Feb. 9, 1960 J. J. ARPS ET AL 2,924,432

EARTH BOREHOLE LOGGING SYSTEM

Filed May 8, 1956 2 Sheets-Sheet 1

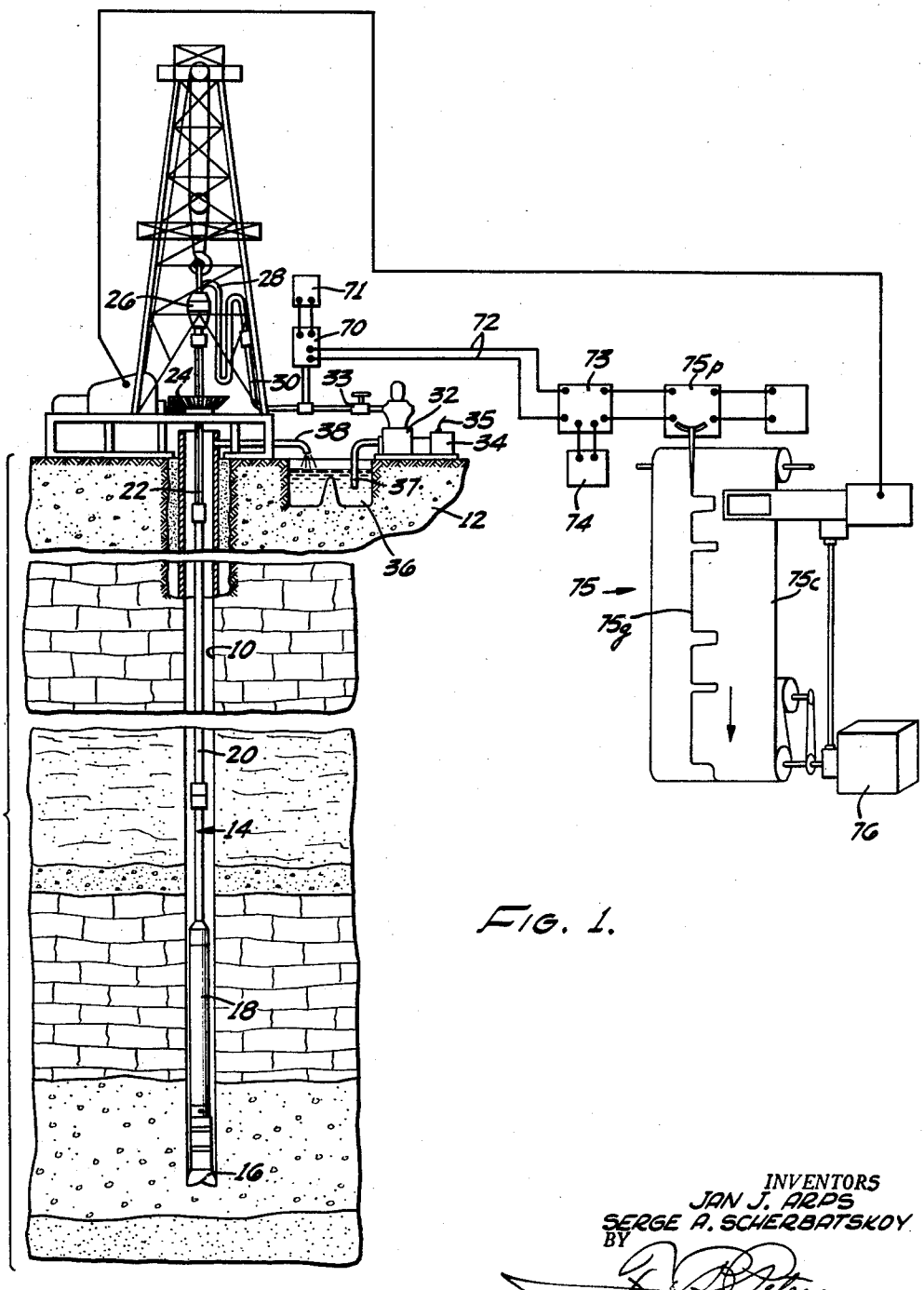


FIG. 1.

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FIG. 2.

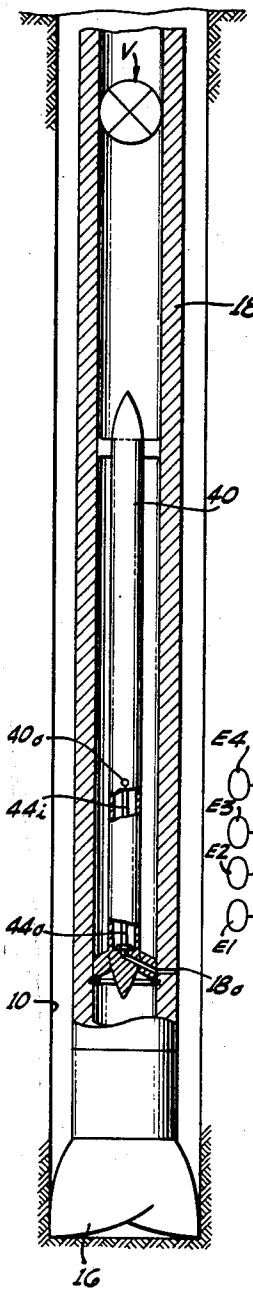



FIG. 4.

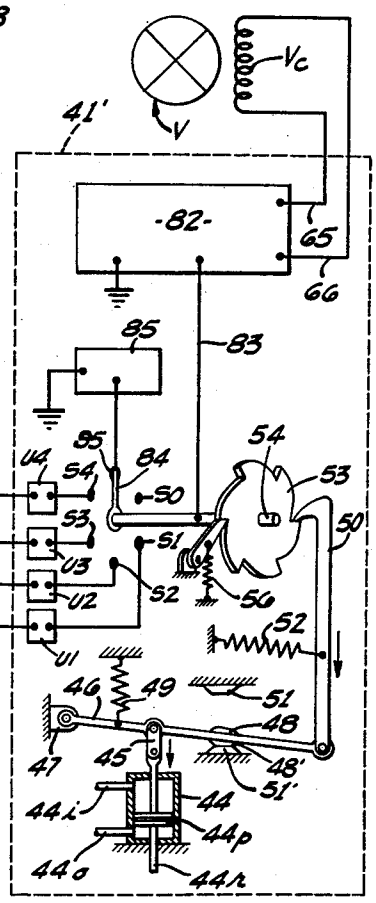
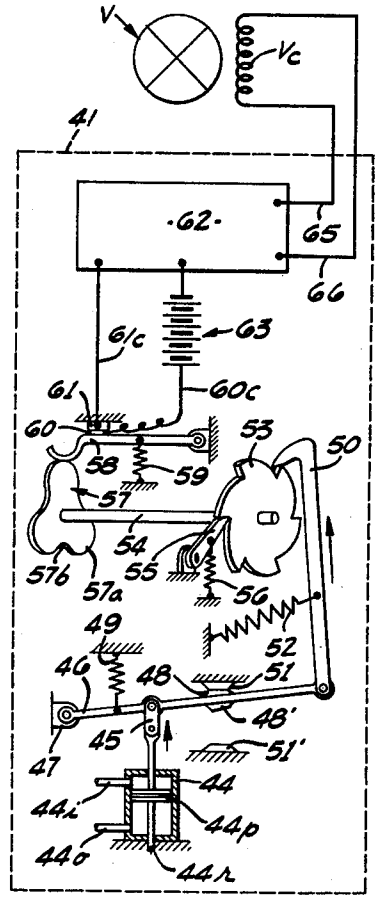



FIG. 3.

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2,924,432

# EARTH BOREHOLE LOGGING SYSTEM

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7 Claims. (Cl. 255—1)

This invention relates to logging systems used for procuring and registering or recording information concerning one or more physical characteristics exhibited at relatively inaccessible locations in earth boreholes; and more particularly, to means for securing for logging purposes any of a group of one or more types of information, selectively and at will and at a desired time, during either continuance of actual drilling of the borehole or a period of suspension of drilling. Still more specifically, the invention relates to a borehole logging system including means for operating apparatus used for securing desired information from within an earth borehole, at only such times during continued drilling of the borehole or during suspension of drilling, as may be desired; and at the will of the operator, without interference with any of the normal drilling procedure and apparatus.

It has been proposed previously to convey information obtained by instruments situated at an inaccessible location within an earth borehole, to an accessible operating point outside the borehole, by employing as information-representing signals, temporary pressure changes created in the downwardly flowing stream of drilling fluid in a drill string. The signals in the previously proposed system were relatively continuously transmitted under the controlling action of automatic timer or like means comprised in instrumentation housed in a part of the lower end of a drill string. No manual or operator control over the operation of the information-obtaining and signal-transmitting means was possible. That apparatus was either manually set in operation when at the surface, or later by operation of an automatic pressure-sensitive switch means actuated by static pressure of the well fluid upon lowering of the drill string into the well, and/or circulation of drilling fluid. Examples of the previously proposed type of logging system are disclosed in copending applications Serial No. 414,381, filed March 5, 1954; Serial No. 431,734 filed May 24, 1954, and Serial No. 489,537 filed February 21, 1955, to which reference may be made in respect to certain details of apparatus and operation. Due to the high cost of batteries of a type suitable for operation in the high-temperature environment near the bottoms of deep earth boreholes, and to the loss in battery life occasioned by operation of logging apparatus during running-in of the drill string and during non-drilling periods, it is desirabe to provide means whereby the apparatus at the lower end of a drill string may be operated or rendered inoperative, at the option of the operator at the operating point outside the borehole. Further, it is desirable that this control may be accomplished without interruption of drilling. The provision of some such remote control means would permit effective battery life to be greatly extended, and would permit a greater flexibility of operation in respect to any given channel of logging information in a multi-channel system. For example, in a system in which such physical characteristics as earth resistivity, natural potential, bit temperature, and bit wear are to be logged, it might at times be desirable to log only resistivity over an extended



period, with only an occasional check on bit wear and bit temperature. In the previously proposed systems, each channel of information or type of characteristic measurement was presented in its respective time position in a cyclical or time-multiplex procedure, once for each operations cycle, irrespective of the relative momentary value of the information.

In view of the preceding considerations, it is a prime object of the present invention to provide a borehole logging system in which the information obtaining and signaling apparatus located in a borehole at or near the lower end of a drill string may be activated, or its action suspended, by an operator outside the borehole, without any electrical connections between the two places and without interruption of drilling.

Another object of the invention is to provide a borehole logging system in which any desired one of a plurality of types of information obtainable at an inaccessible location adjacent the lower end of a drill string in a borehole may selectively be obtained by means under control of an operator outside the borehole.

Another object of the invention is to provide a logging system of the type indicated in which battery power consumption is restricted to desired intervals of time under control of an operator outside the borehole being logged.

An additional object of the invention is to provide a logging system for use during rotary drilling of an earth borehole, in which operation of information-obtaining and signaling apparatus at the lower end of a drill string is under direct control of an operator at a surface location outside the borehole.

The aforestated objects and other objects and advantages hereinafter made apparent are attained in a preferred type of system by provision of apparatus including means sensitive to a pressure differential at the inaccessible location in a drill string in a borehole, which pressure differential sensitive means is arranged to control activation and deactivation of information-obtaining and signaling means in response to one or more short-duration reductions in drilling fluid back pressure produced by temporary reduction of drilling fluid flow. The pressure-sensitive means is arranged to be in hydraulic communication with the downwardly flowing drilling fluid stream in the drill string and the upwardly flowing return stream outside the drill string, and is adapted to move a control linkage member in one direction in response to a reduction from normal back pressure in the drill string at the subsurface location and in the opposite or return direction in response to return of the stream back pressure to normal value. The control linkage member is arranged to operate a step-by-step means which at successive steps alternately closes and opens a power supply circuit leading to the information-obtaining and signaling means, or at successive steps of a series closes individual operating circuits and steps to a neutral attitude or position at which the operating circuits are all left in open-circuit (inoperative) condition.

The preferred type of system comprises apparatus diagrammatically illustrated in the accompanying drawings, in which:

Figure 1 is an illustration showing environmental and other features of the system of the invention as applied to logging operations conducted during drilling of an oil well, and illustrating in some detail certain apparatus components at a surface operating location, and a drill string in a borehole penetrating formations of the earth;

Figure 2 is a diagrammatic view indicating relative locations of apparatus components in a part of the drill string shown in Figure 1;

Figure 3 diagrammatically illustrates the mechanical and electrical features of a system in which a single subject of investigation is to be logged; and

Figure 4 is an illustration similar to that of Figure 3 but relating to apparatus for handling several subjects of investigation to be logged.

Referring now to the drawings and to Figure 1 in particular, an earth borehole **10** is shown penetrating a surface earth formation **12** and a plurality of formations therebelow, the borehole having been drilled by means including drill string designated generally by numeral **14** and terminated at its lower end by a bit **16**. The drill string comprises a drill collar **18** normally situated at an inaccessible location in the borehole as indicated, and a plurality of tubular drill pipe sections such as **20**, to the lowermost of which the drill collar is secured. The drill string comprises at its upper end a tubular kelly **22** which is adapted to be rotated by a rotary table **24** through which the kelly slidably extends. The rotary table is rotatable by power means including gearing as illustrated or as may be well known in the art. The kelly is rotatably supported by a swivel **26** which serves also to conduct drilling fluid supplied through a hose **28**, to the kelly **22**. The swivel is supported and operated by means as indicated and which are well known in the art and not per se of the present invention.

Drilling fluid under considerable pressure is supplied to hose **28** through piping **30** by pump means which may comprise one or more units such as pump **32**. The fluid discharged from the pump may pass by or through a surge bell and through a valve **33** interposed in piping **30** leading from the pump outlet. The pump is driven by a power unit **34** having a throttle lever **35** or other operable means for controlling the speed and the discharge rate of the pump. The pump draws drilling fluid from a supply tank or pit **36** through an intake pipe **37**. Thus drilling fluid is supplied under pressure to the interior of the drill string, through which it flows downwardly in a stream for exit through orifices in the bit **16**. The discharged fluid cleans the bit and carries upwardly through the borehole annulus encircling the bit, the rock chips removed by the bit; and the fluid and transported chips are discharged from the borehole through a lateral pipe **38** at the upper end or top of the borehole. Hence the drilling fluid is circulated by the pump inwardly through the drill string into the lower reaches of the borehole and thence outwardly in the borehole annular space (borehole annulus) around the drill string, to the pin **36**. The fluid, as it is forced through piping **30**, is normally under considerable back pressure, there being a large friction loss in the stream path through the drill bit. Thus there is created a considerable pressure differential between adjacent points inside and outside the drill collar. When the pump **34** is slowed by reverse or throttling motion of control lever **35**, however, the rate of discharge of the pump is lowered, and the back pressure and aforementioned pressure differential experience a corresponding drop in value.

While reverse or throttling movement of pump control lever **35** has been described as a means of temporarily reducing pressure differential or the back pressure in the stream of drilling fluid in the drill string, it is clear that complete cessation of pumping would accomplish a similar result; and the same effect may be attained by partial or complete closure of valve **33** during pumping of fluid. According to the invention, such reduction in back pressure or the corresponding decrease in pressure differential in the drilling fluid stream inside and outside the drill collar, is employed as a means of effecting control of information-securing and signaling apparatus located in the drill collar, using apparatus hereinafter described.

Referring now to Figure 2, wherein bit **16** and drill collar **18** are shown in drilling position in borehole **10**, the drill collar is shown with a portion removed to show an apparatus case **40** and a valve V positioned in respective locations in the drilling fluid passage in the collar. The means and mode of positioning these elements in the drill collar may be as desired or as more particularly



disclosed in one or more of the aforementioned applications. Valve V is preferably an electromagnetically operated valve interposed in the drilling fluid passage to alternately impede and free the flow of fluid therethrough to produce temporary or short-duration pressure-rise signal pulses in the drilling fluid stream, without appreciable reduction in the rate of fluid flow, in a manner and for signaling purposes such as are illustrated and described in the mentioned applications. Apparatus case **40** is fixed in the drill collar **18** so as to permit relatively free flow of fluid therepast, and is provided with hydraulic connections exposed to the downflowing fluid stream inside the drill collar and to the upflowing stream outside the drill collar for operating apparatus by the pressure differential between those two streams. Such apparatus and its operation are hereinafter described.

In Figure 3 there is indicated diagrammatically within dash-line rectangle **41**, apparatus housed in case **40** in the drill collar and electrically connected to the operating coil of valve V in a manner indicated in the aforementioned applications. Within the apparatus case **40** and hydraulically connected as indicated in Figure 2 by suitable fluid-tight tubing **44*i*** to opening **40*o*** in the case and by tubing **44*o*** to the upwardly flowing stream outside the drilling collar at **18*o***, is a pressure-sensitive means herein shown as comprising a fluid-tight cylinder **44** fixedly mounted in the case and a cooperating piston **44*p*** on a piston rod **44*r*** passing through sealed glands in the cylinder ends. Thus piston **44*p*** is made sensitive to the pressure differential between **40*o*** and **18*o***. The piston is adapted, under all normal drilling fluid flow conditions in the drill collar and adjacent upwardly flowing stream, to be forced downwardly to the position or attitude shown in Figure 4 against the lifting influence of a tension spring **49**, by the higher pressure of drilling fluid admitted to the upper end of the cylinder through tubing **44*i***. Downward movement of the piston is limited by means presently to be described. Pivoted to the upper end of piston rod **44*r*** is a connector link **45** which at its opposite end is pivotally connected to a lever **46**. Lever **46** is at its left end pivotally mounted on a fixed abutment **47** in case **40**, and has intermediate its ends a stop **48** for coaction with an upper fixed abutment **51** and a stop **48'** adapted for coaction with a lower fixed abutment **51'**, the abutments **51** and **51'** being secured in any suitable manner in case **40** and acting to limit upward and downward movement of the lever. A tension spring **49** has its upper end secured to fixed structure in case **40** and its lower end to an intermediate portion of lever **46**, the construction and arrangement being that when there is no appreciable pressure differential between points **40*o*** and **18*o*** spring **49** raises lever **46** to a position wherein stop **48** engages fixed abutment **51**. At its right end lever **46** is pivoted to a pawl **50** which is stressed by a spring **52** in a direction to engage a ratchet wheel **53** which is secured to a shaft **54** mounted for rotation in suitable guides and bearings (not shown). Ratchet wheel **53** and pawl **50** are so proportioned and arranged that as piston **44*p*** is forced downwardly incident to creation of an appreciable pressure differential between points **40*o*** and **18*o***, pawl **50** is drawn downwardly and rotates ratchet wheel **53** an extent equal to one tooth space; and spring **49** is concurrently tensioned. Such downward motion of lever **46** and pawl **50** is limited by engagement of stop **48'** with abutment **51'**. During this rotation of ratchet wheel **53**, a holding pawl **55**, stressed by a tension spring **56**, rides idly over a complete tooth of the wheel and acts, under the influence of spring **56**, to engage the rear face of such tooth and hold the ratchet wheel and shaft **54** from retrogressive rotation.

Affixed to shaft **54** for rotation therewith and thereby is a cam disc **57** having alternating lobes **57*a*** and depressions **57*b***, the total number of lobes and depressions being equal to the number of teeth comprised in the rim of the ratchet wheel. Cam **57** has riding thereon a follower lever

58 urged into cam contact by a tension spring 59. The follower lever is pivoted at one end to structure fixed in case 40, and spring 59 is anchored to such structure, as indicated. Lever 58 bears an insulated contact 60 arranged for electrical cooperation with a cushioned substantially stationary contact 61 mounted on insulated fixed structure in case 40. To the contacts are secured respective insulated conductors 60*c* and 61*c* as indicated. The arrangement of the step-by-step controller means comprising the pawl, ratchet wheel, follower lever, contacts and subsidiary parts is such that in response to successive temporary reductions in the pressure differential between openings 40*o* and 18*o*, contacts 60, 61 alternately open and close a circuit comprising conductors 60*c*, 61*c*.

Conductors 60*c*, 61*c* and their respective contacts serve as means for activating and de-activating electrical apparatus in an information-securing and operations unit 62, which is powered from a source of electric power herein represented as a battery 63. The power source is connected to contact 60 and through contact 61 to unit 62 as indicated, and is such that when the contacts are closed, the information-securing apparatus in unit 62 is energized, information is secured, and means included in unit 62 and energized from the power source acts to produce information-representing pulses of electric current in a manner more fully described in one or more of the aforementioned applications. The information-representing electric current pulses produced in unit 62 are translated into equivalent drilling fluid pressure-increase signals for transmission to the surface location outside the borehole, by means including the electromagnetically operated valve V whose coil Vc is intermittently energized by the electric current pulses. The current pulses are conducted to coil Vc through suitable conductors 65, 66 which are connected to the apparatus in unit 62.

From the foregoing description it is evident that when follower lever 58 is riding in a depression of cam 57, and contacts 60, 61 are open, the information-securing means is inoperative for lack of energization by battery 63, and valve V will produce no temporary pressure-increase signals in the drilling fluid stream. Under such conditions the apparatus is quiescent, or idle, and consumes no power. When it is desired to obtain information that can be secured by the subsurface means in the drill collar, the driller or operator temporarily reduces the pressure differential at the lower end of the drill string by retarding control lever 35 (or operating valve 33) for a few seconds, and then returns the lever or valve to normal. In response to the temporary reduction of back pressure at 40*o*, piston 44*p*, lever 46 and pawl 50 are given an upward stroke by spring 49 and are then returned to initial position by return of back pressure, causing rotation of wheel 53 and cam 57 through one-sixth revolution. Thus contacts 60, 61 will be closed, and unit 62 energized. Pressure-increase signal pulses will be created in the drilling fluid stream in the drill collar above valve V, representing the information secured; and these signal pulses will be almost instantly transmitted upwardly through the drilling fluid stream to the surface location. The manner in which the electric current pulses and the corresponding pressure-increase pulses in the drilling fluid represent the information gathered or secured by the apparatus in unit 62 may be widely varied and the apparatus may be of any suitable type, or such as is disclosed in the mentioned copending applications.

The information-representing pressure change pulses transmitted from the subsurface location are detected and translated at the surface location by means including an electrically energized pressure-transducer unit 70 (Figure 1) which is in hydraulic communication with the interior of pipe 30 and is furnished electrical energy from a source of supply 71, all as indicated. The electrical output of transducer unit 70 is applied by way of suitable conductors 72 to an amplifier unit 73 which may be furnished power from a supply 74. The amplified signal output of unit 73 is applied to the pen unit 75*p* of a suitable graphical recorder 75, on the chart paper 75*c* of which the pen traces a graphical representation of the pressure pulse signals detected by the transducer unit. The graph 75*g* indicates by excursions or deviations from normal, the durations and/or time relationships of the pressure pulse signals arriving from the subsurface location, the chart paper being traversed under the pen at a constant or predetermined rate by clockwork 76 or other suitable means as indicated or as described in one or more of the previously mentioned applications.

With the subsurface equipment or apparatus in operation, the described process of obtaining information at the surface as it is secured by the subsurface means may be interrupted and the equipment rendered idle by again inducing a pressure differential drop by operation of lever 35 or valve 33 to temporarily cut down the flow of drilling fluid, such action causing rotation of cam 57 to position a depression 57*b* under follower lever 58 and opening of contacts 60, 61. It is evident that successive temporary reductions of drilling fluid flow or back pressure will cause alternate activation and de-activation of the subsurface apparatus, and that the periods of activity and of quiescence may readily be governed at the will of the driller or operator.

In Figure 4 there is diagrammatically depicted a form of apparatus similar to that indicated in Figure 3 and usable in lieu of the latter when any of several different types or channels of information is to be selectively obtained. In this modified form of apparatus the signaling valve V is unchanged, but is supplied information-representing electric current pulses from a unit 82 which contains a suitable source of power and is connected to ground as indicated. The apparatus in unit 82 may comprise an amplifier and/or other electrical conversion means, and is supplied with electrical currents or signals by way of a conductor 83 and the ground connection indicated. The output of unit 82, when that unit is in operation, is intermittent pulses of electric current of suitable duration, such as of from one to several seconds duration, as required for proper operation of valve V and as required for representation of the information to be transmitted. Unit 82 is rendered active, or inactive, by means operated by ratchet wheel 53 under control of an operator at the surface location.

Secured to shaft 54 (Figure 4) which is rotated in intermittent steps by ratchet wheel 53 in the manner and by means previously described, is a rotary switch arm 84 which is, as the shaft is moved through successive steps, successively positioned at successive stations and in contact with a respective one of a series of circularly disposed stationary insulated contacts S0, S1, S2, S3, S4 and S5, there being as many of such contacts as there are teeth in ratchet wheel 53. One of the contacts (S0) is left blank, or not connected to any other apparatus, whereby when the switch arm is positioned at that station, the information-securing and signaling apparatus is de-energized and logging values or intelligence is not gathered nor signals transmitted. Others of the contacts, such as S1, S2, S3 and S4 in this example, are connected by suitable conductors to respective information-deriving units U1, U2, U3 and U4, each of which, when connected to unit 82 by switch arm 84, is activated to derive or secure information of a particular sort or type. For example, unit U1 may be connected to an electrode system indicated diagrammatically as E1, and furnish electrical current to unit 82 representing self potential of earth formations adjacent the lower end of the borehole. Similarly, unit U2 may be connected to an electrode system represented by E2, and secure information concerning formation resistivity or other physical characteristic and furnish current to unit 82 representative of the information. Unit U3 may comprise, for example, means for securing measured values of temperature, pressure, or other physical characteristic within the

drill collar or within the borehole. As many units U1, etc. are employed as there are types or kinds of information which it is desired to obtain; and there are provided switch stations and contacts S1, etc. equal to two more than the number of units U1, etc. Similarly, ratchet wheel 53 is provided with as many teeth as there are switch stations. The switch station or contact next preceding station or contact S0, and here shown as S5, is connected to a special identification signal-generating unit 85, which, when rendered active by connection to unit 82, provides the latter unit with a distinctive electric signal current which causes unit 82 and the valve V to produce a series of distinctive identification drilling fluid pressure pulses. Thus when switch arm 84 is positioned at station S5 as indicated in Figure 4, there will be received and translated at the surface location a distinctive series of signals indicating the position of the switch arm at station S5.

From the preceding descriptions it is evident that the driller or operator at the surface location may by creating one or more temporary reductions in pressure in the drilling fluid stream through appropriate manipulation of lever 35 or valve 33, cause operation of the pressure differential responsive means comprising cylinder 44 and piston 44*p* in the drill collar, and thus through operation of the step-by-step controller means comprising ratchet wheel 53, activate any one of a plurality of information-securing units U1, etc. and cause information of a selected type to be secured and information-representing pressure-increase signals to be transmitted from the subsurface location to the surface location. If the position of switch arm 84 is not known, successive intermittent operation of the step-by-step means a number of times by appropriate operation of lever 35 or valve 33, will bring the switch arm to station S5 and result in reception of the distinctive or identification signal. The previous operating position of arm 84 may then readily be determined by counting backward from station S5 the noted number of stations. Also, from station S5 the subsurface apparatus may be deactivated by initiating movement of arm 84 to station S0; and any one of the types of information secured by the subsurface apparatus may then be obtained by effecting the proper number of temporary drilling fluid pressure differential reductions.

The apparatus comprised in the information-securing units U1, etc. and in units 82, 85 and E1, etc., may be of any suitable desired type or may be such as are disclosed in one or more of the aforementioned copending applications. Such units per se are not the present invention, and accordingly may be selected from any available type suited to the environment and mode of operation of the invention as herein disclosed. Since in view of the disclosure, variations in the mode and apparatus specifically herein described will occur to others skilled in the art, it is not desired to limit the invention to the specific details of the preferred form of apparatus and operations described, except as indicated in the following claims and what is claimed is:

1. In a system for obtaining at an accessible surface location outside an earth borehole information to be secured at a relatively inaccessible subsurface location in an earth borehole being drilled by means including a rotary drill string, apparatus comprising: means to supply drilling fluid under pressure to the drill string including means to decrease such pressure; and subsurface means for location within the lower end portion of the drill string, including step-by-step controller means, pressure-sensitive means for operating the step-by-step controller means in response to a decrease in drilling fluid pressure followed by an increase in such pressure, and means rendered alternately active and inactive in response to stepping of the controller means for securing information and producing information-representing drilling fluid pressure increase signals in the drilling fluid for reception and translation at the surface location.

2. In a system for obtaining at an accessible surface location outside an earth borehole, information to be secured at a relatively inaccessible subsurface location in an earth borehole being drilled by means including a rotary drill string, apparatus comprising: means to pump a stream of drilling fluid under pressure through the drill string, including means to decrease such pressure; step-by-step operating means in said drill string for stepping in response to repetitive temporary pressure decreases in said drilling fluid stream; and means for incorporation in said drill string, rendered alternately active and inactive by said step-by-step operating means, for securing at said subsurface location information concerning a physical characteristic and for there creating in the drilling fluid stream intermittent temporary increases in pressure representative of the secured information, and means for operation at said surface location for there detecting and translating the intermittent temporary increase in pressure to provide the secured information.

3. In a system for obtaining at an accessible surface location outside an earth borehole, information to be secured at a relatively inaccessible subsurface location in such borehole, apparatus comprising: a drill string extending between such locations; means at said surface location for pumping through said drill string under pressure a stream of drilling fluid, including means for temporarily reducing pressure of the drilling fluid stream; means at said surface location sensitive to temporary pressure increases in said drilling fluid stream for sensing and recording translations of any such pressure increases; means in said drill string at said subsurface location sensitive to temporary pressure decreases in said drilling fluid stream thereat; step-by-step means operated by said pressure-sensitive means at said subsurface location; and means in said drill string at said subsurface location rendered alternately active and inactive by step-by-step means, to there secure information concerning a physical characteristic and to produce in said drilling fluid stream intermittent temporary pressure increase signals representative of secured information, for reception and translation at said surface location to there provide the secured information.

4. In a system for obtaining at an accessible surface location outside an earth borehole, information to be secured at a relatively inaccessible subsurface location in an earth borehole, apparatus comprising: a drill string; means for pumping a stream of drilling fluid under pressure through the drill string, and including means at the surface location for creating temporary reductions in pressure in the stream of drilling fluid; step-by-step movable means at said subsurface location; pressure-sensitive controller means in the drill string for actuating said step-by-step movable means in response to temporary reductions in pressure in the stream of drilling fluid; means at said subsurface location rendered alternately active and inactive by stepping of said step-by-step movable means, for there securing information and creating intermittent temporary increases in pressure in the stream of drilling fluid representative of the secured information; and means at said surface location for detecting and translating information-representing intermittent temporary increases in pressure in the stream of drilling fluid; whereby said temporary increases in pressure are transmitted to said surface location for detection and translation to provide the secured information.

5. In a system for logging an earth borehole being drilled by means including a drill string and a stream of drilling fluid flowing under pressure through the drill string, a subsurface apparatus comprising: a section of such drill string; means in said section including pressure-sensitive means and step-by-step means operated thereby in response to successive temporary reductions in the pressure in the stream of drilling fluid stream thereat,

and means rendered alternately active and inactive by stepping movements of said step-by-step means, and operative only when so rendered active to derive logging information and create information-representing pressure-increase signals in the drilling fluid stream; whereby by said controlled temporary reduction of pressure in the drilling fluid stream, logging of the borehole may be continued or discontinued at will.

6. Information securing and transmitting apparatus adapted for incorporation into a drill string in an earth borehole, comprising, in combination: a section of tubular drill string adapted to convey drilling fluid under pressure therethrough; information-transmitting means in said section; pressure-sensitive means in said section responsive to successive temporary reductions in the pressure of fluid in the section; means including a plurality of terminals and operable controller means movable in step-by-step order by said pressure-sensitive means in response to successive temporary reductions in the pressure of fluid in said section; a plurality of information-securing units each connected to a respective one of said terminals; and means operated by said controller means for connecting each of said terminals in turn to said information-transmitting means, one terminal at each step, whereby by repeated intermittent temporary reduction of pressure in said section, any selected one of said information-securing units may be brought into connection with said information-transmitting means for transmission of secured information.

7. In a system for obtaining at an accessible surface location outside an earth borehole information to be secured at a relatively inaccessible subsurface location in an earth borehole being drilled by means including a rotary drill string, apparatus comprising: means to supply drilling fluid under pressure to the drill string including means to decrease such pressure; and subsurface means for location within the lower end portion of the drill string, including step-by-step controller means, pressure-sensitive means for operating the step-by-step controller means in response to a decrease in drilling fluid pressure followed by an increase in such pressure, and means rendered selectively active and inactive in response to stepping of the controller means for securing information and producing information-representing drilling fluid pressure increase signals in the drilling fluid for reception and translation at the surface location.

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