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METHOD AND APPARATUS FOR IDENTIFYING FORMATION SAMPLES

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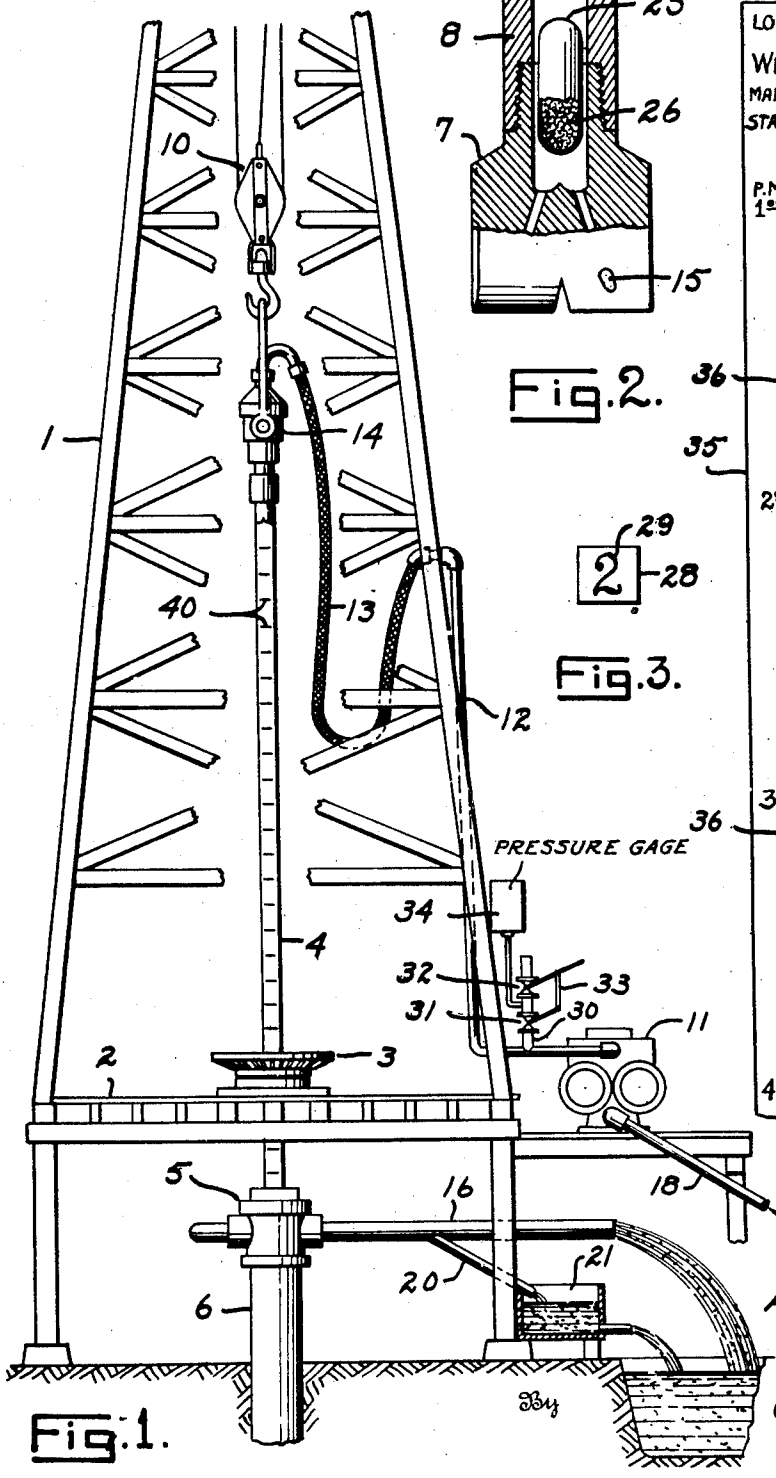


Fig. 1.

Fig. 2.

Fig. 3.

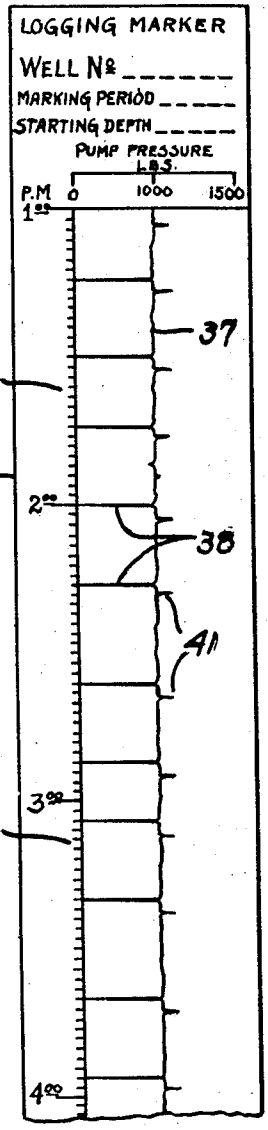


Fig. 4.

Inventor
ALONZO L. SMITH

By Lester B Clark
Attorney

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METHOD AND APPARATUS FOR IDENTIFYING FORMATION SAMPLES

Alonzo L. Smith, Houston, Tex.

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6 Claims. (Cl. 73—153)

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This invention relates to the rotary method of drilling well bores, and in particular to method and apparatus for providing information of the location at which cuttings or mud samples begin their journey upwardly in the well bore as drilling fluid is circulated during drilling operations.

In the drilling of wells by the rotary method of drilling, fluid is pumped downwardly through the drill pipe and the drill bit to carry cuttings to the surface and to function in other ways in the drilling of the well. It is a common practice to collect cuttings and mud samples at the surface and such cuttings and samples are marked as to what is believed to be the approximate depth of the bottom of the hole whence they started their upward journey.

This depth is usually determined from the operation of the pumps which circulate the drilling mud to carry the samples to the surface. However, there is some slippage of the cuttings in the mud during their upward trip and pumps vary both in speed and efficiency. Also, the volume of the well bore is not accurately known and there are additional variables such as water loss, formation intake of mud, etc., which cannot be accurately ascertained. Hence, in the marking of cuttings and mud samples obtained at the surface there is considerable guesswork in the effort to locate the depth at which their upward trip was begun.

It is important to the geologist that samples taken from the drilling fluid returns be accurately marked as to depth in order that he can correlate with other wells, identify formations as to depth, and hence determine the trend of such formations, analyze the samples for oil content, determine the depth of gas-bearing formations, etc. If the depths from which samples are obtained are uncertain the geologist may err in his determinations as to whether or not a well is high or low upon a known geological structure, as well as any other conclusions based upon information with reference to depth.

It is also important that the location of formations be accurately known so that operations such as formation testing, setting and perforating castings, etc., may be accurately and efficiently carried out.

The primary object of the present invention is to provide accurate information of the respective depths from which samples begin their journey upwardly within a well bore.

Another object is to provide, in the circulating mud, containing formation fluids and/or cuttings,

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identifying markers indicating the depth of origin of the fluids and cuttings.

Still another object is to continuously mark fluid samples for identity for depth of origin by the use of identifying markers or material supplied to the sample at the bottom of the well bore.

It is also an object of the invention to signal at the surface the association, at the bottom of the well in a circulating stream of drilling mud, of a formation sample and an identifiable material.

Still another object is to provide a recording mechanism to indicate the time and/or depth that a marked sample began its upward movement within the well bore.

It is also an object to supply successive containers or cartridges to travel with the drilling fluid in the drill pipe and to release the identifying markers or material at the drill bit.

Another object is to provide method and apparatus whereby pump pressure is varied at the time or depth at which an identifying cartridge or identifying markers enter the drill bit and to produce a record of such pressure variation.

These and other objects will be more fully apparent from the following description taken in connection with the accompanying drawing in which:

Fig. 1 is a diagrammatic illustration of the surface equipment used in the practice of the invention;

Fig. 2 is a sectional view through a drill bit showing the entry of a container or cartridge thereto preliminary to release of identifying markers or material from within the drill bit;

Fig. 3 illustrates one type of identifying marker that may be used in the practice of the invention;

Fig. 4 illustrates a logging marker or record produced in accordance with the invention.

In Fig. 1 there is shown a portion of a conventional drilling derrick 1 including a floor 2 upon which is mounted a rotary table 3 to drive the kelly 4. The kelly passes through the casing-head 5 and is attached to a drill pipe within the casing 6. Such drill pipe or string terminates in any suitable bit mechanism such, for example, as that shown at 7 in Fig. 2, and attached to the lower end of the drill string 8.

The kelly 4 and the drill string 8 are lowered at a suitable rate by means of a traveling block 10 and, simultaneously with such lowering step and rotation by the rotary table 3, drilling fluid is forced therethrough by the pump 11 through the

standpipe 12, hose 13 and the hydraulic swivel 14. This fluid is discharged through the ports 15 in the bit 7 at the bottom of the hole to cool the bit and to thereafter rise and carry cuttings upwardly to the return pipe 16 and thence to the pit, 17 where the drilling fluid is separated from the cuttings for reuse by return through the pipe 18 to the pump 11. A shale shaker (not shown) may be used if desired to separate cuttings from the mud, as is well known.

It seems apparent that samples of mud or cuttings may be taken directly from the discharge from the pipe 16 or from the shale shaker. Alternately, however, if desired, a bypass may be provided such as that shown as pipe 20 through which a portion of the returns pass to the collecting basin 21 whence samples may be obtained at any desired time.

As already indicated, the invention in one form contemplates the provision of containers or capsules such as indicated at 25 in Fig. 2. Such containers are made of any suitable material, such as fiber, synthetics, paper, etc., and are adapted to carry suitable markers or marker material 26 downwardly in the drill stem 8. The containers 25 arrive at the drill bit 7, and their movement is arrested at that point due to the arrangement of the discharge ports 15. The container thus tends to clog or close the ports 15 so that pressure immediately builds up within the drill stem 8 until the container is fractured or ruptured, whereupon the markers or the marking material 26 are released instantaneously at that point. Cuttings are being formed by the bit blades and also formation fluids from newly penetrated formations enter the well bore proximate the ports 15 in the bit. Hence the released markers immediately become associated with such cuttings and fluids and start their upward journey with the drilling fluid.

It is intended that, in accordance with the invention, the markers or material 26 in the container 25 shall be distinctive for the respective containers or cartridges, and to this end there may be provided markers such as that shown in Fig. 3 as comprising a small piece of fibrous or other suitable material 28 bearing indicia 29. These markers are borne by the drilling fluid so that any portion of the fluid leaving the bottom of the well at the time the markers were released will contain one or more of these markers. Such markers will also intermingle with and also adhere to the cuttings so that the cuttings may be quickly identified.

This being the case, obviously samples of cuttings need not necessarily be collected at the instant they are discharged at the surface of the well. For example, cuttings may be accumulated and samples may thereafter be taken from the accumulations. Each of such samples will bear desired identification so that it is possible to determine the depth from which the individual samples were removed. It seems apparent also that the markers provide accurate information as to depth when continuous mud analysis is made.

It is to be understood that the marker 28 may be of any suitable nature and may bear indicia as illustrated or, those of a given capsule may be identified by their size, shape, color, etc., or markers of different weights may be used for certain conditions. Preferably, however, the markers will be of a specific gravity that is quite comparable to that of the fluid with which they travel so that there will be no slip between the markers and the fluid. Also, the markers may be absorbent whereby samples of formation fluids at the bit may be obtained directly from the markers. This type of marker is particularly effective where the material thereof is compressed during passage through the ports 15 whereby a major portion of absorbed liquids is forced from the material. Immediately upon their exit from the ports 15, however, reabsorption of fluids takes place and such fluids are thence carried to the surface in the marker material. Such markers may be any suitable spongy material. The formation fluids and cuttings are readily extracted from such material for analysis.

Attention is now directed to one form of mechanism for introducing the marker containers or capsules 25 into the fluid stream and also for providing desired information of the time and/or depth at which the respective capsules were introduced to the system or reached the bottom of the well.

A pipe 30 is attached to the riser 12 and includes valves 31 and 32 provided with an actuating mechanism 33 shown as a lever system. The pipe 30 extends upwardly above the valve 32 and is adapted to receive the cartridges containing the markers or identifying material 26. These cartridges may be introduced manually at desired intervals or, obviously, if desired suitable feeding mechanisms for introducing successive cartridges to the upper end of the pipe 30 may be provided.

The valves of the actuating mechanism 33 are so constructed and arranged that movement of the mechanism 33 in one direction will close the valve 31 and will open the valve 32 to admit one of the capsules to the intermediate chamber. Movement of the mechanism in the opposite direction will close the valve 32 and open the valve 31 whereby the capsule is released for movement with the fluid stream.

A pressure gauge 34 is attached to the pipe 30 intermediate the valves 31 and 32. Such pressure gauge is preferably of the recording type, and in Fig. 4 there is shown a chart 35, such as may be produced by the gauge. It will be assumed that the chart moves at a timed rate, the time intervals being shown at 36. The stylus or other recording element traces a pressure curve shown at 37 and, in the chart as shown, indicates a normal pumping pressure of approximately 1,000 lbs. per square inch. When, however, the lever mechanism 33 is moved to admit a marker capsule through the valve 32, the pressure on the gauge drops to zero and this change in pressure is indicated by the horizontal lines 38. Since this operation is completed in a relatively short period of time, the drop in pressure and the subsequent rise to normal pressure appears as a straight line.

In the practice of the invention by operation of the equipment described it will also be assumed, by way of example, that it is desired to obtain a marked sample of formation fluid and/or cuttings at three-foot intervals. Accordingly, marks 40 on the kelly 4, or other suitable depth indicating means, may be utilized to indicate the instant at which each of the series of markers or capsules is to be introduced to the fluid stream. When this technique is followed the space between two of the horizontal lines 38 on the chart 35 represents three feet of drilling. This portion of the chart therefore is indicative of the rate of drilling and hence the hardness of the formation being drilled.

After a capsule has been introduced to the circulating system it travels downwardly to the bit 7 and, as already explained, lodges at the upper end of the passages 15. Pumping pressure immediately rises as indicated by the lines 41 on the chart 35. This increase in pressure lasts but a short interval of time, since the container is almost instantly destroyed, and the enclosed markers are thus released to start their upward journey from the bit. The markers, or capsules, are introduced into the circulating system in a predetermined order, such as numerical order when numbered markers are used, and hence the samples obtained at the surface are in that order. Thus by observing the chart 35 it will be noted that the first marker was introduced at one o'clock and that at two o'clock the fifth identifying marker was introduced at an increased depth of twelve feet. It is obvious from a consideration of the chart 35 that it is possible to ascertain accurately the depth and the time at which the markers were released at the bottom of the bore hole. For this reason all guess work as to location of origin of collected samples is eliminated.

In some instances it may be desired to make a single observation at a particular point as, for example, when drilling operations indicate that the penetration of a formation has taken place or, in other words, there is a "break" in the formation. A marked sample may be obtained at such break by stopping drilling while circulation of the drilling fluid is continued. A marker cartridge is introduced to the system, the depth at which such marker reaches the bit is noted and drilling is resumed so that the marked sample is obtained at the break or other particular level.

It may also be noted that the invention is of utility when corrective steps are taken to prevent water loss from the mud as by filtration through the filter cake on the wall of the well bore and into the subjacent formation. In such case particular ingredients are added to the mud and are circulated to more effectively seal the walls of the well and hence minimize the loss. Identifying markers may be circulated with the mud to provide information when complete circulation has taken place whereupon analyses indicate the effectiveness of the corrective measures.

Broadly, the invention comprehends method and apparatus of locating the origin of samples obtained from a bore hole during the drilling operation.

What is claimed is:

1. In the method of drilling wells by the rotary method employing a drill stem, drill bit, and the circulation of drilling fluid therethrough the steps of, introducing into the stream of pumped drilling fluid at the surface a frangible container having identifying markers therein, pumping the container to the drill bit, rupturing the container in the bit by drilling fluid pressure, and recording the fluctuation in pump pressure when the container ruptures in the drill bit and releases the markers.

2. In the method of drilling wells by the rotary method employing a drill stem, drill bit, and the circulation of drilling fluid therethrough the steps of, introducing into the stream of pumped drilling fluid at the surface and at predetermined increments of depth a frangible container having identifying markers therein, pumping the container to the drill bit, rupturing the container in the bit by drilling fluid pressure, and indicating the fluctuations in pump pressure when successive containers rupture in the drill bit and are disintegrated whereby the markers are released and travel upwardly in the well with the cuttings and the drilling fluid.

3. An article of manufacture comprising a container shaped to be carried along in a stream of liquid to travel downwardly in the mud stream in the drill stem in the rotary drilling of well bores, a quantity of material wtihin said container which is identifiable after association with the drilling mud and circulation thereof to the surface, said container being frangible and of a size to rupture at the ports of the drill bit so as to release the material into the mud at the drill bit.

4. In the art of drilling wells by the rotary method the improvement comprising the steps of continuing circulation of drilling fluid and discontinuing drilling when a given depth is reached, introducing an identifying material into the stream of drilling fluid, at the surface, signalling when such material passes from the drill bit, and simultaneously resuming drilling so that samples originating at that depth are identified by the association therewith of the identifying material.

5. A method of sampling and identifying formation samples as to depth comprising the steps of selecting individual absorbent markers, circulating the markers when drilling, signalling the depth at which the markers are discharged into contact with the samples of the formation, and recovering at the mouth of the well bore the cuttings and any fluid content absorbed by the markers as an indication of the formation at a given depth.

6. A method of correlating formation encountered in the rotary method of drilling with the depth at which such formation is encountered which comprises, introducing individual frangible cartridges containing marker material into the inflowing stream of drilling mud entering the drill stem, circulating such containers to the drill bit, blocking the discharge ports in the drill bit with a container so as to build up a pressure in the bit and drill stem, causing the cartridge to rupture due to such pressure so as to release the marking material to discharge from the bit, thus associating the marking material with the formation being drilled, circulating the associated materials to the surface, recording the elevation of the formation at which the association took place by recording the release of the built up pressure, and synchronizing the material marked with such elevation.

ALONZO L. SMITH.