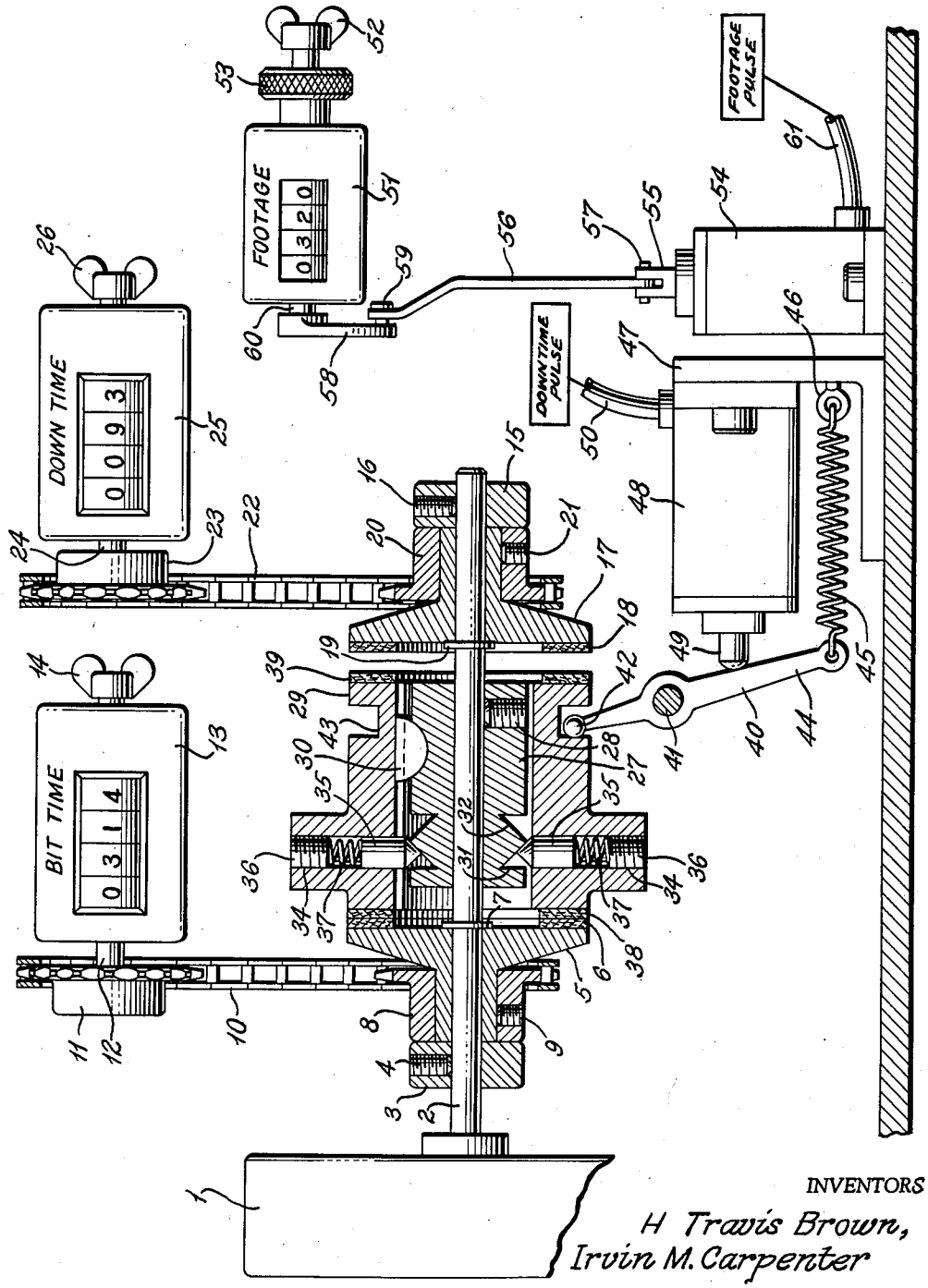
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TIME RECORDER AND COMPARATOR FOR DRILLING OPERATIONS

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INVENTORS
H Travis Brown,
Irvin M. Carpenter

BY
Stevens, Davis, Miller & Mosher
ATTORNEYS

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TIME RECORDER AND COMPARATOR FOR DRILLING OPERATIONS

H Travis Brown and Irvin M. Carpenter, both of Oklahoma City, Okla., assignors to The Geolograph Company, Oklahoma City, Okla., a corporation of Oklahoma

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The present invention relates to a device for recording, simultaneously, the time sequence involved in drilling operations in conjunction with the corresponding number of feet which have been drilled, such that it is possible to compare the relative down time and drilling time for any given increment of drilling or for the life of a drill bit.

In the drilling art (as is also the case in many other fields of endeavor), emphasis is being placed more and more upon automation. Furthermore, the operators and/or owners of wells and well drilling equipment have expressed an interest in obtaining the most complete information in the shortest period of time. Heretofore, the information which is now provided by the present invention has been interpolated or extrapolated from other data. The principal advantage of the present invention resides in the fact that there is provided a single unit which is capable of indicating the ultimate information on a comparative basis, this information being readily available by visual inspection and without requiring interpretation of other data.

The present invention comprises a single unit which includes three separate counters, two of which are driven by a constant speed device, such as a clock. The clock has a shaft which is capable, alternately, of driving the two counters. The driving relation between the clock shaft and each of the two counters, is such that the total appearing on each counter will be indicative of the number of minutes or hours during which the clock has been placed in driving relation with that particular counter. A clutch, which is keyed to the clock shaft, is movable into engagement, alternately, with the two means for driving the two counters respectively. The clutch is driven into engagement with one or the other of the two aforementioned driving means in response to the movement of a lever which is actuated by a pneumatic cylinder. Preferably, this pneumatic cylinder connects with a remote pneumatic valve which is located in a recorder of the type shown in Patent No. 2,980,486, this valve being actuated when the operating handle of the recorder shown in the aforementioned patent is placed in the "OUT" position.

As indicated above, the present invention also includes a third counter mounted within the same unit for recording the number of feet drilled. This counter is preferably driven by another pneumatic cylinder which connects remotely with a pneumatic device operating in response to the movement of the drill string; preferably, this last-mentioned device is of the type disclosed in application Serial No. 111,778, filed on May 22, 1961, and entitled Cam Operated Pulsing Device. Thus, each time that a given increment of drilling distance has been completed, a pulse comes from the aforementioned cam operated pulsing device to energize the second pneumatic cylinder for operating the footage counter.

The present invention provides three items of information simultaneously:

(*a*) The time during which actual drilling has taken place;

(*b*) The down time, or the time during which the drilling operations have been interrupted; and

(*c*) The total number of feet drilled for the total time represented by the sum of the aforementioned time for (*a*) and (*b*).

Thus, for any given increment of drilling, it is possible to compare the time of drilling with the down time and thus determine the efficiency of the drilling operation for that particular increment of drilling. Secondly, with respect to any drilling bit, it is possible to determine the time required for that particular bit to complete a certain given number of feet.

Therefore, it is a principal object of the present invention to provide a device of the type described above capable of producing time information with respect to the drilling operation proper as well as the down time, with these items of information being compared directly with the number of feet drilled.

Other and further objects and advantageous features of the present invention will hereinafter more fully appear in connection with a detailed description of the attached drawing which is a semi-diagrammatic view, with certain parts in section, of the essential components of the present invention.

Referring to the drawing in detail, there is illustrated a clock **1**, the internal details of which are considered conventional and hence are not shown. It will be assumed that the clock **1** is provided with a means (not shown) for winding the clock. The clock is provided with an output shaft **2** which is driven at a constant rate of speed. A collar **3** is mounted on the shaft **2** for rotation therewith by means of the set screw **4**. A clutch plate **5** having thereon a suitable friction ring **6** is mounted for free rotation on the shaft **2** between the collar **3** and a retaining ring **7**, the latter being locked in a suitable groove in the shaft **2**. A hollow sprocket-type gear **8** is keyed to the clutch plate **5** by means of a set screw **9**. A chain **10** passes around the sprocket gear **8** and another sprocket **11** keyed to the outer end of a shaft **12** of a counter **13**. The latter is a standard type counter, and, therefore, the internal details of the same will not be described further. However, this counter is provided with a reset handle **14** for the purpose of returning the counter back to zero whenever it is seen fit to do so.

At the outer end of the shaft **2** there is mounted another collar **15** which is keyed for rotation with the shaft **2** by means of a set screw **16**. Another clutch plate **17** having a friction ring **18** attached to its left-hand face is freely rotatably mounted on the shaft **2** between the collar **15** and another retaining ring **19**, the latter also being mounted in a suitable groove in the shaft **2**. A sprocket-type gear **20** is keyed to the clutch plate **17** by means of a set screw **21**. A chain **22** passes over the sprocket **20** and a sprocket wheel **23** mounted on the outer end of a shaft **24** of another counter **25**. This counter is similar in all respects to counter **13** previously described. Counter **25** is also provided with a reset handle **26** for the purpose of returning this counter to zero whenever it is desired to do so.

Between the two clutch plates **5** and **17**, there is mounted an inner cylindrical member **27** which is keyed to the shaft **2** by means of a set screw **28**. An outer sleeve **29** is mounted for sliding movement in an axial direction relative to the cylinder **27**, but is keyed, as at **30**, for rotation with the cylindrical member **27**. The outer surface of the cylindrical member **27** is provided with two adjacent annular grooves **31** and **32**. The adjacent portions of these grooves come together to form an inverted V as shown in the drawings whereas the remote portions of these grooves are substantially normal to the rotational axis of the cylinder **27**. The outer sleeve **29** is provided with a plurality of radial holes **34** in which are mounted pointed nylon plugs **35**. Threaded plugs **36** received in the outer ends of the holes **34** and the springs **37** serve to urge the nylon plugs **35** radially inwardly such that their pointed ends engage one or the other of the grooves **31** and **32**. Although only two nylon plugs **35** are shown

in the drawing, it should be understood that a greater number, if desired, can be mounted similarly around the periphery of the sleeve 29.

The left-hand surface of the sleeve 29 is provided with a friction ring 38 which is adapted to engage the friction ring 6 on the clutch plate 5 when the sleeve 29 is in the position shown in the drawing. The right-hand surface of the sleeve 29 is provided with a friction ring 39 which is adapted to engage the friction ring 18 on the clutch plate 17 when the sleeve 29 is moved toward the right. It should be noted that the grooves 31 and 32 together with the pointed nylon plugs 35 form a type of friction lock which tends to hold the sleeve 29 in such a position that it engages either one or the other of the clutch plates 5 and 17 through the intermediate friction rings described above.

A lever 40 is pivotally mounted on a rod 41. The upper end of the lever 40 is rounded as at 42 and is received within a suitable annular groove 43 in the outer periphery of the sleeve 29. The other end 44 of the lever 40 connects with one end of a spring 45; the other end of the spring 45 connects with an eye 46 attached to a bracket 47. Therefore, under normal operating conditions, the spring 45 will urge the lever 40 in such a direction that the sleeve 29 will tend to be retained in the position shown in the drawing.

A pneumatic cylinder 48 is also mounted on the bracket 47. This pneumatic cylinder 48 is of essentially standard construction having therein a suitable piston (not shown) mounted for sliding movement within the cylinder. The outer end of a piston rod 49 which connects with the piston in a conventional manner, bears against the lower arm 44 of the lever 40. A hose 50 connects with the pneumatic cylinder 48 as shown. The internal construction of the pneumatic cylinder 48 is such that, when a source of fluid under pressure is applied to the pneumatic cylinder through the hose 50, the piston within the pneumatic cylinder will be urged toward the left such that the outer end of the piston rod 49 will also be urged towards the left thus turning the lever 40 in a clockwise direction with respect to the rod 41. This movement of the lever 40 will cause the sleeve 29 to move towards the right so that the shaft 2 is now in driving engagement with the sprocket 20. Preferably, the hose 50 connects with a source of pressure such as a valve which would be mounted within a recorder of the type shown in Patent No. 2,980,486, this valve being operated to energize the cylinder 48 whenever the clutch in this recorder is moved to the "out" position. However, any pneumatic means which is capable of producing a pulse whenever the drilling apparatus is placed in an inoperative condition will suffice for the purposes of the present invention.

A third counter 51 is mounted within the unit represented by the drawing. This counter is essentially the same as the counters previously described having a reset handle 52 for the purpose of returning the counter to zero whenever it is desired to do so; in addition, this counter 51 is provided with a knob 53 for the purpose of moving the counter backwards or forwards in the event that it is desired to correct for an error.

A second pneumatic cylinder 54 is mounted within the unit of the present invention. This pneumatic cylinder is also provided with an internal piston (not shown) which is movable vertically whenever the pressure within the cylinder goes above a certain predetermined amount. The outer end of a piston rod 55 (connected to the internal piston in a conventional manner) is connected to the lower end of a link 56 by means of a pin 57. The upper end of the link 56 is connected to the outer end of an arm 58 by means of a pin 59. The arm 58 is keyed to the outer end of a shaft 60 which is the operating shaft for the counter 51. The pneumatic cylinder 54 is provided with a hose 61 such that, whenever pressure is applied to the pneumatic cylinder 54 from the hose 61, the piston within the pneumatic cylinder 54 will be moved

upwardly and the piston rod 55 will be moved upwardly correspondingly. The upward movement of the rod 55 will cause, through the link 56 and the arm 58, an advance in the reading on the counter 51. Preferably, the hose 61 connects with a device such as that disclosed in copending application Serial No. 111,778, filed on May 22, 1961, entitled Cam Operated Pulsing Device. The last-mentioned device is capable of providing a pneumatic pulse in response to the completion of a given drilling increment.

It will be assumed that the driving relation between the shaft 2 and the counter 13 is such that the units on the counter will represent hours of elapsed time, the right-hand digit of the counter 13 representing tenths of hours. It will be assumed further, that the driving connection between the shaft 2 and the counter 25 is the same as that described with reference to the counter 13. The left-hand counter 13 will be used to represent the drilling time or the actual time wherein the bit was working. The right-hand counter 25 will represent the down time which includes all the various cumulative time other than actual drilling time. The counter 51 will represent the total number of feet drilled. Thus, with regard to the drawing, it will appear that a total of 320 feet have been drilled for, presumably, a single bit. The counter 13 shows that this bit was in operation for 31.4 hours. Counter 25 shows that the total down time was 9.3 hours.

After a new bit has been placed in operation, the counters 13, 25 and 51 can be returned to zero so that the data taken from these counters will represent information specific to the new drill bit, or, in the alternative, the counters can be left in their last position so as to give an overall aggregate total with respect to all drill bits used. Thus, the information on the three counters 13, 25 and 51 might well represent the total information for the drilling of one complete well.

Whereas the present invention has been described with particular relation to the drawing attached hereto, it should be understood that other and further modifications of the present invention, apart from those shown or suggested herein, may be made within the spirit and scope of this invention. For example, although actuating members 48 and 54 have been shown and described as pneumatic cylinders, it should be understood that these members can be replaced by solenoids, in which case the latter would be energized by microswitches operating in the equivalent sense as the valves which are used to energize the pneumatic cylinders.

What is claimed is:

1. A time recorder and comparator for well drilling operations comprising a single recording unit including three separate counters, a first one of said counters having a first input shaft for operating said first counter so as to indicate the total elapsed time during which actual drilling has taken place, a second one of said counters having a second input shaft for operating said second counter so as to indicate the total elapsed time during which the drilling operations were interrupted, the third one of said counters having a third input shaft for operating said third counter so as to indicate the total depth of drilling, a constant speed device mounted within said unit and having an output shaft rotating at a constant rate of speed, a first clutch plate freely rotatably mounted on said output shaft and being relatively axially immovable with respect thereto, a second clutch plate freely rotatably mounted on said output shaft in spaced relation with said first clutch plate, said second clutch plate being relatively axially immovable with respect to said output shaft, means drivingly connecting said first counter input shaft with said first clutch plate whereby rotation of said first clutch plate will advance said first counter, means drivingly connecting said second counter input shaft with said second clutch plate whereby rotation of said second clutch plate will advance said second counter, a slidable clutch member mounted on said output shaft and keyed

thereto between said first and second clutch plates, means for moving said clutch member slidably with respect to said output shaft so as to engage said clutch plates alternately, resilient means mounted within said unit and operatively connected to said moving means for urging said slidable clutch member into engagement with said first clutch plate, means operatively associated with said moving means and responsive to the interruption of the drilling operations for moving said slidable clutch member into engagement with said second clutch plate, and means connected to said third input shaft and responsive to the completion of a given increment of drilling for advancing said third counter.

2. Apparatus as set forth in claim 1 including a cylindrical member mounted between said slidable clutch member and said output shaft, said cylindrical member constituting the means keying said slidable member to said output shaft, said cylindrical member having a pair of adjacent peripheral grooves, said slidable clutch member having mounted therein a plurality of radially slidable members whose inner ends are adapted to be received alternately in one of said peripheral grooves, and means resiliently urging said radially slidable members towards said peripheral grooves, whereby when said radially slidable members are received in one groove said slidable clutch member is in engagement with said first clutch plate, and whereby, when said radially slidable members are received in said other groove, said slidable clutch member is in engagement with said second clutch plate.

3. A time recorder and comparator for well drilling operations comprising a single recording unit including three separate counters, a first one of said counters having a first input shaft for operating said first counter so as to indicate the total elapsed time during which actual drilling has taken place, a second one of said counters having a second input shaft for operating said second counter so as to indicate the total elapsed time during which the drilling operations were interrupted, the third one of said counters having a third input shaft for operating said third counter so as to indicate the total depth of drilling, a constant speed device mounted within said unit and having an output shaft rotating at a constant rate of speed, a first clutch plate freely rotatably mounted on said output shaft and being relatively axially immovable with respect thereto, a second clutch plate freely rotatably mounted on said output shaft in spaced relation with said first clutch plate, said second clutch plate being relatively axially immovable with respect to said output shaft, means drivingly connecting said first input shaft with said first clutch plate whereby rotation of said first clutch plate will advance said first counter, means drivingly connecting said second input shaft with said second clutch plate

whereby rotation of said second clutch plate will advance said second counter, a slidable clutch member mounted on said output shaft and keyed thereto between said first and second clutch plates, said clutch member being slidable with respect to said output shaft so as to engage said clutch plates alternately, a first lever pivotally mounted within said unit and having one end engaging said slidable clutch member, a first pneumatic cylinder mounted within said unit and having an outwardly projecting piston rod connected to the other end of said first lever, resilient means mounted between said other end of said first lever and a fixed portion of said unit for urging said lever in such a direction that said slidable clutch member is forced into engagement with said first clutch plate, means responsive to the interruption of the drilling operations for supplying pneumatic pressure to said first pneumatic cylinder so as to energize said pneumatic cylinder thereby moving said lever to force said slidable clutch member into contact with said second clutch plate, a second lever mounted at one end on said third shaft of said counter, a second pneumatic cylinder having an externally projecting piston rod, means connecting said outer end of said piston rod of said second pneumatic cylinder to the outer end of said second lever, means responsive to the completion of a given increment of drilling for supplying a pneumatic pulse to said second pneumatic cylinder so as to energize the same causing movement of said second lever and resulting in advance of said third counter.

4. Apparatus as set forth in claim 3 including a cylindrical member mounted between said slidable clutch member and said output shaft, said cylindrical member constituting the means keying said slidable member to said output shaft, said cylindrical member having a pair of adjacent peripheral grooves, said slidable member having mounted therein a plurality of radially slidable members whose inner ends are adapted to be received alternatively in said peripheral grooves, means resiliently urging said radially slidable members towards said peripheral grooves, whereby, when said radially slidable members are received in one groove, said slidable clutch member is in engagement with said first clutch plate, and whereby, when said radially slidable members are received in said other groove, said slidable clutch member is in engagement with said second clutch plate.

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