure the resistivity of said exposed stratum. The voltage out-put of vacuum tube 77 is constant over the entire audio-frequency range. Thus with a high resistivity between electrodes 4 and 68, there is a high voltage and low current indicated in the stratum. With a low resistivity of the stratum there is developed a low voltage and a high current between the electrodes 4 and 68. A change of resistivity between electrodes 4 and 68 causes a change in voltage between these electrodes, this voltage being applied to the grid of vacuum tube 71, thus causing a change in the cathode current of said vacuum tube 71. The amount of current drawn by the cathode of vacuum tube 71 determines the voltage drop across the resistor 73. Since the cathode of both voltage measuring circuit 71 and signal generator 72 are connected to a common side of resistor 73, any change in cathode voltage of circuit 71 is also applied to the cathode of generator 72. The frequency generated by generator 72 is regulated by the voltage applied to its cathode. It can be seen that with a certain resistivity in the earth stratum a certain audio-frequency signal will be generated and produced by the amplifier. Thus, a given audio-frequency will indicate a given resistivity, enabling the operator at the surface to record changes in resistivities of the strata of the bore hole.

The invention includes not only the wall scraper and electrical logging device but also the method of locating the formation strata in a well, ascertaining the nature of the stratum so located and the recovery of a sample of the located stratum.

What I claim is:

1. A device for taking samples from a well comprising a sample receiving chamber having an inlet, a wall scraping probe pivotally mounted relative to the wall of the chamber and movable to active or inactive positions and provided with a channel, means to move the probe to active position to engage the wall of the well bore, said probe being mounted relative to the inlet whereby to cause the wall formation to pass along said channel and through said inlet into the chamber, when the probe is in active position, upon longitudinal movement of the device in a well.

2. A device for taking samples from a well comprising a sample receiving chamber having an inlet, a wall scraper mounted relative to the chamber wall and movable to active or inactive positions, means arranged to be operated by fluid under pressure to move the scraper to active position to engage the wall of the well bore, said scraper being shaped to direct wall formation through said inlet into the chamber, when the scraper is in active position, upon downward movement of the device in the well.

3. A device for taking samples from a well comprising a sample receiving chamber having an inlet, a wall scraper mounted relative to the chamber wall and movable to active or inactive positions, means arranged to be operated by fluid under pressure to move the scraper to active position to engage the wall of the well bose, said scraper being shaped to direct wall formation through said inlet into the chamber, when the scraper is in active position, upon downward movement of the device in the well and sample entrapping means arranged to be brought into communication with said chamber for receiving and entrapping the sample for removal to the ground surface.

4. A device for taking samples from a well comprising a body having a sample receiving chamber therein provided with an inlet, an outwardly movable member thereon, means arranged to be actuated by fluid under pressure to move said member outwardly into position to engage the wall of the well bore and to remove a portion of the formation therefrom upon longitudinal movement of the device in the well.

5. A device for taking samples from a well comprising a body having a sample receiving chamber therein provided with an inlet, an outwardly movable member thereon, means arranged to be actuated by fluid under pressure to move said member outwardly into position to engage the wall of the well bore and to remove a portion of the formation therefrom upon downward movement of the device in the well, said outwardly movable member being shaped to direct the removed formation through said inlet into said chamber upon such movement of the device in the well.

6. A device for taking samples from a well comprising a body having a sample receiving chamber therein provided with an inlet and adapted to be connected to a tubular operating string, an outwardly movable member on the body, means for actuating said member outwardly into position to engage the wall of the well bore and to remove a portion of the formation therefrom upon downward movement of the device in the well, means arranged to be actuated by fluid pressure exerted through said member outwardly, said outwardly movable member being shaped to direct the removed formation through said inlet into said chamber upon such movement of the device in the well.

7. A device for taking samples from a well comprising a body having a sample receiving chamber therein provided with inlets and adapted to be connected to a tubular operating string, a plurality of outwardly movable members thereon, an expander, means arranged to be actuated by fluid under pressure exerted through said string to move said expander in position to expand said outwardly movable members into position to engage the wall of the well bore and to remove a portion of the formation therefrom upon downward movement of the device in the well, said outwardly movable members being shaped to direct the removed formation through said inlets into said chamber on such movement of the device in the well.

8. A device for taking samples from a well comprising a body having a sample receiving chamber therein provided with an inlet and adapted to be connected to a tubular operating string, an outwardly movable member on the body, means for actuating said member outwardly into position to engage the wall of the well bore and to remove a portion of the formation therefrom upon downward movement of the device in the well, means arranged to be actuated by fluid pressure exerted through said member outwardly, said outwardly movable member being shaped to direct the removed formation through said inlet into said chamber upon such movement of the device in the well and sample entrapping means shaped to be lowered into and withdrawn from the operating string and effective to receive and entrap the sample from said chamber for removal to the ground surface.

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