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REMOTE CONTROL SYSTEM FOR BOREHOLE LOGGING DEVICES

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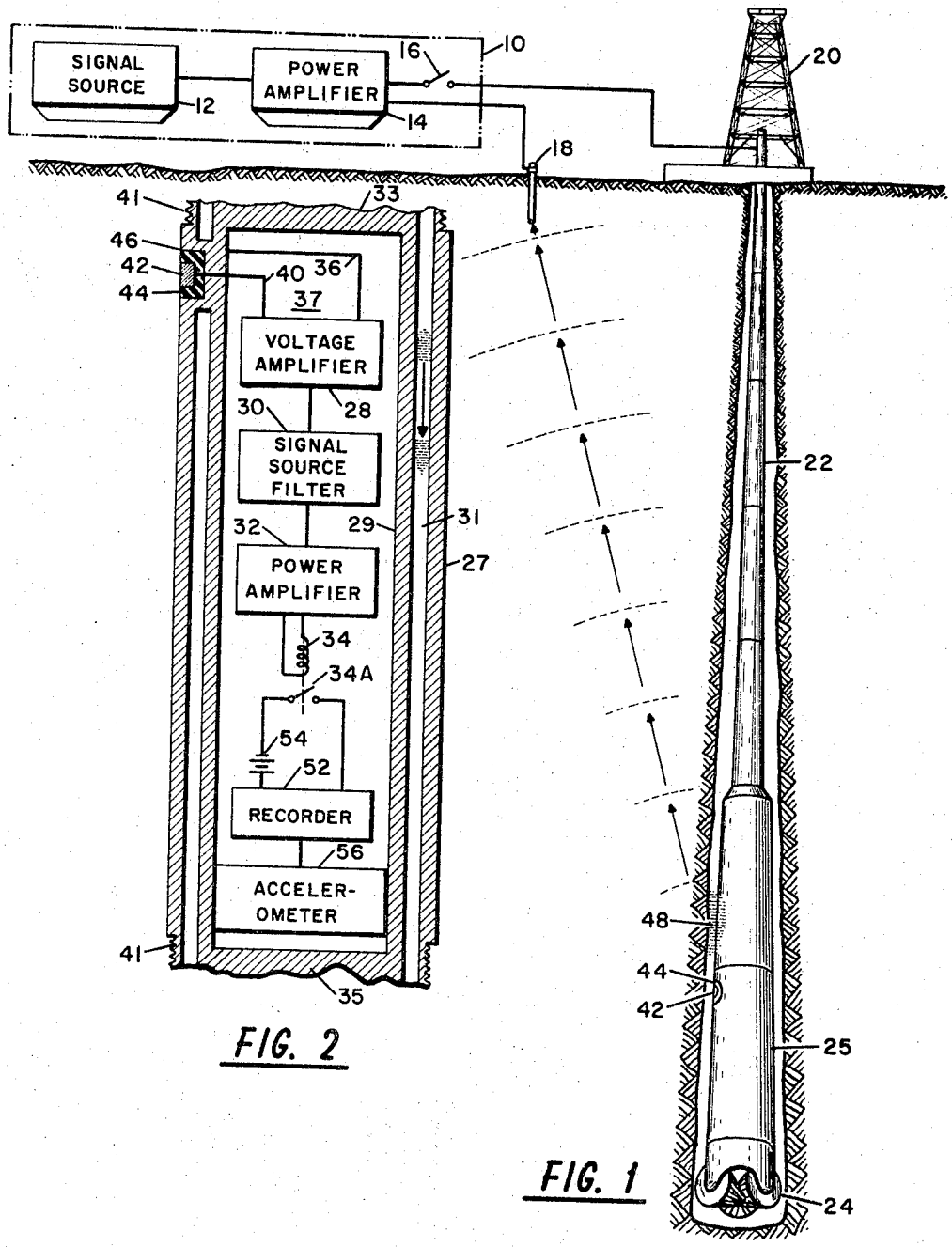


FIG. 2

FIG. 1

Paul M. Ferguson
INVENTOR.

BY John D. Gassett
ATTORNEY

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REMOTE CONTROL SYSTEM FOR BOREHOLE LOGGING DEVICES

Paul M. Ferguson, Tulsa, Okla., assignor, by mesne assignments, to Esso Production Research Company, Houston, Tex., a corporation of Delaware

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This invention relates to a method and apparatus for controlling down-hole logging. It especially relates to a method and apparatus whereby down-hole logging at the lower end of a string of drill pipe is controlled from the surface.

The most common system of drilling oil wells is the rotary drilling system. Here a bit is suspended in a borehole by a string of drill pipe which is supported and rotated from the surface. A string of drill pipe is ordinarily of high quality steel and the drilling fluid is circulated down through the drill string, through the bit and back to the surface through the annulus between the drill string and the borehole wall. The drilling fluid serves to lubricate and cool the bit as well as to remove the cuttings from the hole to the surface.

It has been found that during the course of drilling a well it is sometimes desirable to control certain down-hole operations from the surface. Then such operations can be carried out at the correct times. One example of such down-hole operation is a logging operation employing a down-hole recorder. The present invention includes a system whereby the time of down-hole logging is precisely controlled from the surface without the use of wires, pressure pulses, go-devils etc.

One preferred embodiment of the invention includes an apparatus for use with a drill string for controlling the starting and stopping of a down-hole recorder which is connected to a down-hole transducer which detects some parameter such as the vibration of the drill bit. The self-contained recorder is supported by the drill string in a special sub adjacent the bit. The down-hole recorder includes a switch for starting and stopping the recording. A power oscillator is located at the surface and has a known frequency output. The oscillator is connected in a circuit between the drill string and a remote electrode placed at a point in the ground remote from the drill string. A pick-up probe insulated from the drill string is supported down-hole by the drill string and includes an electrode in fluid communication with the drilling fluid within the well bore. A signal detecting means is electrically connected in a circuit between the probe and the drill string. The detecting means has an output control signal or voltage level responsive to the output of the power oscillator. Actuating means are provided adjacent the recording means for energizing the recording means in response to the control signal from the detecting means. At the exact time that it is desired to start the down-hole recorder, the power oscillator is started and transmission of the signal begins over a path which includes the earth, the pick-up probe and the drill string. The oscillator is kept running as long as it is desired to record. During this time the detecting means has an output signal which maintains the recording means in an energized state. When it is desired to stop recording, the oscillator is stopped and the recording means is no longer energized. Thus, a very precise control of the down-hole recorder is obtained.

Other objects and a better understanding of the invention can be had from the following description taken in conjunction with the drawing in which:

FIG. 1 illustrates an apparatus upon which the method of the invention can be practiced; and,

FIG. 2 illustrates schematically a cross-section of the drill pipe sub containing a pick-up probe, signal detector and down-hole recorder.

Shown in FIG. 1 of the drawing is a transmitter **10** which includes a control signal source **12**, such as an oscillator, amplifier **14** and a switch **16**. Signal source **12** can be an oscillator having a selected frequency output. The output should be at a frequency which is different from that which would normally be employed in connection with the apparatus normally used for drilling boreholes. For example, a convenient and useful frequency different from that normally associated with drilling units is 400 c.p.s. The output of the signal source **12** is connected to an amplifier **14**. The ground side of amplifier **14** is connected to a ground electrode **18** which is embedded in the surface of the earth at a point remote from the drilling unit **20**.

Suspended from drilling unit **20** is a string of drill pipe **22** to which drilling fluid is conducted and also through which is transmitted the rotational force for the bit **24** which is supported at the lower end of the drill pipe. Drill pipe **22** is normally of high quality steel which is also electrically conductive.

Located just above bit **24** and supported by drill pipe **22** is sub **25**. The sub includes an outer shell or cylindrical member **27** and inner shell or cylindrical member **29** with an annular space **31** therebetween for the flow of drilling fluid. Threads **41** are provided on outer shell **27** for connection within the drill string. Shell **29** is enclosed at the upper and lower end by end members **33** and **35** respectively forming a fluid-tight down-hole detector and recorder compartment **37**. The down-hole detector includes an amplifier **28**, a signal source filter **30**, power amplifier **32** and a relay means **34** having a normally opened switch **34**–A. Filter **30** is pre-tuned to the output frequency of oscillator **12**. One side of voltage amplifier **28** is electrically connected through conduit **36** to drill pipe **22**. The other side of the voltage amplifier **28** is connected to conduit **40** to an insulated button **42**. Button **42** is supported from drill pipe **22** but is electrically insulated therefrom by insulation means **44**. The insulation and button **42** are in recess **46**. Button **42** is in direct contact and communication with the fluid **48** in the borehole.

When switch **16** is closed and the precision oscillator energized, the transmission of the output of the oscillator takes place over a path including drill pipe **22**, conduit **36**, amplifier **28**, conduit **40**, button **42**, fluid within well bore, and the earth which serves as a return circuit.

The signal is amplified in amplifier **28**, filtered in filter **30**, and again amplified in amplifier **32**. The resultant signal from amplifier **32** energizes or actuates relay **34**. Relay **34** operates a switch **34**–A which turns off and on the down-hole recorder. In this case the down-hole recorder takes shape of a magnetic tape recorder **52**. Power for tape recorder **52** is a downhole power source **54**. The variable which is recorded on tape recorder **52** is shown as an accelerometer **56** which is connected to the inner shell **29** just above the drill bit **24**. Other down-hole variables can be recorded by providing suitable detectors which detect the desired variable and provide the parameter to be recorded on tape recorder **52**. In fact, many such parameters can be simultaneously recorded on a multiple head magnetic tape recorder.

The operation of this device will now be briefly described. Before the drill pipe is set in the hole, the down-hole signal detecting and recording unit sub **25** is inserted in the drill string near bit **24** or at any desired point in the drill string. Amplifier **28** of the down-hole signal detector is connected through conduit **40** to the insulated button **42** and through conduit **36** and outer

shell **27** which is connected directly to the drill pipe itself. The accelerometer is fixed to the inner shell **29** which is sufficiently rigid so that when sub **23** is connected into the drill pipe that the accelerometer is responsive to movement of the drill pipe and bit. Down-hole recorder **52** is placed in position and power source **54** provided. Filter **30** is tuned to the same output frequency as that of the output of oscillator **12**, e.g. 400 c.p.s.

At a given depth or time it is desired to record the output of the accelerometer. The recorder is kept turned "off" until such depth is reached. Drilling is then commenced as in a conventional manner as there are no wires or other obstructions. The drill bit advances into the ground until it reaches the depth or time at which it is desired to record some parameter which in this case is the output of the accelerometer. At this depth or time, switch **16** is closed. When switch **16** is closed, a voltage of 400 c.p.s. is placed between the drill pipe and the ground electrode **18** which causes current to flow from the drill pipe to the electrode. The down-hole detector senses the current as filter **30** is also set for or tuned to 400 c.p.s. The output of filter **30** actuates control relay **34** causing its associated switch **34–A** to close. This connects power source **54** to recorder **52** thus energizing it. The output of accelerometer **56** is thus recorded while the recorder is energized.

Any signal which may be connected to the amplifier **28** has no effect upon relay **34** except the signal which has the same frequency as that of the output of oscillator **12**, which in this case is 400 c.p.s. This is due to the filtering action of filter **30** which is tuned to the frequency of oscillator **12**. The output of filter **30**, which only has an output when switch **16** is closed, energizes relay **34** to close its associated switch **34–A**. This starts recorder **52** to record the output of accelerometer **56**. As long as switch **16** is closed the down-hole recorder is "turned on" and recording continues. When it is desired to stop the recorder, all that is necessary to do is open switch **16** at the surface. Then no voltage of 400 c.p.s. is impressed across the electrode **18** and drill pipe **22**. Therefore, no control signal is detected down-hole (as there is none) and filter **30** has no output. Relay **34** is no longer energized and switch **34–A** is again opened. When switch **34–A** is opened, down-hole recorder **52** is turned off. The down-hole recorder can be retrieved in a conventional manner, for example, by pulling drill pipe **22**.

While there is disclosed above but one embodiment of the system of the invention herein presented, it is possible to produce still other embodiments without departing from the concepts herein disclosed. It is therefore desired that only such limitations be imposed on the appended claims as are stated therein.

What is claimed is:

1. A recorder for use with a drill string in the drilling of boreholes in the earth which comprises:
- a control signal source;
- a power amplifier having a ground terminal and a second terminal;
- first circuit means connecting said power amplifier to said control signal source;
- second circuit means connecting the ground terminal of said power amplifier to the earth;
- third circuit means including a switch connecting the second terminal of said power amplifier to said drill string;
- a sub insertable within said drill string;
- a signal detecting means supported within said sub, said signal detecting means including a conducting button supported at the exterior of said sub and insulated therefrom, fourth circuit means connecting said button and said drill string and including an amplifier and a filter connected to the output of said amplifier and responsive to the output signal of said control signal source;
- a recorder mounted within said sub; and

- means to actuate said recorder responsive to the output of said filter.

2. A logging system for use with a drill string used in the drilling of boreholes in the earth which comprises:
- signal generating means having two output terminals;
- first circuit means connecting one of said terminals of said signal generating means to the earth;
- second circuit means including a switch connecting the other terminal of said signal generating means to said drill string;
- signal detecting means supported down-hole by said drill string, said signal detecting means having an output signal upon detecting a signal from said signal generating means;
- a recording means supported down-hole by said drill string; and
- means to actuate said recording means responsive to the output signal of said signal detecting means.

3. An apparatus for use with a drill string used in the drilling of boreholes in the earth which comprises:
- control signal means for applying a control signal between a drill string and a remote point on the ground;
- a pick-up probe supported down-hole by and insulated from said drill string;
- signal detecting means between said probe and said drill string and responsive to the output of said control signal means;
- recording means supported down-hole by said drill string; and
- means to actuate said recording means in response to the output of said signal detecting means.

4. An apparatus as defined in claim **3** in which said signal detecting means includes:
- a filter operable to pass the frequencies generated by said control signal means;
- a power amplifier connected to the output of said filter; and
- a relay having a normally opened switch, said relay operable by the output of said power amplifier.

5. A device insertable within a drill string used in the drilling of boreholes in the earth which comprises:
- a housing member made of an electrical conductive material;
- a fluid-tight compartment within said housing member;
- passageway means for passing fluid longitudinally from and adjacent one end of said compartment to the other;
- a conductor button on the exterior wall of said housing member;
- insulating means insulating said button from the remainder of the housing member;
- signal detecting means in said compartment;
- circuit means connecting said signal detecting means between said button and said housing member;
- a recorder within said compartment; and
- means actuating said recorder in response to said signal detecting means.

6. A sub insertable within a drill string used in the drilling of boreholes in the earth which comprises:
- an outer shell made of an electric conductive material, said outer shell having a recess in the exterior thereof;
- an inner shell supported from said outer shell and spaced therefrom to provide an annulus;
- means to close the ends of said inner shell forming a fluid-tight compartment;
- a recorder supported within said fluid-tight compartment;
- a conductor button located within said recess;
- insulating means insulating said button from said exterior shell;
- a circuit means including a signal detector connected between said button and said exterior shell;
- a power source within said compartment; and

means responsive to said signal detector to connect said recorder to said power source.

7. A device for use with a drill string in the drilling of boreholes in the earth which comprises:

a control signal source;

a power amplifier having a ground terminal and a second terminal;

first circuit means connecting said power amplifier to said control signal source;

second circuit means connecting the ground terminal of said power amplifier to the earth;

third circuit means including a switch connecting the second terminal of said power amplifier to said drill string;

an outer cylindrical member insertable within said drill string and made of an electrical conductive material, said outer cylindrical member having a recess in the exterior thereof;

an inner cylindrical member supported from said outer cylindrical member and spaced therefrom to provide fluid passageway;

means to close the ends of said inner cylindrical member forming a fluid-tight compartment;

a recorder supported within said fluid-tight compartment;

a conductor button located within said recess of the exterior of said outer cylindrical member;

insulating means insulating said button from said exterior cylindrical member;

a fourth circuit means including a signal detector connected between said button and said exterior cylindrical member;

a power source within said compartment; and

actuating means responsive to said signal detector operative to connect said recorder to said power source.

8. An apparatus as defined in claim 7 in which said signal detector includes:

a filter operable to pass the signal generated by said control signal source; and

a power amplifier connected to the output of said filter.

9. An apparatus as defined in claim 8 including:

a transducer for measuring a down-hole parameter;

means to support said transducer from said exterior cylindrical member; and

means connecting the output of said transducer to said recorder.

10. An apparatus as defined in claim 9 in which said actuating means includes a relay having a normally open switch, said relay operable by the output of said power amplifier.

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BENJAMIN A. BORCHELT, *Primary Examiner.*

R. M. SKOLNIK, *Assistant Examiner.*