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METHOD AND APPARATUS FOR DETERMINING THE POSITION OF FLUID BEARING SANDS WHILE DRILLING WELLS

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Fig. 1

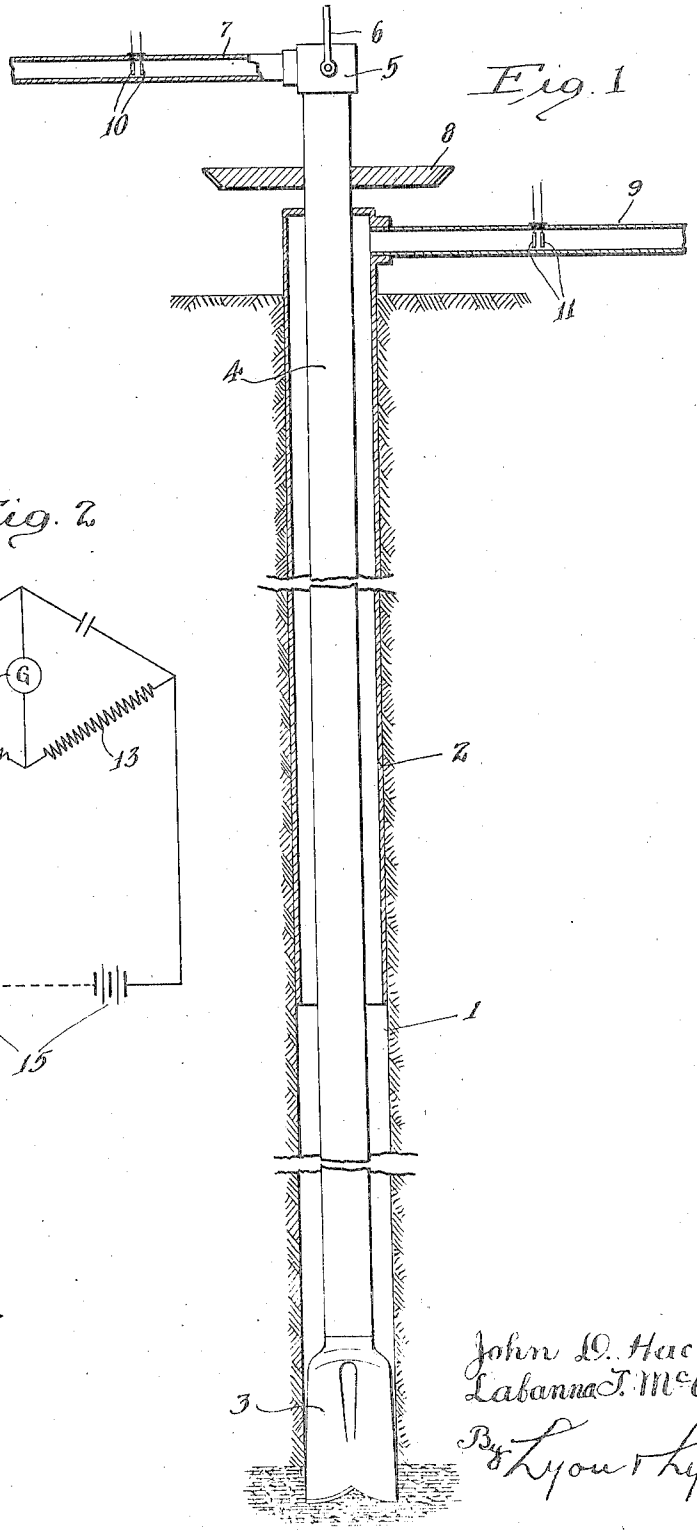


Fig. 2

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METHOD AND APPARATUS FOR DETERMINING THE POSITION OF FLUID-BEARING SANDS WHILE DRILLING WELLS.

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This invention relates to the art of drilling wells, such as oil wells, by the hydraulic rotary method and refers particularly to a method and apparatus by means of which the position of fluid bearing formations encountered in drilling a well may be determined.

In the hydraulic rotary method of drilling a well, the hole is drilled by means of a drilling bit attached to a string of pipe or casing extending to the bit from the surface. During drilling operations a drilling fluid consisting of water carrying a large amount of colloidal suspended mud is continuously pumped down the drill pipe to the drill bit and from thence continuously returns around the outside of the drill pipe. This drilling fluid carries the detritus or cuttings formed by the drilling bit continuously to the surface. During the drilling operations sands carrying water are frequently penetrated by the drill and it is of great importance that the position of these sands be located so that they may be shut off from the well.

These water bearing sands generally contain water possessing a considerable salt content, and when the drilling bit first penetrates the sands the salt content of the returning stream of drilling fluid is markedly increased. The fact that the drill has encountered a water bearing sand can occasionally be determined by making a chemical analysis of the returning drilling fluid for its salt content. However, this method is unreliable inasmuch as it frequently occurs that when a water bearing sand is penetrated by a drill the sand discharges salt water into the well only for a very short period of time, after which the mud carried by the drilling fluid is forced into the water bearing sands in such a way as to temporarily seal off the sands from further discharge of salt water. Accordingly, unless an analysis of the returning drilling fluid happens to be made practically simultaneously with the penetration of the drill into the water sand, the momentary increase in salt content of the drilling fluid will escape detection and the existence of the water bearing sand will not be known. Later when the drill penetrates an oil bearing formation and the mud laden fluid within the well is removed, the seal on the water bearing formations will be released and the well will start to produce salt water.

It is an object of the present invention to provide a method and means by which the drilling fluid returning to the surface of the well during drilling operations can be continually tested for its salt content whereby each change in the salt content of the drilling fluid will be known and whereby no portion of the drilling fluid may escape unanalyzed and whereby no salt water bearing formation can be drilled through unnoticed.

In accordance with the present invention it is found that by placing a pair of electrodes in the stream of returning drilling fluid and connecting said electrodes with a necessary apparatus to indicate the conductivity of the fluid passing between the electrodes the salt content of said fluid may be continuously determined. Whenever the salt content of the returning drilling fluid increases, the conductivity of the returned drilling fluid between the electrodes will likewise increase, giving an indication at the top of the well that the drill has penetrated into a formation yielding salt water.

The method and apparatus of the present invention also may indicate the penetration of the drill into other formations such as formations yielding oil or gas. When the drill enters a formation yielding oil or gas, the presence of oil or gas in the returning drilling fluid will change the conductivity of the drilling fluid and thereby indicate at the surface of the well the fact that such a formation has been penetrated.

The present invention, together with various additional objects and advantages thereof, will best be understood from the description of a preferred form of a method and apparatus embodying the invention. For this purpose there is hereinafter set forth with reference to the accompanying drawings a description of a preferred form of the invention.

In the drawings:—

Figure 1 is an elevation mainly in vertical section of a preferred form of apparatus; and

Figure 2 is an electrical diagram of the apparatus.

Referring to the drawings, 1 indicates a well hole, the upper portion of which may be enclosed by a well casing 2. 3 indicates

a drilling bit within the well hole which is carried by a hollow string of casing or drill pipe 4. The drill pipe 4 is shown as extending to the surface of the well where it is supported on a swivel 5 by suitable means 6. The swivel 5 is indicated as connected with a line 7 which leads to a source of drilling fluid or rotary mud. 8 indicates a means such as a rotary table for rotating the drill pipe 4 in the well. At the top of the casing 2 there is provided a line 9 by means of which the drilling fluid returning from the well may be discharged.

In the preferred form of the invention there is employed a pair of electrodes 10 in the line 7 by means of which the conductivity of the drilling fluid entering the apparatus may be determined. There is also employed a pair of electrodes 11 in the line 9 by means of which the conductivity of the discharged drilling fluid may be determined.

The apparatus also includes a means for indicating the relative conductivity of the drilling fluids in lines 7 and 9. A preferred form of said means is indicated in Figure 2. Referring to Figure 2, the pair of electrodes 10 and 11 are indicated as positioned in a Wheatstone bridge in which 12 and 13 indicate resistances and 14 a galvanometer. 15 indicates a source of electrical potential for the Wheatstone bridge. Said source of electrical potential may be a direct current source, but a source of alternating potential is preferred as it produces less polarization around the electrodes. The galvanometer 14 is preferably of a recording type.

In operation of the process and apparatus, continually during the drilling operations, current is supplied to the Wheatstone bridge which includes the pairs of electrodes 10 and 11, and the Wheatstone bridge is adjusted so that in normal drilling operations no current passes through the galvanometer. When the drilling bit 3 penetrates a fluid bearing formation, the cognate fluids of said formation by intermingling with the returning drilling fluid effect a change in the conductivity of the drilling fluid. This change in conductivity of the drilling fluid is detected by the galvanometer 14 as soon as the returns arrive at the surface of the well. Where a formation is penetrated yielding salt water, the salt content of the drilling fluid is increased increasing the conductivity of the drilling fluid and the galvanometer 14 registers such increase in conductivity. Where the encountered formation yields gas or oil, the presence of such gas or oil intermingled with the drilling fluid decreases the conductivity of the drilling fluid giving an opposite indication of reading at the galvanometer 14.

The process and apparatus of the present invention give a continual indication of the conductivity of the drilling fluid thereby insuring that no portion of the drilling fluid can escape unanalyzed. Each time the drilling bit 2 penetrates a fluid containing formation, accordingly the presence of such formation is recorded by the galvanometer 14.

While in the preferred form of the invention we have shown electrodes positioned both in the inlet line for mud fluid entering the drilling apparatus and in the discharge line for mud fluid leaving the apparatus and we have shown both such pairs of electrodes formed into a Wheatstone bridge, it is to be understood that the method and apparatus of the present invention may not necessarily be confined to these features as various modifications of the method and apparatus may be employed. For example, only a single pair of electrodes may be employed, said electrodes being positioned in the discharge line from the drilling apparatus and such electrodes may be connected to any apparatus adapted to indicate the conductivity of the stream passing between said electrodes. Said apparatus may give only a visual indication of the conductivity of the drilling fluid passing between the electrodes or may continually record such conductivity. The present invention also may have the recording instrument operate together with a suitable time clock so that the change of conductivity is recorded or charted against time or the recording instrument may be connected with the drill pipe 3 or the draw works which support said drill pipe 3 so that the record of the conductivity of the drilling fluid will appear plotted or charted against the progress of the drill, or the apparatus may include a recording instrument which is adapted to record both the time and progress of the drill as well as the conductivity of the drilling fluid. Various well known forms of recording apparatus may be used for these purposes and the same are not herein specifically described.

While the form of the invention herein described is well adapted to carry out the objects of the invention, it is understood that various modifications and changes may be made without departing from the invention and the invention includes all such modifications and changes as come within the scope of the appended claims.

We claim:

1. A process of determining the location of fluid bearing sands encountered when drilling a well by the hydraulic rotary method which comprises determining the difference in conductivity of the drilling fluid entering the well and the drilling fluid discharged from the well, said latter determination being made while the drilling fluid is being discharged as a flowing stream.

2. A process of determining the location of fluid bearing sands encountered when

drilling a well by the hydraulic rotary method which comprises disposing electrodes in the returning stream of drilling fluid and measuring continually during drilling operations the conductivity of the fluid passing between said electrodes.

3. The combination with a rotary well drilling apparatus of electrodes disposed in the stream of drilling fluid returning from said apparatus, means for passing current between said electrodes, and an instrument adapted to indicate the conductivity of the drilling fluid passing between said electrodes.

4. An apparatus for determining the location of fluid bearing sands encountered when drilling a well by the hydraulic rotary method which comprises the combination with a hydraulic rotary drilling apparatus having a conduit for entering drilling fluid and a conduit for drilling fluid returning from the well, of electrodes positioned in said inlet conduit, means for passing electric current between said electrodes, electrodes positioned in such discharge conduit, means for passing electric current between said latter electrodes, and an instrument adapted to indicate the difference in conductivity of the fluid passing between the first electrodes and the fluid passing between the second electrodes.

5. An apparatus for determining the location of fluid bearing sands encountered when drilling a well by the hydraulic rotary method which comprises electrodes adapted to be positioned in the stream of drilling fluid passing to a drilling apparatus, electrodes adapted to be positioned in the stream of drilling fluid discharging from the well, said electrodes being located in a Wheatstone bridge, and said Wheatstone bridge including an instrument for indicating the difference in conductivity of the liquid passing between the first and second mentioned electrodes.

6. A process of determining the location of fluid bearing sands encountered when drilling a well by the hydraulic rotary method, which comprises circulating drilling fluid from the surface of the well to the bottom of the well bore and back to the surface, and simultaneously measuring the conductivity of the returning stream of drilling fluid.

7. A process of determining the location of water sands encountered when drilling a well by the hydraulic rotary method which comprises circulating drilling fluid from the surface of the well to the bottom of the well bore and back to the surface, and simultaneously measuring the conductivity of the returning stream of drilling fluid.

Signed at Los Angeles, California, this 13 day of October, 1927.

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