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McCullough

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[54] **METHOD AND APPARATUS FOR SIMULTANEOUSLY DRILLING AND LOGGING**

[76] Inventor: **Ira J. McCullough,** 10845 Sunset Blvd., Los Angeles, Calif. 90024

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[21] Appl. No.: **195,639**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 854,506, Sept. 2, 1960, abandoned.

[52] **U.S. Cl.** **175/50,** 73/151

[51] **Int. Cl.** **E21b 49/00**

[58] **Field of Search** 175/40, 50, 41, 46; 73/151, 73/152; 324/1, 10; 166/77

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Primary Examiner—Marvin A. Champion
Assistant Examiner—Richard E. Favreau
Attorney, Agent, or Firm—Whann & McManigal

[57] **ABSTRACT**

Method and apparatus for simultaneously drilling and logging a bore hole employing an electric cable extending through a drill string which has a swivel at the top end and a bit secured to its lower end. The electric cable communicates with a detecting probe which is disposed adjacent the bit. This provides a continuous circuit from the formation at the bottom of the well to the surface recording instruments at the top of the well. During the simultaneous drilling and logging operations the drill string and bit rotate while the surveying cable remains non-rotative. The swivel, drill string, cable and probe are lowered together during the simultaneous drilling and logging operation.

16 Claims, 5 Drawing Figures

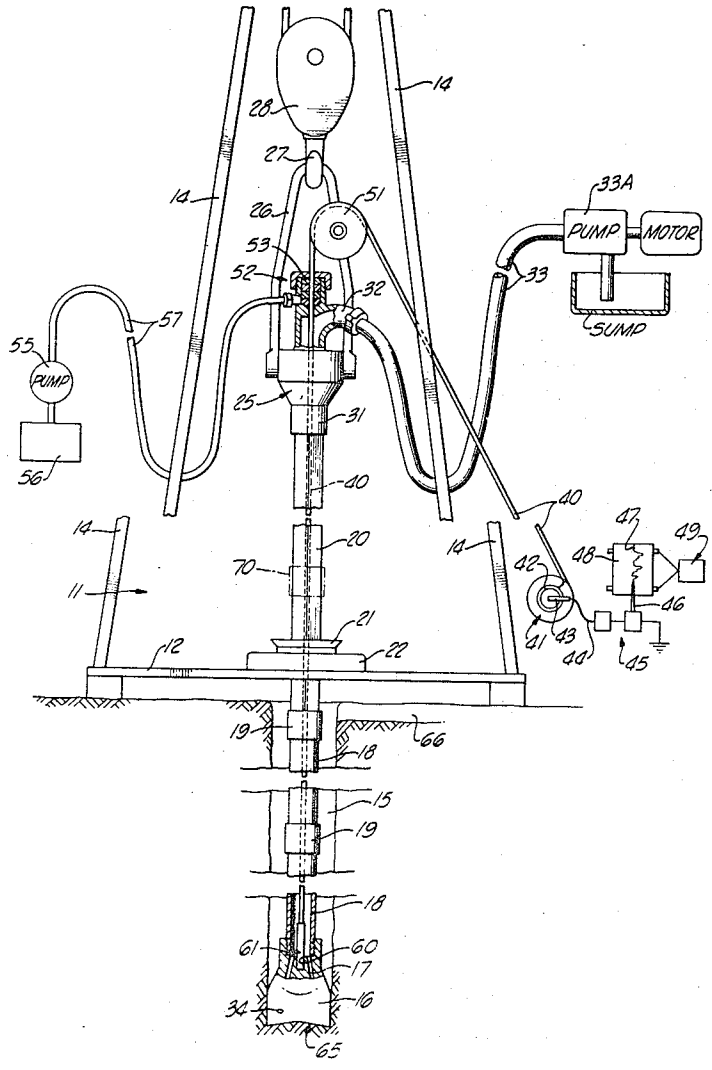


FIG. 1.

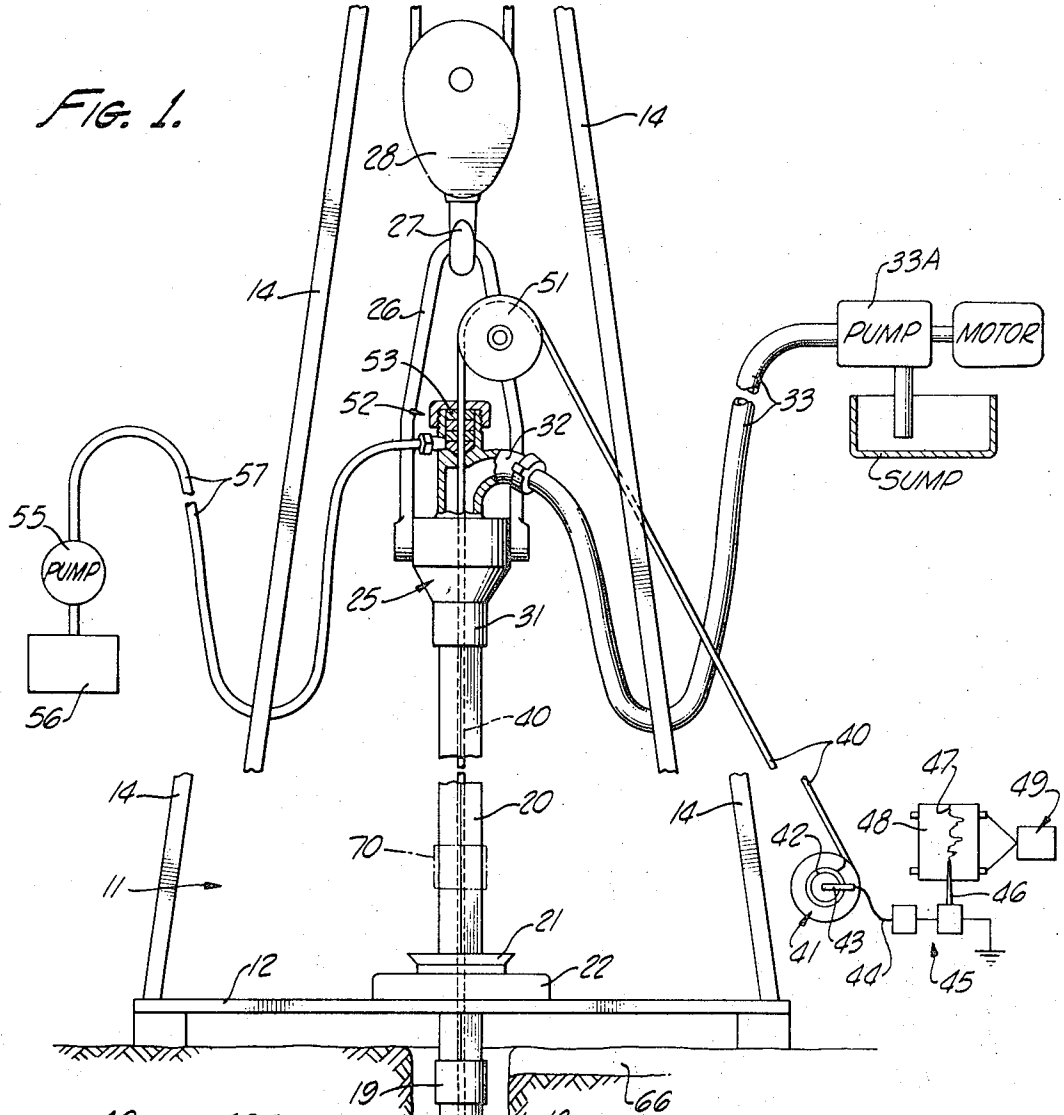


FIG. 2.

IRA J. Mc CULLOUGH
INVENTOR
WHANN & McMANIGAL
Attorneys for Applicant
BY

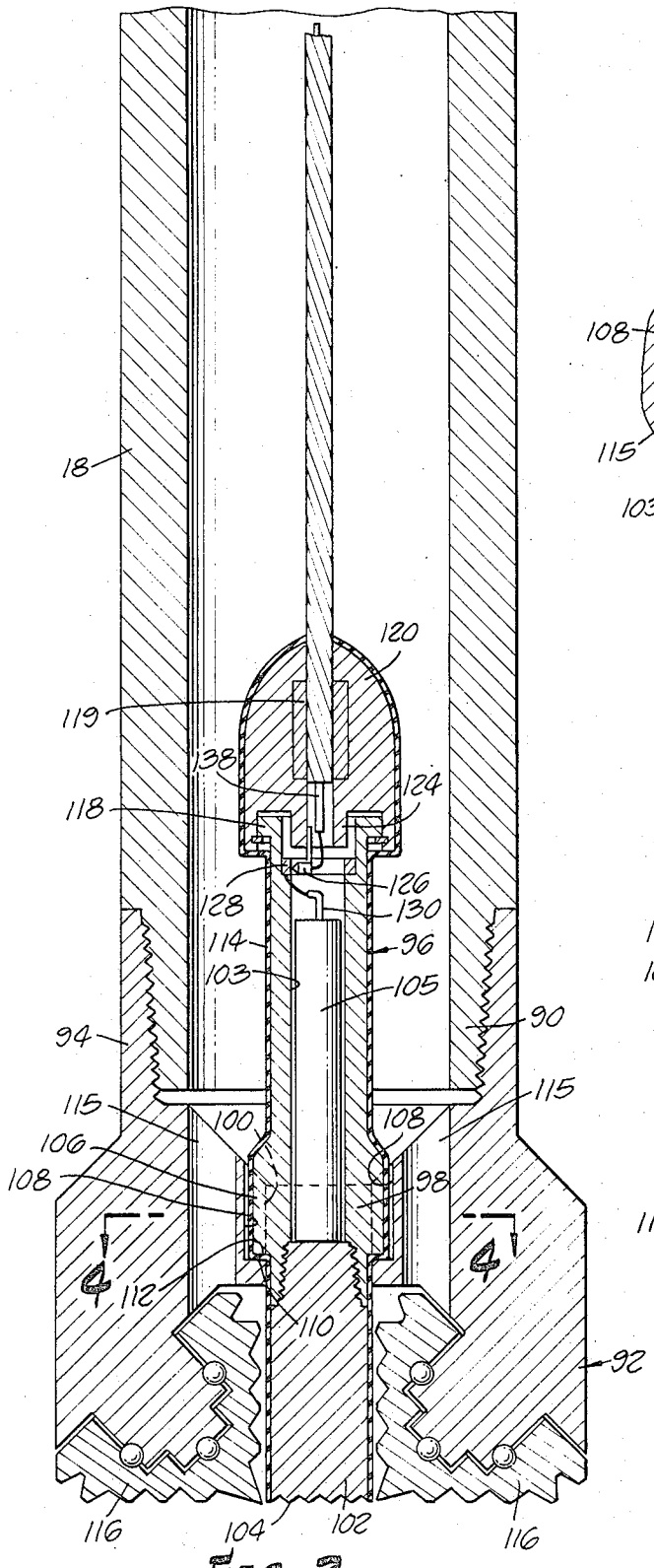


Fig. 3.

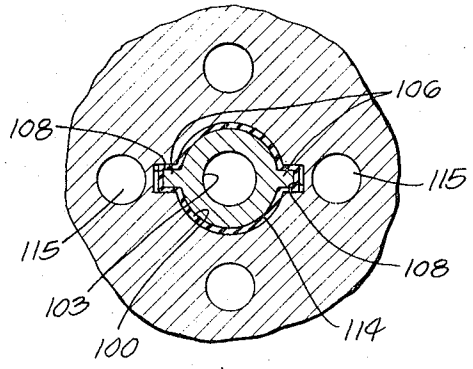


Fig. 4.

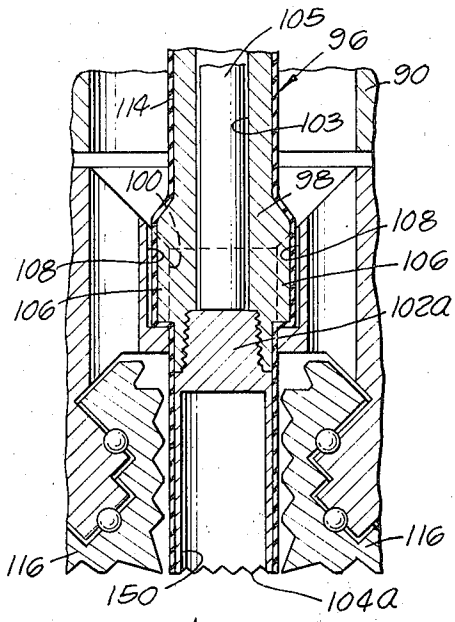


Fig. 5.

IRA J. McCULLOUGH
INVENTOR
WHANN & McMANIGAL
Attorneys for Applicant
BY

METHOD AND APPARATUS FOR SIMULTANEOUSLY DRILLING AND LOGGING

This application is a continuation in part of my copending application Ser. No. 854,506 filed Sept. 2, 1969, entitled Method and Apparatus for Simultaneously Drilling and Logging, and now abandoned.

BACKGROUND OF THE INVENTION

Numerous methods have been attempted and failed to obtain a satisfactory electric bore hole log while drilling. The Arps system, U. S. Pat. Nos. 2,524,031 and 2,583,288, proved unsuccessful. Sections of conductor cable and conductor rods have been inserted in the center of each joint of a drill pipe string to reach the bottom of the well with various types of connections. All have been unsuccessful. A system of conductor tubes attached to the interior wall of the drill pipe with slip joint connections failed. Also, a conductor system embedded in the actual drill pipe wall with rings and brushes for connectors at the joints of the drill pipe, has been proposed. None of these have been successful largely due to the inability to maintain a continuous conductor from the bottom of the well to the surface receiving and recording instruments. The many connections involved provide a multiplicity of points for the drilling fluid to invade the conductor system and the mechanical fastening and sealing contacts have been a failure. More than 25 years time and many millions of dollars have been spent without success.

SUMMARY OF THE INVENTION

The invention relates to method and apparatus for accomplishing bore hole logging simultaneously with the drilling operation. This method of logging during drilling employs an electric conductor cable which extends through the drill string to the probe instrument positioned adjacent to the drill bit which continuously transmits information to a surface recorder at the top of the well. Drilling mud circulation is carried on in the conventional manner and drilling operations are also conducted in the conventional manner.

The drilling and logging system of my invention provides a new method of obtaining an electric survey log recorded while drilling and which provides instant and continuous important information. Very often the success or failure of a well depends on accurate information being promptly supplied to the driller, preferably as the events occur. The log obtained by my invention determines the oil or mineral possibilities immediately and warns the driller of formation changes and conditions in the well bore or equipment, such as bottom hole mud pressure, weight imposed on the bit, etc. A log simultaneously made by my invention as the well is being drilled is far superior to a log made after the well is drilled and which has become masked and damaged to the extent that the drilling mud invades the formation zones. Most wells are presently logged several days after the drilling has been done.

It is an object of my invention to provide a method and apparatus for simultaneously logging and drilling wherein the electric cable extending into the drill string at the surface of the ground extends to a location at or near the drill bit, the cable being so supported as to be fed into the well simultaneously with the drill string.

In one form of my invention a surveying probe and downhole instrument housing is secured to the lower

end of the cable and is positioned in a socket at or near the bit, preferably in electrical contact or coupling therewith.

It is a further object of my invention to provide drilling and logging operations which involve the feeding of a non-rotatable supporting means whereby the drill string and bit, as well as the electric cable, are simultaneously lowered into the well, the cable extending through the non-rotatable supporting means and being sealed to prevent leakage when drilling mud is being pumped into the well through the drill string.

It is a still further object of my invention to provide at or near the drill bit a socket for receiving the probe in order to centralize the same and to support it in such a manner that it may remain non-rotative while the drill bit and drill string rotate, and also to make electrical coupling or contact so that the probe may receive and transmit signals from the well bore.

It is a still further object of my invention to provide method and apparatus for simultaneously drilling and logging a well involving the rotating of a drill string and bit in order to drill the formation at the bottom of the well, positioning an electric cable in the drill string with a probe positioned adjacent to the bit, simultaneously feeding the drill string and the bit and also the cable and probe as the drill bit removes the formation at the bottom of the well and receiving and recording at the surface of the well of various signals received during the use of the instruments in the well.

It is another object of my invention to provide a method and apparatus of the character referred to in which a fixed elevational relationship is maintained between the bit and the probe during the simultaneous drilling and logging operations, directly from the face of the bit at the bottom of the well to the surface recording instruments at the top of the well.

It is likewise an object of my invention to provide a drilling and logging method and apparatus wherein the drilling portion rotates to drill the well, the logging cable remains non-rotative during the drilling of the well and during the receiving of the logging signals, and in which both the drilling equipment and the cable and electrode are simultaneously lowered as drilling operations and logging operations are performed.

In a second form of my invention, a surveying probe extends through and is coupled for rotation with the drill bit. In this form of my invention the down hole lower-most extremity of the probe is positioned so that, as the well is being drilled, the probe will encounter, simultaneously with the drill bit, the formation at the bottom face of the well bore. At its upper end the surveying probe is interconnected with the cable by means of a conducting swivel and, to preclude transmission of spurious data received from other than the formation at the bottom face of the well bore, is carefully and completely insulated from the drill bit and the drill string.

It is consequently a further object of my invention to provide a centrally located longitudinal bore through the drill string and drill bit for receiving and supporting the probe in a manner such that during the drilling operations the probe will contact the formation at the bottom face of the well bore.

It is another object of my invention to provide an apparatus of the character referred to in the preceding paragraph in which the probe is electrically insulated from the drill bit and is rotatably coupled thereto.

It is likewise an object of my invention to provide an apparatus of the type described in the immediately preceding paragraphs in which the probe is coupled to the conducting cable by means of swivel-type electrically conductive coupling so that the probe may freely rotate relative to the cable, while at the same time making electrical coupling or contact so that the probe may receive and transmit signals directly from the formation at the bottom face of the well bore.

It is still a further object of my invention to provide an apparatus of the type described in which the lower portion of the probe comprises a center drill bit adapted to drill the formation near the center of the bottom face of the well bore as the drill string is lowered into the well bore during the well-drilling operation.

It is another object of my invention to provide an apparatus as described in the preceding paragraph in which the center drill bit is provided with an axial bore so that a core sample may be obtained during the well drilling operation.

I believe that my invention is the first time that a continuous electrical conductor extending from the instruments at the surface of the well to the actual cutting face at the bottom of the well has been employed during drilling operations anywhere. Most wells are logged several days after drilling has been done. Mud invasion starts instantly the formation is cut by the bit. I believe it is the first time that a drill pipe has been rotated in the well bore with a conductor cable suspended therein for receiving logging signals and in which drilling and logging operations are conducted simultaneously. It is the first time that a conductor cable has been used in a well while drilling with the mud circulating through the interior of the drill string while the well survey conductor cable is non-rotatable and the drill string is rotating.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagrammatic view illustrating a form of my invention;

FIG. **2** is fragmentary and diagrammatic sectional view showing the lower end of a well and an alternative arrangement employed;

FIG. **3** is a fragmentary sectional view showing still another form of my invention in which the probe extends through, rotates with and is insulated from the drill bit;

FIG. **4** is a cross-sectional view taken along line **4—4** of FIG. **3**; and

FIG. **5** is a fragmentary sectional view of another form of my invention which is similar to that shown in FIGS. **3** and **4**, but in which the lower portion of the probe is provided with an axial bore for obtaining core samples.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the accompanying drawing I have diagrammatically illustrated my invention and the manner in which the process and apparatus operate in the well. Because of the fact that we deal with lengths and height which are quite large with respect to diameters of the equipment, the diagrammatic view is shortened by breaking away intermediate portions.

As shown in the drawing, **11** is a derrick having a floor **12** and legs **14.** The crown of the derrick which supports the well-known crown block, is not shown. The derrick **11** is positioned over a well **15** which is being drilled by means of a bit **16,** which is shown in the form of a fish-tail bit. Any other type of bit suitable for drilling through the various formations may be used at any time.

The bit **16,** in accordance with usual practice is provided with mud passages **17** and is secured to the lower end of a drill string **18,** which consists of joints or sections secured together by tool joints **19.**

The upper part of the drill string is in the form of a kelly **20,** which is of rectangular exterior cross-section and which extends through a table **21** of a rotary machine **22,** whereby the drill string and bit are rotated.

The drill string is suspended from a swivel **25** having bails **26** supported by a hook **27** of a traveling block **28,** the traveling block constituting a part of a means whereby the swivel, drill string and bit may be raised and lowered.

The kelly is connected to the swivel by means of a rotatable joint **31** whereby the kelly, drill string and bit may be rotated by the rotary machine **22** while the swivel body remains non-rotative. The swivel has a gooseneck **32** which is connected to a rotary hose **33,** which hose is connected to a mud pump **33A.** By this means drilling mud is circulated through the hose **33,** the gooseneck **32,** the swivel **25,** the kelly **20,** drill string **18** and the bit **16,** the drilling mud flowing through openings **34** in the bit picking up the cuttings and carrying them to the surface of the ground by flowing upward through the annulus of the well **15** around the bit and drill string.

The surveying equipment is provided in the form of a cable **40** which extends from a drum **41.** The insulated electric conductor **40a** of the cable **40** is connected to a ring **42** engaged by a brush **43** which, in turn, is connected by a conductor **44** to well surveying equipment generally indicated at **45.** This equipment **45** includes a movable pen arm **46** which makes a trace **47** on graph paper **48.** The numeral **49** is representative of conventional means for correlating the movement of the graph paper **48** with the movement of the drill bit during drilling operations.

The survey equipment, of which the surface equipment **45** forms a part, may be any one of a number of wellknown types of equipment, such, for example, as the electric log illustrated in U.S. Pat. No. 2,317,304, the gamma ray log illustrated in U.S. Pat. No. Re. 23,226, the neutron log as illustrated in U.S. Pat. NO. 2,308,361, and the gamma ray and neutron log as illustrated in U.S. Pat. No. Re. 25,634. My invention may have one or more insulated conductors connected to one or more probes near the bottom of the well and one or more pens at the surface apparatus, this being taught by the prior patents referred to. These patents teach the construction and operation of the particular equipment and the details of construction may be had from these patents and need not be shown in detail herein.

The cable **40** extends from the drum **41** over a sheave **51** from which the cable extends through a special pack-off unit **52** into and through the swivel **25,** the drill string, and terminates at or adjacent to the bit **16.** The pack-off unit **52,** uses packing **53,** which packing may be placed under pressure so as to form a non-leaking seal around the cable **40** and for holding the cable against rotation.

This pressure may be formed by any well knwon means, such as by means of a pressure pump **55** which takes liquid from a reservoir **56** and pumps it through a conduit **57** into the pack-off unit **52** for applying a suitable pressure on the packing **53.**

In the bit or in a part connected to the bit is a receiving means in the form of a socket **60** for receiving the probe **61** which is connected to the insulated conductor **40a** within the cable **40,** but is insulated from the sheathing of the cable. The receiving means **60** acts as a stop so that the probe **61** will always be in the same position with respect to the bit **16,** supports it in a centralized position, and acts as an electrical connection to the bit face. The receiving means **60,** however, loosely surrounds the probe when it is in position so as to permit relative rotational movement so that the cable **40** and probe **61** do not rotate along with the drill string and bit.

In performing the method of my invention the rotary machine **22** rotates the drill string and causes the bit to cut away the bottom **65** of the well. At this time drilling mud is being pumped through the drill string, the passages **17,** and outwardly through the openings **34** in the bit. This drilling mud serves to remove the cuttings upwardly through the well to the surface of the ground where it may flow through a trench **66** to a suitable sump. The drilling mud also performs the additonal usual functions of preventing cave-ins and sealing the walls of the well.

When there is severe vibration occurring at the bottom of the hole when drilling certain formations, friction type leaf springs (which are well known in the industry), may be added to the probe **61** to maintain contact with the walls forming the receptacle or socket **60.** Also the drilling mud pressure will aid to keep probe **61** in contact in the socket at the top of the bit when drilling. The fluids in the earth formations being drilled through will provide electrical coupling through the cutting face or teeth of the bit to the probe in the socket thereby providing direct signals through the conductor cable to the recording instruments at the surface.

As the drilling proceeds the traveling block **28** is slowly and uniformly lowered as to lower the bit **16** and keep the desired pressure on the bottom of the hole during the drilling operation. The signal receiving means, probe **61,** receives the signals. They are amplified if necessary and are conveyed by the conductor in the cable to the surface of the ground, where they are delivered to the surface surveying equipment **45,** with the result that the movable pen arm **46** will make a trace **47** which has certain characteristics including the peaks and other formations as diagrammatically illustrated on the chart paper **48.**

In some logging methods more than one trace is made and there is instrumentation whereby a plurality of traces may be made on one or more graphs. My invention, of course, comprehends the use of a plurality of pens and traces where the particular logging method requires it.

Because of the fact that the chart paper is moved in correlation to the downward movement of the bit **16,** the configurations on the chart will correspond to the signals received by the signal receiving instrument which correspond to the depth at which the drill is operating at any particular time.

Because of the fact that the cable **40** is tightly secured to the pack-off unit **52,** and because of the fact that the drum **41** is in a free feeding position, the cable will be fed downwardly simultaneously with the bit, and the probe **61** will always occupy the same relative horizontal position in or adjacent to the bit. Because there is a looseness between the probe **61** and the socket **60** there is relative rotation between these two parts. By this arrangement the drilling operation may be performed without any interference either with the rotation of the parts and downward feeding, or of the passage of rotary mud through the drill string and bit.

It is common practice to drill the well until the swivel has been lowered to the rotary table **21.** At this time drilling is stopped, the drill string is raised to move the uppermost tool joint to a position above the table, as illustrated by dotted lines **70,** at which time the mud circulation is stopped. The pack-off unit **52** is loosened and the drum **41** is rotated to wind the cable **40** in order to remove the probe from the well to a position within the kelly so that it will not interfere with the operations involved in adding a new section to the drill string.

After the tool joint has been positioned at **70,** slips are then installed in the opening of the rotary table to support the drill string, whereafter the joint at **70** is broken, an additional drill string is attached to the drill string in the well, the kelly is attached to the upper drill string section, whereafter the drill string is again lowered to the bottom of the well. The probe may then be lowered from its position within the kelly to its position within the receptacle at the drill bit. The pack-off unit **52** is again sealed and the circulation of mud may then be commenced.

The swivel is then lowered to position the drill bit at the bottom of the well so that the parts are again in the position as shown in FIG. **1,** whereafter drilling and surveying operations are again started and continued until such time as an additional section of drill string must be added.

Subsequent to the drilling and logging as previously explained, the probe on the conductor cable may be lowered into the well after the drill pipe has been removed in order that an open-hole log may be made, such as self-potential, resistivity, natural and induced radioactivity, sonic and density so that if desired there may be a comparison made with the information recorded while drilling.

In FIG. **2** I have shown a form of my invention in which the bit is insulated from the drill string in such a manner that signals from the formation will be received principally from the bottom face of the well bore before mud invasion occurs. In this form of my invention the lower end of the drill string **18** is provided with a threaded pin **80** and the bit **16** is provided with a threaded pin box **81** into which the pin **80** is threaded. The probe **61** in this form of my invention is shown somewhat longer than in FIG. **1** and the lower part **82** thereof comprises a probe and the upper part **83** thereof comprises an instrument receptacle in which the down-hole portion of the survey apparatus may be included. This may be amplifying means as well as other down-hole equipment.

The socket or receptacle **60** is shown as receiving the lower end of the probe **82** and is shown as having a relief passage **84** so that when the mud is under pressure there will be a pressure differential tending to hold the probe **61** in place. In this form of my invention insula-

tion **85** is applied to the lower part of the drill string and to the threads of the pin and box connection **80** and **81**, and to the upper part of the bit as shown. This insulation may be one of any number of suitable insulations, such as aluminum oxide, which may have the insulation coating applied by a conventional coating gun. The form of aluminum oxide such as supplied by the Norton Company under the trade name "ROKIDE" may be used. In this form of my invention the signal from the well is received from the very bottom of the well and principally from the bottom face which is being cut by the bit **16**. The only portion of the bit which acts as the receiver for the well signal is that lower portion which is not coated with the insulation coating **85**. The drill bit is insulated from the potential of the drill string because the threads of the pin and box are insulated. For this reason the probe **82** receives the signals directly from the lower part of the bit.

With this arrangement a larger portion of the signals are received directly from the bottom face of the well bore during the time that the bit is removing the bottom surface of the well bore and this occurs before mud contamination which would affect the accuracy and value of the signal. This constitutes an important part of my invention because when the rotary mud gets into a formation it can shut out important signals which would constitute extremely valuable information to the well owner.

In FIG. **3** I have shown another form of my invention in which the probe rotates with the drill string and the drill bit, but is completely insulated therefrom by a suitable insulating material which is placed between the interfacing surfaces of the parts. In this embodiment, the probe extends through the drill string and the drill bit so that as the well as being drilled, signals from the formation will be received by the probe directly from the bottom face of the well bore before any mud invasion can occur.

In this form of my invention, the lower end of the drill string **18** is provided with a threaded pin **90** and the bit **92** is provided with a threaded pin box **94** into which the pin **90** is threaded. As shown in FIG. **3**, the probe **96** is somewhat longer than the probe shown in FIG. **1** and the lower part **98** thereof protrudes through a centrally located bore **100** which extends through the drill bit. The lower part **98** of the probe is provided with means for drilling the formation at the bottom face of the well in the form of a center bit **102** having a cutting face **104** which contacts the central area of bottom face of the drill bore as the drilling progresses. Disposed within an axial cavity **103** within the probe and comprising an integral part of the probe is an instrument package **105** adapted to house various types of detectors and their cooperating electronics.

Referring to FIG. **4**, it can be seen that means for rotatably coupling the probe and the drill bit is provided in the form of driving lugs **106** formed on the periphery of the probe which are adapted to be received in longitudinally extending grooves **108** of bore **100** which extends through the bit. Shoulders **110** which are formed at the lower extremities of grooves **108** are adapted to engage shoulders **112** formed at the lower extremities of driving lugs **106** so as to provide means for elevationally positioning probe **96** within the drill string. The mud pressure holds the probe bit **102** down when drilling.

In this form of my invention insulation **114** is applied to all the external surfaces of probe **96** so as to completely insulate the probe from the drill string, the drill bit, and the circulating mud. This insulation may be one of any number of suitable insulations, as, for example, aluminum oxide.

As shown in FIGS. **3** and **4**, the drill bit is provided with a plurality of communicating passageways **115** for conducting drilling mud from the interior of the drill string through the drill bit along a path formed between the insulated periphery of the probe and the cutters **116** of the drill bit.

Referring to FIG. **3**, a swivel is diagrammatically shown. The upper portion of the probe can be seen to have a flanged portion **118** which is configured to rotatively receive the non-rotating lower extremity of the electrical cable.

Affixed to the end of the cable and coupled therewith by a zinc ring **119** is an adapter **120** which has a radially reduced portion **124** which is receivable in bell-shaped portion **118**. Means for electrically coupling the probe and the cable is shown diagrammatically in FIG. **3** in the form of an electrical contact **126** which is carried by adapter portion **124** so as to cooperate with rotating electrical contact means shown here as a slip ring contact **128** carried within bell-shaped portion **118**. Slip ring contact **128** is electrically connected to the instrument package **105** by means of electric conductor **130**. The coupling arrangement shown in FIG. **3** is intended to be illustrative only, and in rotatively connecting the probe and the cable various types of swivel arrangements well known in the prior art may be used. Similarly, various well known arrangements may be employed to electrically couple the probe and the cable.

During the drilling operation signals received by the lower face of the probe directly from the formation at the bottom face of the well bore are transmitted from the instrument package to the probe slip ring contact **128** to contact **126**, then through conductor **138** which is connected thereto, and finally to the instrumentation at the surface of the well. In this way the instrumentation is reading only data taken directly from the bottom face of the well bore unmasked by any mud invasion.

In FIG. **5** I show another form of my invention which is similar to the embodiment just described. In this embodiment, probe **96** also extends through and is completely insulated from the drill bit. The probe is identical in all respects with the probe described in the previously described embodiment except that the center bit portion **102***a* is provided with an axial bore **150**. As in the previously described embodiment center bit portion **102**a has a cutting face **104**a which is electrically coupled with instrument package **105** so that signals may be received directly from the bottom face of the well bore and communicated to the surface before any mud invasion can occur. By forming an axial bore **150** in the center bit portion of the probe, means is provided for obtaining a core sample during the drilling operation for subsequent analysis at the surface.

I claim:

1. Apparatus for simultaneous drilling and logging, the combination including:

a. a drill string adapted to extend into a well being drilled;

b. a drill bit secured to the lower end of said drill string;

c. means for rotating said drill string and said drill bit;
d. means for supporting and feeding said drill string into the well as drilling proceeds;
e. an electric cable connected to said means for supporting and feeding said drill string into the well in such a manner that said cable is nonrotatable during the drilling and surveying operations, said cable extending into said drill string near the surface of the ground, said cable extending through said drill string to a place adjacent to the drill bit, said cable being so supported as to be fed into said well along with said drill string;
f. a probe secured to the lower end of said cable, said probe being positioned for direct communication with said drill bit to receive signals directly therethrough from the lower part of said drill bit; and
g. signal receiving and recording means connected to said cable at the surface of the ground whereby well logging signals may be recorded while said well is being drilled.

2. A combination as defined in claim **1** in which said probe is nonrotatably supported relative to the drill string and drill bit in order that it may remain nonrotative during the drill operation.

3. A combination as defined in claim **1** in which there is a receiving means positioned adjacent to said bit for receiving said probe at the lower end of said cable.

4. Apparatus for simultaneous drilling and logging, the combination including:
a. a drill string adapted to extend into a well being drilled;
b. a drill bit secured to the lower end of said drill string;
c. means for rotating said drill string and said drill bit;
d. non-rotative means rotatably supporting said drill string at the surface of the ground;
e. means for feeding said non-rotating supporting means as the drilling operation proceeds;
f. an electric cable extending into said drill string near the surface, said cable extending through said drill string to a place adjacent to the drill bit, said cable extending through said non-rotatable supporting means and sealed at the place said cable extends to the exterior thereof, said cable being fed into said well during the drilling operation simultaneously with the downward feeding of said drill string by said non-rotating support means;
g. a probe means secured to the lower end of sad cable; and
h. signal receiving and recording means connected to said cable at the surface of the ground whereby well logging signals may be recorded while said well is being drilled.

5. A combination defined in claim **4,** in which said electric cable is sealed at the place said cable extends to the exterior of said non-rotatable supporting means, by a releasable seal around said cable, said seal being adapted to prevent leakage of drilling mud under pressure during the drilling operation and being releasable to allow said cable to be fed into or withdrawn from said drill string when the drilling is stopped.

6. A method of drilling a well using a conventional drill string and drill bit while simultaneously logging the well by recording at the surface of the well signals received from the bottom face of the well by a probe means disposed adjacent the drill bit, the steps including:
a. positioning an electrical cable within the drill string in electrical communication with the probe means which is disposed adjacent the drill bit;
b. rotating the drill string and the drill bit relative to the cable to drill the formation;
c. simultaneously feeding the drill string, the drill bit, the electrical cable and the probe into the well as the drill bit removes the formation at the bottom of the well; and
d. receiving and recording at the surface signals received by the probe and transmitted through said electrical cable, simultaneously with the drilling away of the formation at the bottom of the well.

7. A method comprising the steps of claim **6** which also includes positioning the probe relative to the drill bit so that it contacts and receives signals from the formation at the bottom face of the well and transmitting such signals through the cable and recording the same at the surface.

8. A method comprising the steps of claim **7** which also includes electrically insulating the probe from the drill string and the drill bit.

9. Apparatus for simultaneous drilling and logging, the combination including:
a. a drill string adapted to extend into a well being drilled;
b. a drill bit secured to the lower end of said drill string;
c. a probe coupled for rotation with and insulated from said drill bit and said drill string, said probe being coupled with said drill bit so that during the drilling operation the lower extremity of said probe contacts the formation at the bottom of the well;
d. means for rotating said drill string and said drill bit;
e. means for supporting and feeding said drill string into the well as drilling proceeds;
f. an electric cabl extending into said drill string near the surface of the ground, said cable extending through said drill string to a position adjacent said probe, said cable being sealed at the place the cable enters the drill string and being so supported as to be fed into said well along with said drill string;
g. coupling means for electrically coupling said probe and said cable; and
h. signal receiving and recording means connected to said cable at the surface of the ground whereby well logging signals may be recorded while said well is being drilled.

10. A combination as defined in claim **9** in which said probe comprises means for drilling the formation at the bottom face of the well bore.

11. A combination as defined in claim **9** in which said probe is coupled with said drill bit so that during the drilling operation the lower extremity of the probe contacts the formation at the bottom face of the well simultaneously with the drill bit.

12. A combination as defined in claim **9** in which said coupling means comprises at least one non-rotative electrical contact carried by said cable which is adapted to interengage a rotating electric contact means carried by said probe as said drill string rotates.

13. A combination defined in claim **9** in which said electric cable is sealed at the place said cable extends into said drill string by a releasable seal around said cable, said seal being adapted to prevent leakage of drilling mud under pressure during the drilling operation

and being releasable to allow said cable to be fed into or withdraw from said drill string when the drilling is stopped.

14. A combination defined in claim **9** in which said probe is provided with means for obtaining a core sample during the drilling operation.

15. Apparatus for simultaneous drilling and logging, the combination including:

a. a drill string adapted to extend into a well being drilled;

b. a drill bit secured to the lower end of said drill string;

c. a probe coupled for rotation with and insulated fro said drill bit and said drill string and any fluid in said bit and said drill pipe;

d. means for rotating said drill string and said drill bit;

e. means for supporting and feeding said drill string into the well as drilling proceeds;

f. an electric cable extending into said drill string near the surface of the ground, said cable extending through said drill string to a position adjacent said probe, said cable being sealed at the place the cable enters the drill string and being so supported as to be fed into said well along with said drill string;

g. coupling means for electrically coupling said probe and said cable, said coupling means permitting said cable to remain non-rotative while said bit and probe rotate; and

h. signal receiving and recording means connected to said cable at the surface of the ground whereby well logging signals may be recorded while said well is being drilled.

16. A combination as defined in claim **15** in which said probe means is provided with means for obtaining a core sampling during the drilling operation.

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