Dec. 4, 1945. H. M. RUTHERFORD 2,390,178

DRILLING RATE RECORDER

Filed June 21, 1941 5 Sheets-Sheet 1

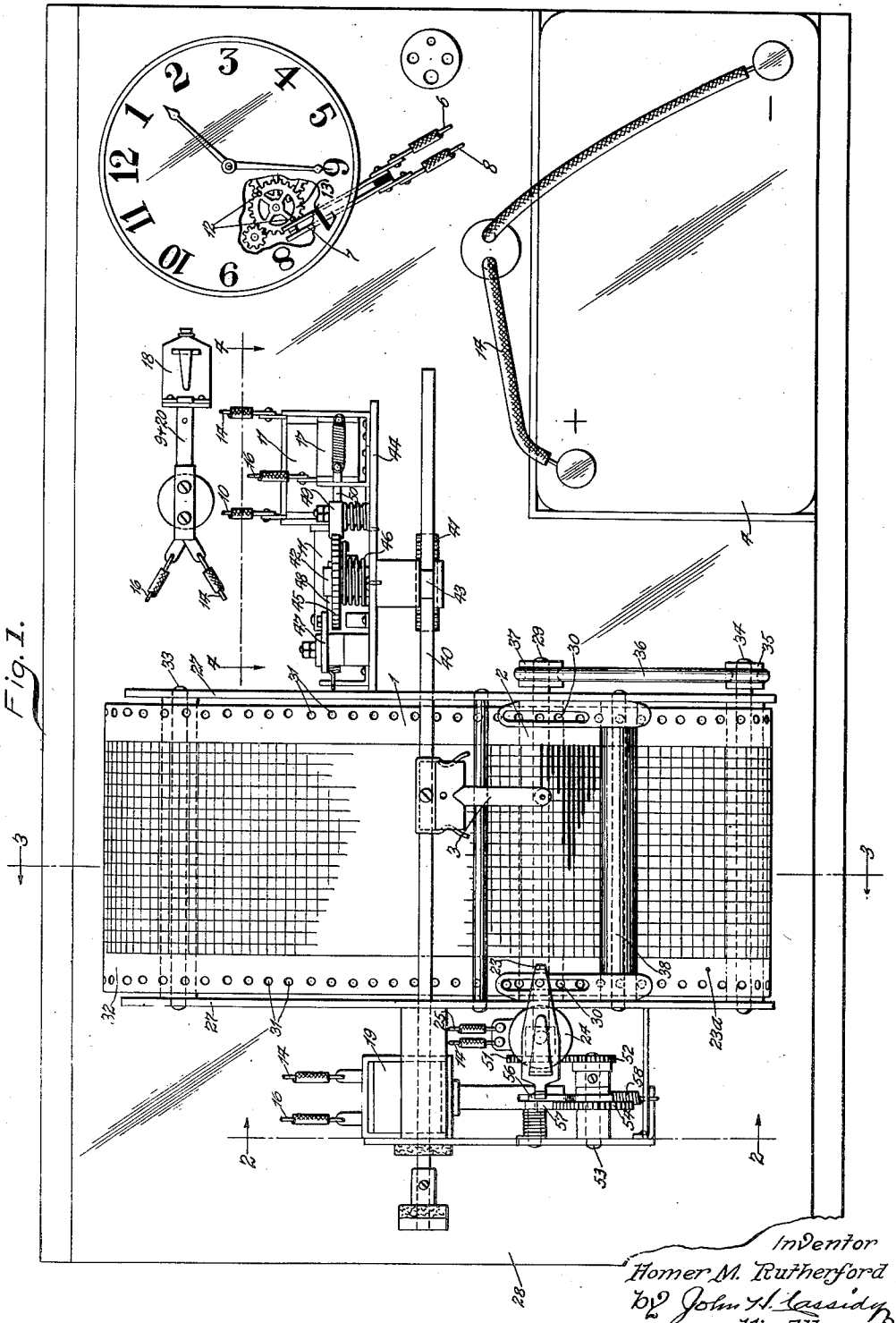

Fig. 1.

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DRILLING RATE RECORDER

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Fig. 2.

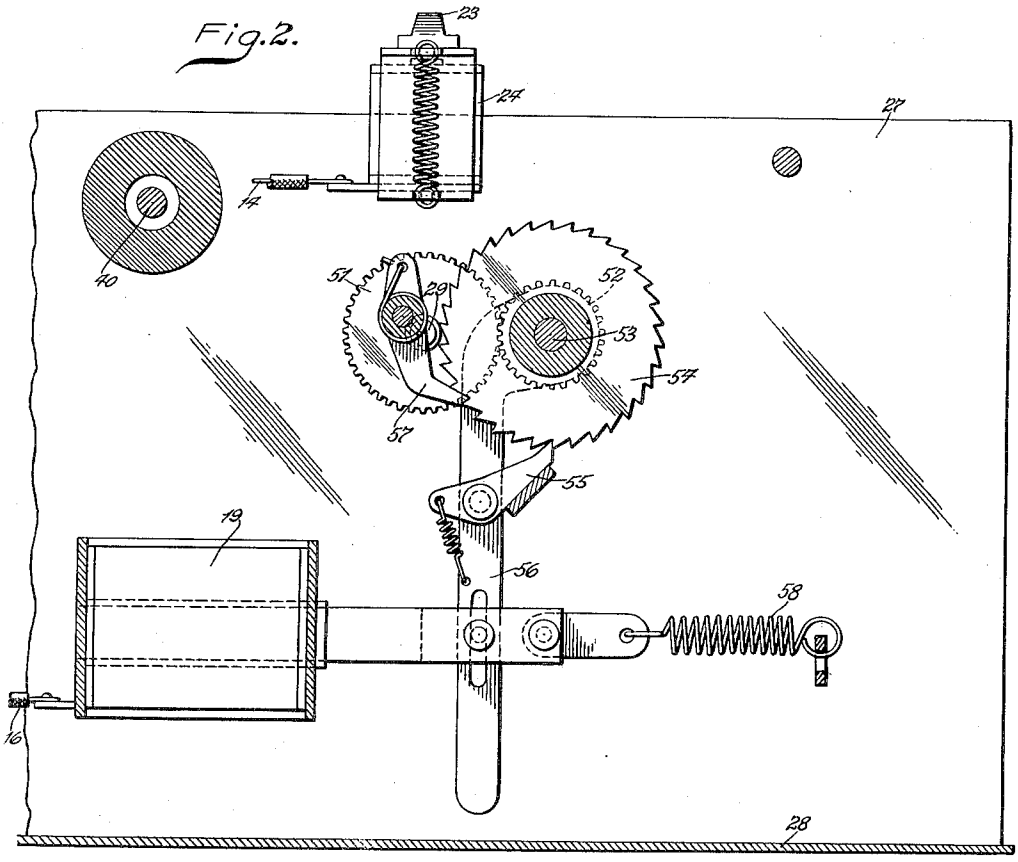
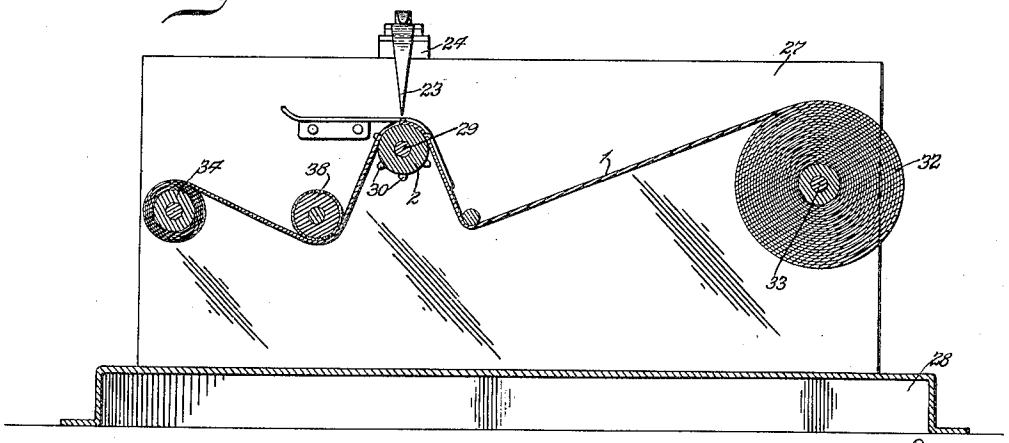


Fig. 3.



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DRILLING RATE RECORDER

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Fig. 4.

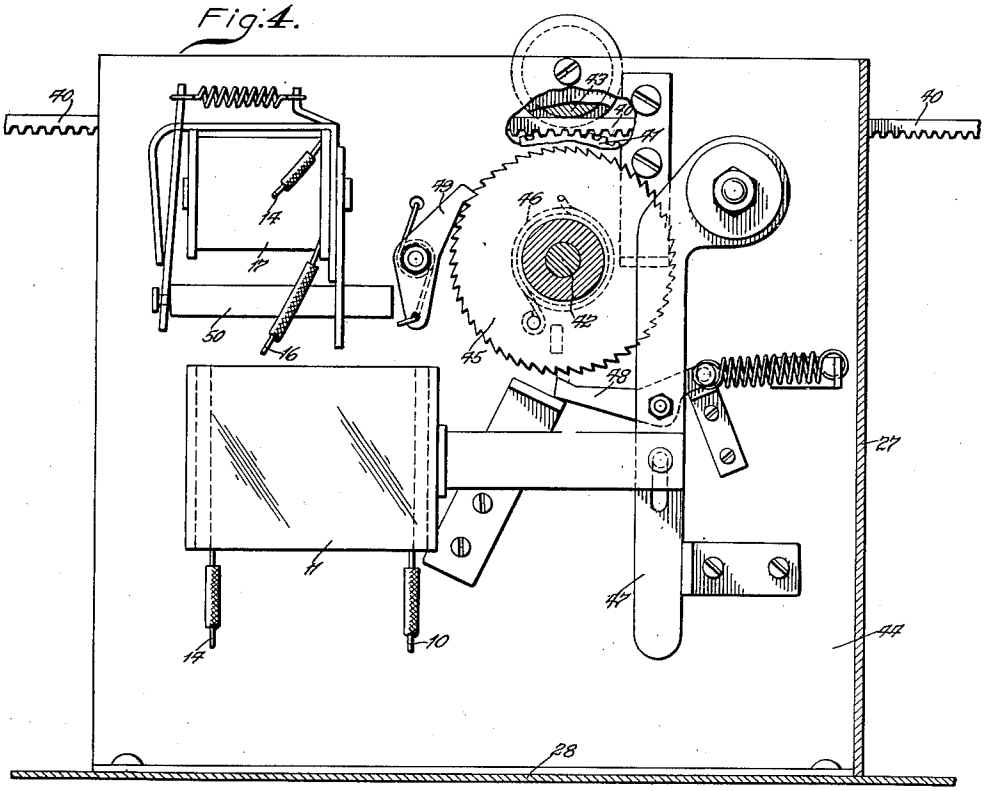
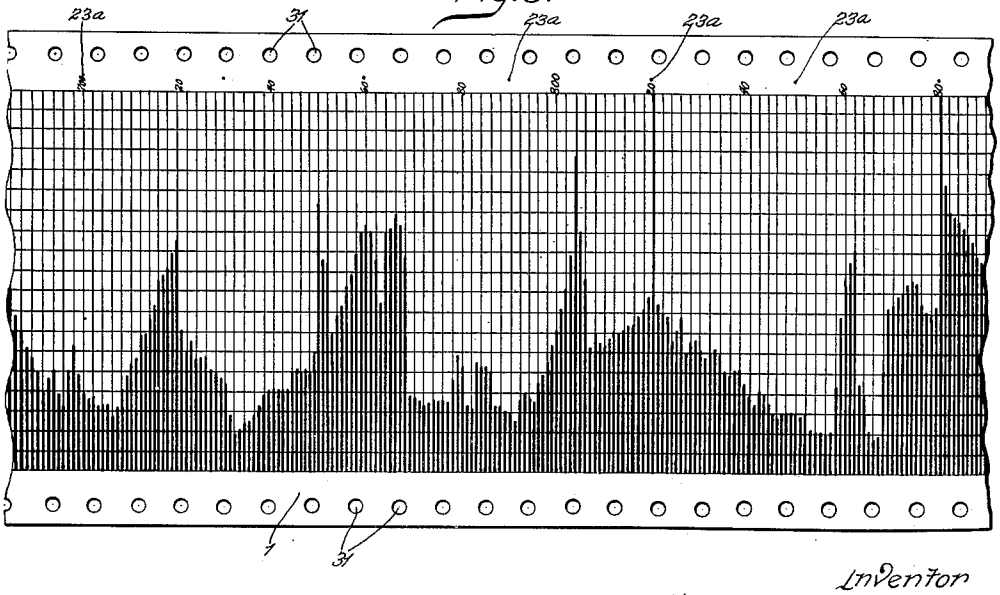


Fig. 5.



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DRILLING RATE RECORDER

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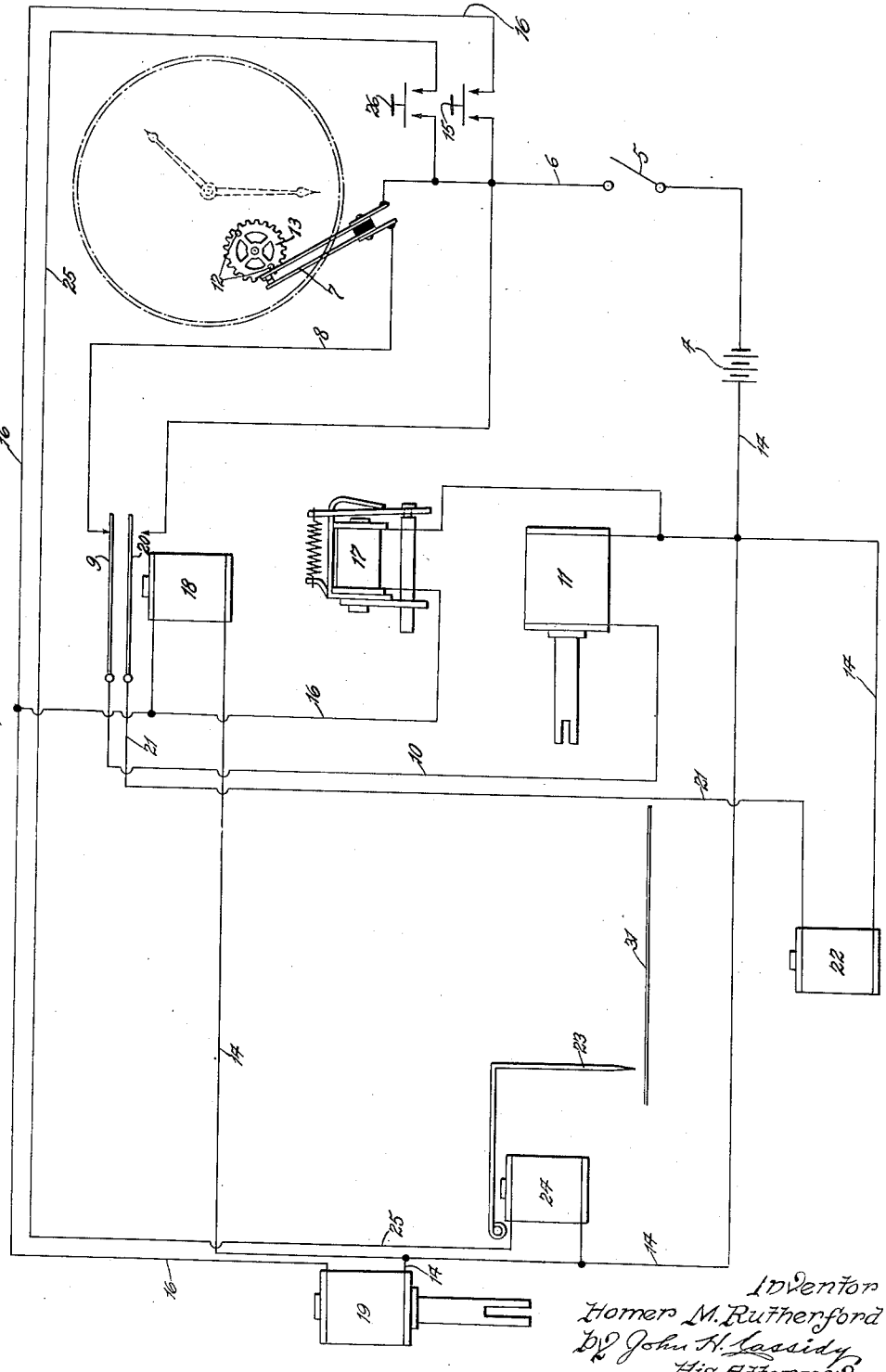

Fig. 6.

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Fig. 9.

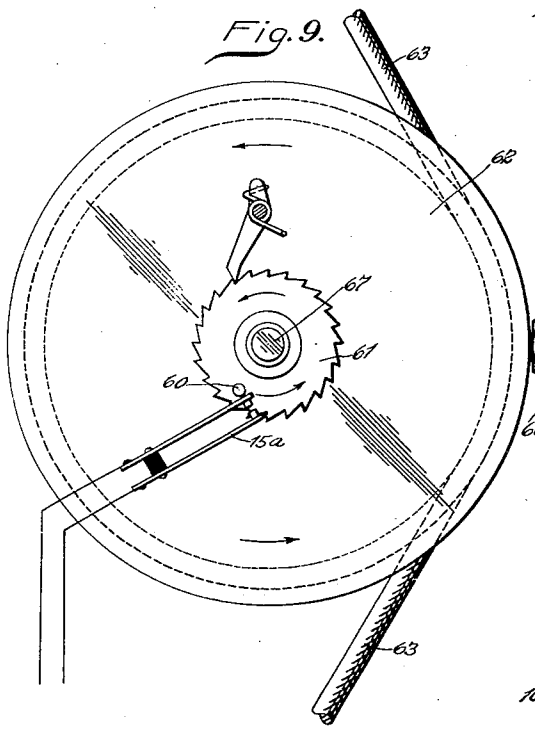


Fig. 8.

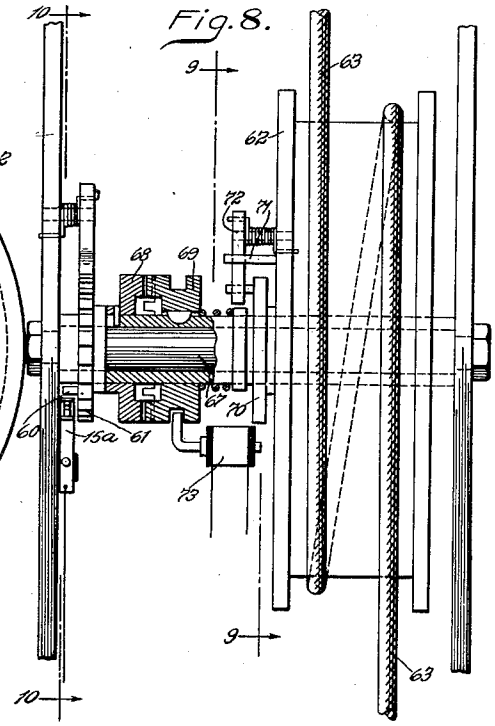


Fig. 10.

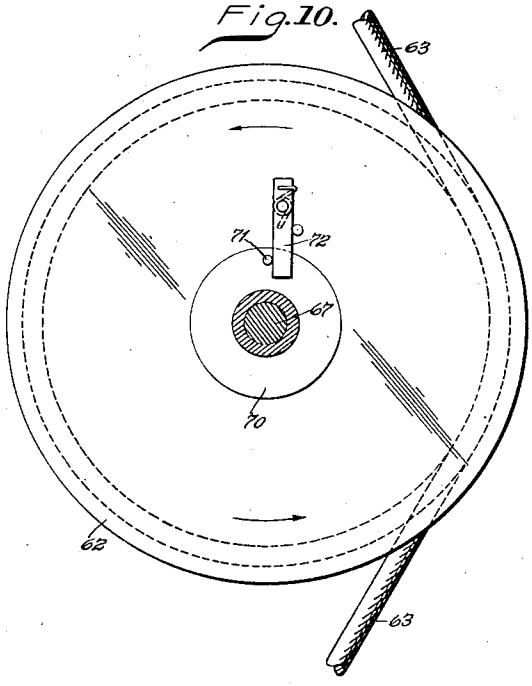
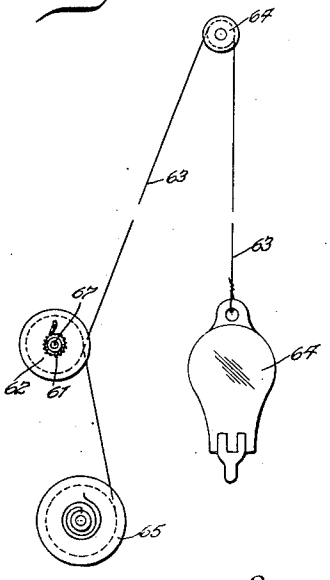


Fig. 7.



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2,390,178

UNITED STATES PATENT OFFICE

2,390,178

DRILLING RATE RECORDER

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Application June 21, 1941, Serial No. 399,082

3 Claims. (Cl. 234—36.5)

This invention relates to well logging, and particularly to the production of a log which will indicate the rate of well drilling by which the nature of the successive strata may be determined.

The object of this invention is to provide a log or register indicating the rate at which each unit of the well is drilled, and to provide means therefor which are simple and efficient.

Various specific objects will be apparent from the following detail description, taken in connection with the accompanying drawings.

Fig. 1 is a plan view of apparatus embodying this invention;

Fig. 2 is a section on line 2—2, Fig. 1;

Fig. 3 is a section on line 3—3, Fig. 1;

Fig. 4 is a section on line 4—4, Fig. 1;

Fig. 5 is a section of a log;

Fig. 6 is a circuit diagram; and

Figs. 7 to 10 are views showing devices for automatically controlling the apparatus by the progress of the drill, Fig. 7 being a diagrammatical view, Fig. 8 a detail elevational view, Fig. 9 a section on line 9—9, Fig. 8, and Fig. 10 a section on line 10—10, Fig. 8.

The invention contemplates the use of a strip of paper 1 upon which the log is inscribed by a series of parallel equally spaced lines, each line beginning along a marginal line, and each line being of a length proportional to the time required for drilling a unit of the well, for instance a foot. That is to say, the log will show a consecutive series of lines, each representing the time required to drill a particular foot of the well. The inscribed lines will represent respectively the units or feet of the well from top to bottom, and the time consumed in drilling each foot separately. Since the time used in drilling each particular unit, other things being equal, depends upon the hardness of the stratum encountered in that particular unit, such a log will give the trained technician accurate data concerning the geological structures throughout the well bore.

The device as shown in the drawings includes means for carrying a strip of paper 1 over a platen 2. The paper is advanced either manually or automatically one space for each unit of depth after the unit has been completed. While that unit is being drilled a pen, or stylus 3, is advanced across the paper, step by step, in the specifically illustrated apparatus, the steps occurring at predetermined time intervals, for instance thirty seconds. As specifically shown the pen will be advanced from right to left, Fig. 1, while the drilling of the unit is progressing, and then when the unit has been completed the pen will be returned in one step the entire distance to the right margin line of the paper strip, and immediately the paper will be advanced one space so that the pen can trace the time consumed in drilling a succeeding unit of depth.

The device is controlled electrically. Having described the general results and functions, the electric circuits by which they are obtained may next be described. The specific construction and operation of the mechanism by which the electrical impulses are utilized to secure the results will appear later in detail. Electric energy is supplied by a battery 4, while a cutout switch 5 is arranged to disconnect the battery when drilling is not in progress. Assuming that drilling is in progress, the switch 5 will be closed, and the circuit will lead through a line 6 to a clock-controlled switch 7, then through a line 8, through a relay switch 9, and through a line 10 to a solenoid 11, whose function is to operate the pen 3 from right to left (Fig. 1), step by step through mechanical apparatus which will be described later in detail, and which is shown in Figs. 1 and 4.

As specifically shown the switch 7 is closed once every thirty seconds, by means of pins 12 on a minute wheel 13. That is to say, the minute wheel 13 is rotated completely once in sixty seconds and causes the switch 7 to close twice during that period. Thus it will be understood that the solenoid 11 in the apparatus specifically illustrated moves the pen 3 from right to left a predetermined step once in every thirty seconds. The circuit of the solenoid 11 is completed to the battery by a line 14.

When a predetermined unit of drilling, such as a foot, has been completed a switch 15 is closed, either manually or automatically. This switch connects the line 6 with a line 16 which leads to an electromagnet 17, a relay 18, and a solenoid 19, the opposite sides of the electromagnet 17, relay 18 and solenoid 19 being connected with the line 14 to complete the circuit to the battery.

The function of the electro-magnet 17 is to release the pen 3 permitting it, by mechanism which will be later described, to travel to the right margin line of the sheet 1 in one quick continuous step. The function of the relay 18 is to open the switch 9, thus preventing operation of the solenoid 11 while the switch 15 is closed, and to close the relay switch 20. The switch 20 connects with a lead 21 to a solenoid 22 for operating a counter or an accumulator, not shown.

That is to say, the solenoid 22 operates a set of accumulator wheels and thus registers the number of times the switch 15 is closed. This is a matter of convenience and has no connection, except the electrical connection as described, with the logging apparatus.

The function of the solenoid 19 is to turn the platen 2 a predetermined distance, thus spacing the lines produced by the pen 3 on the sheet 1. It may now be understood that when the switch 5 is closed, and the drilling is progressing, the pen 3 will be caused to move across the paper 1 from right to left, moving step by step, one step each thirty seconds. When a unit of drilling has been completed, such as a foot, the switch 15 will be closed. This may be done manually or it may be done automatically, by apparatus which will be described later in detail. When the switch 15 is closed the relay 18 is energized, thus cutting out by means of the switch 9 the solenoid 11 and energizing the electro-magnet 17 and the solenoid 19. The electro-magnet 17 permits the pen to be moved to the right of the sheet to start a new line while the solenoid 19 causes the platen 2 to advance the sheet one space. At the same time the relay 18 closes the switch 20 to energize the solenoid 22, and thus operate a counter or accumulator, not otherwise shown.

In order to check the accuracy of the log a special indication or punch mark is placed upon the sheet 1 by a punch 23, when a new connection to the drill stem is made. The length of the drill stem sections are known accurately so that the distance between punch marks on the sheet 1 give a check of the drilling depth. The punch 23 is operated by an electro-magnet 24 connected by a line 25 through a switch 26 to the battery 4, and on its return side is connected to the battery by the line 14. It will be understood now that whenever a new section of drill stem is connected the switch 26 will be manually operated to make a mark by the punch 23 on the left side of the sheet 1.

The general operations and functions, and the electrical circuits responsible for those functions and operations, have been described. There will now be described the specific mechanical devices which are responsive to the electrical impulses or electrical devices and which complete the operations.

The platen 2 is mounted on a pair of frame members 27, which are secured to a base 28; that is, its shaft 29 is journalled in the frame members 27. Sprockets 30 are secured at the end of the platen and propel the strip 1 by meshing in holes 31 at the margins of the strip 1. A roll of paper supply 32 is supported on a shaft 33 which is journalled in the frame members 27. The paper is wound on a reel 34 whose shaft is journalled in the frame members 27. A pulley 35 is attached to the reel 34 and connected by a belt 36 to a pulley 37 secured to the shaft 29 of the platen 2. An idling roll 38 is also journalled in the frame members 27.

The pen 3 is mounted on and moved by a rod 40 which is supported by and slides in the frame members 27. The rod 40 has a rack on its bottom surface meshing with a gear 41 on a shaft 42. An idling wheel 43 is spaced above the gear 41, holding the rod 40 in proper position with the gear 41. As shown in Figs. 1 and 4, the shaft 42 with the gear 41 is mounted on and supported by a vertical plate 44, which in turn is supported by the base 28. A ratchet wheel 45 is secured to the shaft 42 and is, therefore, integrally connected with the gear 41 by which the gear is driven. A spring 46 is wound as the ratchet 45 is moved in a clockwise direction (Fig. 4). That is to say, the spring is wound as the pen is moved in a step by step movement from right to left, Fig. 1, and this spring serves as a means for returning the pen to the right marginal line of the sheet 1 in one quick continuous stroke.

The means for moving the gear 41 to advance and retract the pen 3 are best shown in Fig. 4. The solenoid 11 is connected to a lever 47 to which is secured a pawl 48 engaging the ratchet 45. By reference to Fig. 4, it will be understood that when an electrical impulse is applied to the solenoid 11, the lever 47 and pawl 48 will be moved to the left to move the ratchet 45 and gear 41 one step, thereby advancing the rod 40 and the pen 3 one step. A spring-pressed detent lever 49 prevents, until released, any backward motion of the rod.

The electro-magnet 17 is arranged, when energized, to release the detent 49. A tappet 50 is secured to the armature of the electro-magnet 17 and strikes the free arm of the lever detent 49, thereby releasing the detent whenever the electro-magnet 17 is energized. When the detent 49 is released the spring 46 causes the gear 41 to move the rod 40 to return the pen to the right marginal line of the sheet 1 in one quick continuous stroke.

The driving mechanism operating on the shaft 29 of the platen 2 is shown in Fig. 1, and shown in more detail in Fig. 2. A gear 51 secured to the shaft 29 meshes with and is driven by a pinion 52 on a shaft 53, to which is also secured a ratchet wheel 54. The ratchet 54 is driven by a pawl 55 on a lever 56 connected to the solenoid 19. The ratchet is held by a detent 57. The solenoid 19 is opposed by a spring 58, and the arrangement is such that the ratchet 54 and thereby the platen 2 is caused to move in response to the spring 58 after it has been put in tension by the solenoid 19, so that platen is not moved until the solenoid 19 has been de-energized and until after the pen has been returned to the starting line.

It may now be understood that when drilling has commenced, the switch 5 is closed and the clock operating the wheel 13 is placed in operation. As time progresses the pins 12 on the minute wheel 13 of the clock will close the switch 7 periodically, once every thirty seconds as specifically shown. Whenever the switch 7 is closed the solenoid 11 will be energized and the ratchet 45 with its gear 41 will be moved one step to advance the rod 40 with the pen 3 attached thereto across the paper one step from right to left, Fig. 1. This operation will be continued until the switch 15 is closed, either manually or automatically. Upon closing of this switch the relay 18 will disconnect the circuit to the solenoid 11 and will energize the electro-magnet 17 to release the detent 49, thereby permitting the spring 46 to move the rod 40 and the pen 3 back the full distance permitted. At the same time that the electro-magnet 17 has been energized the solenoid 19 will be energized, moving its armature to the left, Fig. 2, against the force of the spring 58. As soon as the switch 15 is opened again the spring 58 will return the pawl 55 to the right, Fig. 5, thereby advancing the platen one space.

A section of the chart or log is illustrated in Fig. 5. The log lines begin at the lower marginal lines and comprise that series of uneven parallel lines clearly shown in the drawings. The numerals on the upper margin indicate the depth

at which the log lines are made. The punchings produced by the punch **23** are indicated by the reference **23***a*, and are found in the upper margin which corresponds to the left margin Fig. 1.

Mechanism for automatically operating the distance switch to return the pen and to move the platen is indicated in Figs. 7, 8, 9 and 10. In this case a switch, indicated by reference **15***a*, corresponds to the push button switch **15**, as shown in the circuit diagram **6**, and is arranged in the circuit precisely as is the manual switch **15**. The devices shown in Figs. 7 to 10 are provided for the purpose of intermittently closing the switch **15***a* in accordance with the descent of the drill during the drilling operation. By way of illustration, it may be considered that the mechanism is arranged to close, then open the switch **15***a*, once for each foot of descent of the drill.

The switch **15***a* is closed by a pin **60** on the rotating member **61** which is releasably connected to a sheave **62** about which is wound a cable or line **63**, connected to the drill or drill stem. As specifically illustrated in Fig. 7, it is connected to the traveling block **64** which supports the drill stem.

The cable **63** is wound upon a spring propelled reel **65** and passes therefrom around the sheave **62** over a pulley **66** on the crown block of the derrick and down to a fastener on the traveling block **64**. It will be understood then that, if the rotating member **61** is caused to rotate with the sheave **62** and the sheave **62** has a circumference of one foot, the switch **15***a* will be closed once for each foot of descent of the drill. The rotating member **61** and the sheave **62** are mounted for rotation on a common shaft **67**.

The rotating member **61** is connected to the sheave **62** through clutch members **68** and **69**, and an intermediate rotating member **70**. The intermediate rotating member **70** with a sleeve is mounted on the shaft **67** and has a pin **71**, which is engaged by a spring pressed pawl **72** on the sheave. The arrangement is such that the pawl **72** will engage the pin **71** to rotate the member **70** as the sheave **62** rotates in a counterclockwise direction, Figs. 9 and 10, but will not back up the member **70** as the drill bounces, thus avoiding undesired closing of the switch **15***a*. The arrangement of the pawl is such, however, that a substantial raising of the drill will permit the pawl **72** to slide over the pin **71**.

The clutch member **69** is splined on the sleeve of the intermediate member **70**, and is spring pressed to engage the clutch member **68** integrally with the rotating member **61**. It is movable out of engagement with the clutch member **68** by a solenoid **73**. The clutch will be disconnected, for instance, by the solenoid **73** whenever it is desired to raise or lower the traveling block **64**, except when the drill is actually in operation.

It will be obvious from the foregoing that the invention accomplishes its objects. A method and apparatus has been provided for logging a well, which will give accurate and valuable information as to the strata traversed by the drill and in a form which can be read and understood at a glance.

I claim:

1. In a well logging device in which repeatedly a writing implement is moved across a strip of paper a distance corresponding to elapsed time, and then the implement is returned to the place of starting and the strip is advanced a space, the improvement comprising an electrical device and circuit for moving said implement across the strip, a switch in said circuit, a timing device constructed and arranged to periodically close said switch, a spring for returning the implement to the place of starting, a detent for holding the spring against action, an electromagnet for releasing the detent, and a circuit therefor having a relay which when energized breaks the first circuit.

2. In a well logging device in which repeatedly a writing implement is moved across a strip of paper a distance corresponding to elapsed time, and then the implement is returned to the place of starting and the strip is advanced a space, the improvement comprising a spring for returning the implement to the place of starting, a detent for holding the spring against action, an electromagnet for releasing the detent, a solenoid for advancing the strip, a circuit supplying the electromagnet and solenoid, and a switch in the circuit whereby the electromagnet and solenoid are energized simultaneously.

3. In a well logging device in which repeatedly a writing implement is moved across a strip of paper a distance corresponding to elapsed time, and then the implement is returned to the place of starting and the strip is advanced a space, the improvement comprising a spring for returning the implement to the place of starting, a detent for holding the spring against action, an electromagnet for releasing the detent, a ratchet and pawl for advancing the strip, a second spring for operating the pawl, a solenoid for ratcheting the pawl and for tensioning the last mentioned spring, a circuit for supplying the electromagnet and solenoid, and a switch in the circuit whereby the electromagnet and solenoid are energized simultaneously to release the detent and tension the second mentioned spring, thereby returning the writing implement and then when the switch is opened permitting the second spring to move the strip.

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