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MEANS FOR LOGGING WELLS

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Fig. 1.

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Comparison with typical indication
set up by lead for initial testing.
This invention relates to an apparatus for logging wells whereby characteristic vibrations set up by the drill bit may be recorded automatically along with other information incident to the drilling operation.

When a drill bit is cutting in a particular formation, vibrations are set up and travel longitudinally up the drill stem which indicate the particular formation through which the bit is boring. If these vibrations are properly recorded, the formation or strata may be ascertained, without the necessity of the drilling operation being stopped. It will be obvious also that variations within a particular formation, such as the presence of an oil in a sand or water in a sand, may be identified by slight differences in recorded characteristics.

It is one of the objects of this invention to provide an apparatus and method for practising the same whereby the vibrations initiated by a drill bit cutting in a formation may be automatically recorded while the well boring operation is going on.

Another important object of the invention is the provision of such an apparatus whereby other pertinent and desirable information required for complete analysis of the strata may also be automatically recorded. Such information consists of the speed of rotation of the drill bit, the weight on the drill bit and the type and condition of the same, also the drilling depth of the well and the mean amplitude of the recorded vibrations.

The invention may be readily understood from a perusal of the following detailed description, taken in connection with the accompanying drawings, and in the drawings:

Figure 1 is an elevational view of an oil well derrick and a part of the well boring rig illustrating an embodiment of the invention.

Figure 2 is an enlarged detail elevational and partly sectional view of the vibration detector means mounted on the upper end of the Kelly joints;

Figure 3 is an enlarged detailed sectional view of a housing carrying the means for recording well depth, drill bit rotation speed, weight on the bit, pattern of vibration, etc., the view being had on line 3–3 of Figure 4;

Figure 4 is a transverse vertical sectional view of Figure 3, the view being taken on the line 4–4 thereof;

Figure 5 is a detail fragmentary view of an arrangement of dials for recording the speed of the drill bit, Figure 6 being a sectional view thereof on line 6–6;

Figure 7 is a diagrammatic electrical circuit for connecting up the parts shown in Figures 3 to 6, inclusive;

Figure 8 is a diagrammatic electrical circuit for connecting up the parts shown in Figure 2; and

Figure 9 is a view of a circuit showing a voltmeter for measuring the speed of rotation of the drill bit.

In Figure 1 there is shown a derrick 1 with blocks 2 and swivel 2–a, for raising and lowering the Kelly joint 3 (carrying a bit, not shown) in the well. The hose line is indicated at 4. Fastened to the upper end of the Kelly or drill stem joint is the detector unit which consists of a plurality of contact vibration pickups having high fidelity and indicated at 5 and mounted on a collar 6 which is in turn secured to the top of the Kelly joints. Directly below the collar 6 is provided an insulating bushing 7 and on which are mounted in spaced relation the contact and light rings indicated at 8 and 8a and 9. The bushing is provided with a stationary housing 10 for the parts comprising the detector unit and a bearing 11 is shown within which the shaft bushing, etc., rotate. Included in the detector unit assembly are brushes 12 and 13 for contact with the rings 8 and 8a, a pre-amplifier 14 and a photo-electric tube 15 for synchronizing the sweep trace of the cathode ray tube. The action of photo-electric sweep device 9 is that the light ring 9 moves before the phot-to-electric cell and the exciter light 8 increases or decreasing the light to dark ratio on its surface, increasing proportionately the current in the cell. This current change is translated by suitable amplifiers into a voltage which sweeps the spot across the tube in synchronism with the rotation of the drill bit. The supporting means for the detector unit also includes a collar 16 which is connected to the collar 6 by the links 17 and the pins 16a fitted with rubber bushings, the collar 16 being attached to the swivel 2–a. An insulating means in the form of a rubber hose is indicated at 18 for vibration insulating the pickup unit from the swivel and blocks.

The apparatus also includes a camera unit shown in Figures 3 to 6, inclusive and enclosed in a housing H and this unit records automatically at any specified interval the vibration pattern, the speed of rotation of the drill bit, the weight on the bit, the depth of the well, and the amplitude of the vibrations picked up. The vi-
bration pattern as indicated at 19 is produced during one rotation of the drill bit at that point in the formation where it is drilling. This pattern is seen on the cathode ray tube 20 disposed in one end of the housing H by applying the output of the detector unit with its amplifier to the vertical plates of the cathode ray tube and sweeping the trace with a voltage synchronized to the rotation of the drill bit. The speed of the rotation of the bit is recorded on a voltmeter and indicated in Figure 9 at 42, measuring the output of a small magnet or magnets 22 incorporated in the detector unit in the housing 10.

The weight on the drill bit is recorded by means of a sheave 23 and a dial arrangement shown in Figures 3 and 4. A line 24 is fastened to the sheave 23 and rides over the pulleys 25 at the top of the derrick as shown in Figure 1.

A spring 25 is secured to the sheave and has one end fastened to the housing H and serves to retract the sheave to normal position. By this arrangement when a stress is put on the rig by the addition of a drill stem, the rig shortens slightly, causing the line 24 to wind slightly around the sheave 23, against the tension of the spring 25, and resulting in a slight rotation of the pin sheave. A very small pinion gear indicated at 27 is in meshed relation with the teeth of the sheave as shown in Figure 5, this pinion gear being mounted on a pin 28 and on the pin is carried an indicator needle 29. Two diaphragms are also associated with the needle; one dial indicated at 30 is stationary and registers the total stress on the rig. The other dial 31 has a slight frictional contact with the dial 30 so that it may move up to a maximum point with the needle and remain there when the needle recedes from that point. The amount the needle recedes from maximum registers the amount of weight on the drill bit. The camera unit and the vibration detector means are connected by a cable 4—a which is attached to the hose 4.

The depth of the well is shown by a counter indicated at 32 and which is actuated by means of a line 33, one end of which is wound about a spring loaded drum 34 the rotation of the drum driving the counter 32. The drum is made to rotate by attaching the line 33 to the lower of the blocks 2 and directing it over a pulley 25. The drum carries fingers 36 which move against a bar 37 in actuating the counter 32, the bar being held in inactive position by a spring 38. On the face of the drum 34 are projections 39 for operating the switches 40 and 42 connected in the circuit. An amplitude indicator and an R. P. M. indicator are shows at 41 and 42, respectively and a voltmeter is provided across the A. V. C. control to measure the amplitude of the vibrations picked up. The type of drill bit may be disclosed at 43 and a clock is indicated at 44.

Enclosed in the sub-housing S are the tubes T for the amplifiers and the power supply mechanism.

All these instruments on the panel are photographed by a camera shown at C which is provided with a shutter operating means synchronized with the sweep circuit by means of suitable amplifiers, relays and solenoids S1 and S2 and a film feeding means indicated at E, operating through suitable solenoids S3 shown in the circuit in Figure 7. Exposures may be made at any desired interval in drilling, i.e., at 10 feet, five feet or one foot. The exposed film may be removed from the camera and processed for study whenever desired. An observation window is also provided so that the conditions may be observed at any instant.

From a study of the foregoing it should be apparent that the records obtained by photographing the instruments at aforesaid intervals will allow correlation of formation from well to well. It is also claimed that very close control of the drilling of a well may be had by watching the vibration pattern and input lever indicator closely as the drill bit encounters a suspected break in formation. Variation within a particular formation, such as the presence of an oil in a sand or water therein may be identified by differences in recorded characteristics. It may also be pointed out that the apparatus and method of operation of the same is continuous and that there is no necessity to cease drilling to make a determination.

It is believed that the preceding description in detail of the apparatus in connection with the function of each part is sufficient information without further explanation and that those familiar with the geophysical technique and well drilling may readily comprehend the invention.

While the disclosure presents a practical working embodiment of the apparatus it is to be understood that there are numerous changes, alterations and modifications which may be made therein in keeping with the invention and which might be said to come fairly within the scope and meaning of the claim appended hereto.

What is claimed is:

An apparatus for logging wells comprising a vibration pick-up unit assembly mounted on the Kelly joint of a well rigging and arranged to rotate with the drill stem thereof, said unit being provided with means for transmitting amplitude and traversing electrical impulses and including a sweep device with a light ring and a photoelectric tube, the light ring rotating before the tube to produce an electric current change in the tube, proportional to the rotation of the drill bit; the apparatus including an oscillograph for receiving and exhibiting said impulses.

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