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DRILLING LOG COMPARATOR

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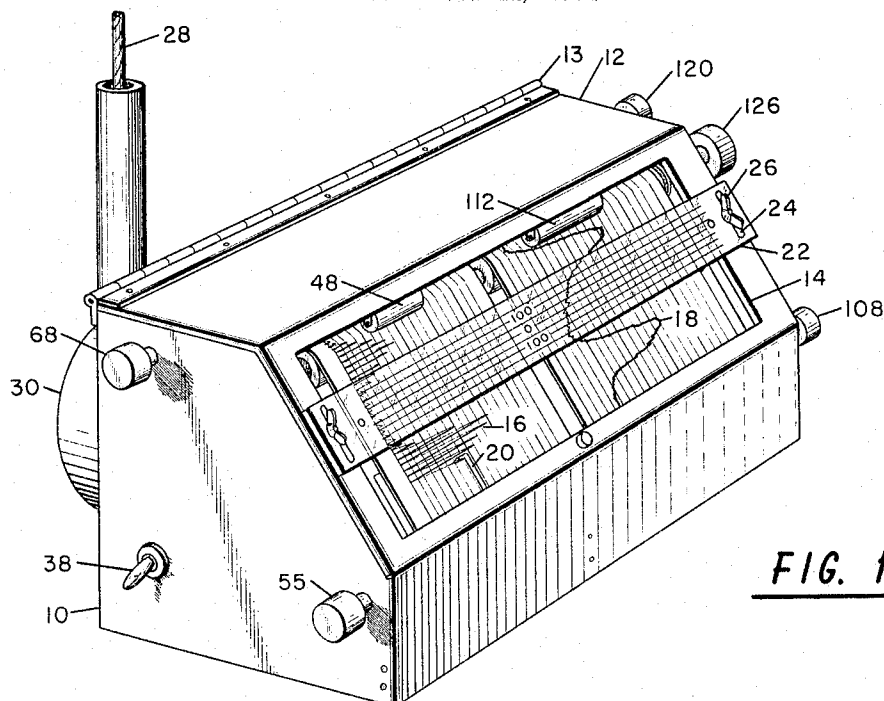


FIG. 1

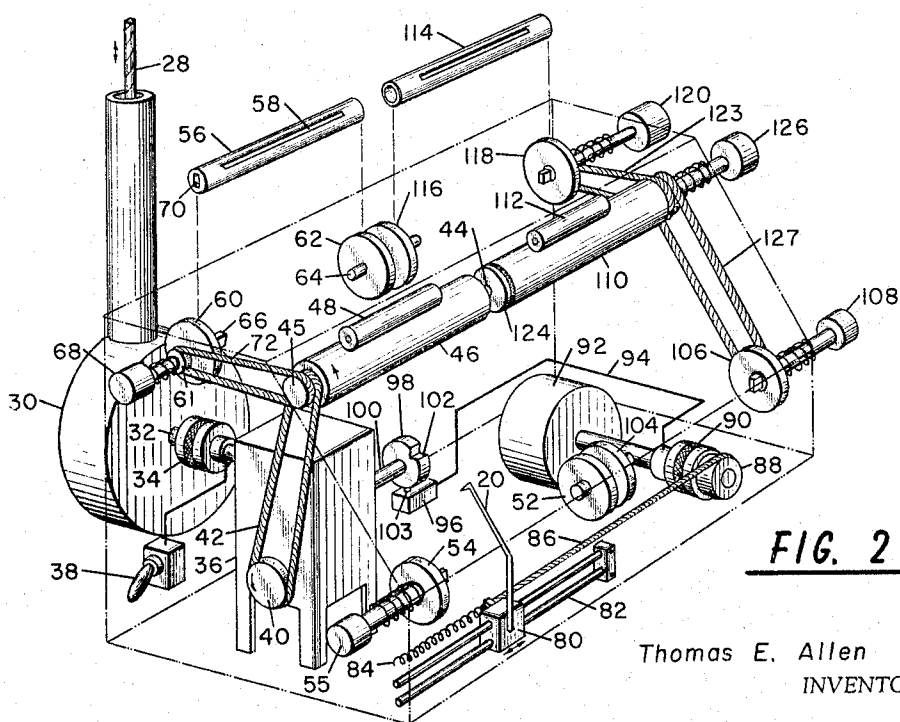


FIG. 2

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DRILLING LOG COMPARATOR

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2 Claims. (Cl. 346-17)

This invention relates to the art of drilling wells into the earth, particularly in the search for petroleum. More specifically, the invention relates to a logging system which makes it possible for a driller to compare the log he is obtaining on a well as it is being drilled with a similar log obtained from an adjacent well drilled earlier.

It is customary, while drilling a well, to continuously log or record certain information, such as drilling rate, etc. This information is used by the driller to follow and optimize the progress of his drilling operation. For example, if the drilling rate falls off quickly, it is frequently an indication that the drill bit should be replaced. However, sometimes the drilling rate drops off for other reasons such as a change in formation. If the driller had information that would indicate to him that a harder formation had been encountered, he would know that the drop in drilling rate was not necessarily due to a dull bit.

It is advantageous for a driller to compare logs or records from wells previously drilled in the immediate area with the log being obtained from the well being drilled. The present invention provides a continuous log comparator which readily makes this possible. For convenience, the term "prior log" means the log from the wells previously drilled, and the term "current log" means the log being made for the well as it is currently being drilled. In this continuous log comparator the prior log is mounted adjacent the current log. Means are provided to drive the prior log and current log concurrently. As drilling progresses, the driller at a glance can tell the nature, not only of the formation he is actually in the process of drilling, but also when he can expect to encounter the next deeper formation. As the formation being penetrated thickens or thins, the logs will lose their exact correlation. The degree to which the logs will differ depends upon the amount of thickening and thinning of the formation or other changes in geological conditions. To resume correct alignment in correlation between the logs, means are provided for advancing or retarding the prior log with respect to the current log until the general contours of the two logs coincide.

It is therefore an object of the invention to provide a system permitting a driller to continuously compare the log he is obtaining on a well with a log obtained from an adjacent well and with means for adjusting the relative longitudinal position of the two logs to obtain relative correlation.

Other objects and a better understanding of the invention can readily be obtained from the drawing in which:

FIG. 1 is a perspective view of the continuous log comparator; and

FIG. 2 is a view of the operating mechanism of the drilling log comparator.

Referring to the drawing, there is disclosed in FIG. 1 an exterior view of the drilling log comparator. It includes a housing 10 having a cover 12 hinged at 13. Cover 12 contains a rectangular opening or window 14 for permitting the viewing of the logs during drilling operations. Shown through window 14 is the current log 16 and a prior log 18. The current log is being printed by pen 20. The pen, in this embodiment, as is shown hereinafter is driven laterally by a timing clock. The

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prior log and the current log are driven upward proportional to the penetration of the drilling bit.

Mounted across window 14 is a transparent viewer slide 22. The viewer slide has slots 24 on each end so that it is adjustable up and down with respect to the log and is fastened in place by wing nuts 26. The viewer slide has a scale thereon for comparing alignment of the two logs.

Line 28 is wound around a follower drum within container 30. This drum is biased so as to keep the line 28 in a taut condition. Line 28 goes upward from the housing to a connection on the Kelly (not shown) so that line 28 unwinds in an amount sufficient to follow the movement of the drilling string as the string is lowered with the deepening of the hole. Thus the follower drum upon which line 28 is wound, rotates proportional to the penetration of the drill bit.

The operational mechanism of the comparator can be more clearly seen in FIG. 2. Shown thereon is container 30 housing the follower drum upon which line 28 is wound.

Attention will first be directed toward that part of the mechanism for preparing the current log. An axle 32 of follower drum is connected through an electric clutch 34 to gear box 36. Electric clutch 34 is engaged or disengaged by operating switch 38. The output or power sheave 40 on gear box 36 rotates at a speed which is proportional to the rotation of the follower drum when clutch 34 is engaged. Drive belt 42 connects power sheave 40 with sheave 45 which is fixed to the main log drive shaft 44. Main drive shaft 44 extends laterally across the comparator and near its top. Fixedly mounted on drive shaft 44 is a first drive roller 46 which rotates with the rotation of the drive shaft. Mounted above drive roller 46 and in frictional engagement therewith is idler 48. In operation, the paper upon which the current log is being made is inserted between idler 48 and drive roller 46.

The "stock" end of the log is mounted upon a roller (similar to roller 56) which is supported between pin end 52 and pin end 54. Pin end 54 has a spring loader plunger 55. The take-up of the log is on take-up roller 56 which has a longitudinal slot 58 into which the end part of the log is inserted. The take-up roller 56 is mounted between pin ends 60 and 62 which are supported from housing 10 toward the upper back side. Take-up roller 58 is fastened in place on pin guides 64 and 66 between pin ends 62 and 60 respectively. Pin guide 66 is moved axially by spring loaded take-up roller plunger 68. Slot 70 of roller 56 receives pin guide 66 such that rotation of pin end 60 rotates roller 56. Pin end 60 obtains its power through belt 72, which is connected to multiple pulley 45 such that drive belt 42 also drives belt 72. Drive belt 72 is preferably a spring-type drive belt such that it can slip on sheave 61 of pin end 60 when the torque is excessive. The primary function of the belt 72 is to maintain the roll of the log on take-up roller 56 in a tight manner.

Pin 20 is mounted on pin carrying block 80 which in turn is mounted on two horizontal carrying rods 82 which are supported from housing 10 at the lower front end portion. A spring 84 biases pin carrying block 80 to the left. A line 86 is mounted about sheave 88 which is connected through electric clutch means 90 to a clock 92. Other type clutch arrangements can be used, but normally for the use herein the electric clutch is preferred. In operation, when clutch means 90 is engaged, clock 92 rotates sheave 88 and as line 86 is wound about sheave 88, the carrying block 80 and pin 20 are carried to the right.

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Electric clutch 90 is connected through lead line 94 to an electric switch 96 which is operated by cam 98. Cam 98 is connected through shaft 100 to gear box 36. This cam rotates one revolution for a given or selected number of feet of penetration of the drill bit. For example, it rotates one time for each five feet the bit penetrates. When indent or recess 102 is above contact spring loaded button 103 of the switch, the switch is opened and electric clutch 90 is disengaged. This permits spring 84 to quickly draw carrying block 80 and pin 20 to the "at rest" or zero position. The particular log obtained by this embodiment has a horizontal line at every unit of penetration, for example, five feet. The length of the mark is dependent upon the time required to drill the interval between marks. Thus, short lines indicate rapid drilling and longer lines indicate slower penetration.

Attention will now be directed toward that part of the apparatus of FIG. 2 upon which is mounted the prior log 18. The prior log 18 is mounted between end members 104 and 106, similarly as the logging paper is mounted between end members 54 and 52. End member 106 has spring loaded take-up plunger 108. End member 106 is driven by spring belt 127 from a sheave connected to the end of roller 110. The prior log extends upward between drive roller 110 and idler 112 to take-up roller 114. Take-up roller 114 is similar to take-up roller 56 and is mounted between end members 116 and 118 similarly as take-up roller 56 is mounted between end members 60 and 62. End member 118 is driven from roller 110 by spring belt 123. Spring loaded take-up roller plunger 120 is provided similarly as take-up roller plunger 68. Plunger 120 is pulled outwardly to insert roller 114 and then released to fit into a slot on the end of roller 114 similarly as with slot 70 of take-up roller 56 receives pin 66. The end of the prior log is mounted in take-up roller 114.

Means will now be discussed for driving and for releasing drive roller 110 from main drive shaft 44. Drive roller 110 is rotatably mounted about the main drive shaft 44. A clutch member 124, when engaged, connects the main drive shaft 44 to drive roller 110 such that rotation of the drive shaft rotates the roller. When it is desired that the drive roller 110 be disengaged from rotation of the drive shaft, clutch 124 is released as by pulling outwardly on knob 126. When clutch 124 is disengaged, rotation of knob 126 advances or retards log 18 relative to log 16.

Attention will now be directed briefly toward the operation of the drilling log comparator. Prior to drilling a well, a roll of logging paper is mounted between end members 52 and 54 and threaded between idler 48 and drive roller 46. The end of the logging paper is inserted into slot 58 of wind-up roller 56. Wind-up roller 56 is then inserted between end members 62 and 60. The logging paper is adjusted so that pen 20 is on the proper index footing on the logging paper. At the same time, a log from a previously drilled well is mounted between end members 106 and 104 and threaded between idler 112 and drive roller 110. The end of the prior log near the zero foot indicator is mounted around wind-up roller 114 which is then placed between end members 116 and 118. The prior log is adjusted so that its footage aligns with the index on the logging paper upon which the new log will be made.

As drilling progresses, line 28 moves upward, thus rotating the follower drum. The rotation of the drum is transmitted through clutch 34 to gear box 36 which in turn drives drive roller 46 proportional to the drilling of the borehole. At the same time that drilling commences, clock 92 commences and starts winding line 86 about pulley 88. This draws pen 20 laterally across the logging paper at a uniform rate. At each selected interval, e.g., five feet, cam 98 makes one rotation and switch 96 is opened when the drill has penetrated the selected interval. This releases clutch 90 and permits

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pen 20 to be pulled backward toward the zero time index of the log by spring 84. As soon as switch 96 is again closed, clutch 90 is energized and pen 20 is again pulled to the right.

The same time that the new log is being made, the old or prior log 18 is being carried along beside the new log, thus the log of the previously recorded well is advanced simultaneously with the penetration rate depth log being recorded. The logs being compared lie beside one another and have a movement in the same direction and at the same rate. As the formation being penetrated thickens or thins, the logs may lose their exact correlation. In other words, the formation characteristics as represented by each log will no longer line up on an imaginary horizontal line drawn across the logs as indicated by one of the indexes on guide member 22. To obtain the corrected alignment between the two logs, the prior log is either advanced or retarded as necessary by first disengaging clutch 124 and then rotating knob 126 in the desired direction. The zero hairline and other hairline guides on viewer 22 used in conjunction with the comparator make an accurate comparison of the logs easy and aid in determining the amount of formation thickening and thinning when it is required to advance or retard the prior log, and help in predicting the depth at which a new formation will be encountered.

The advantages of the continuous drilling log comparator are quite apparent as the visual correlation between logs of previously recorded wells and the penetration rate depth log being recorded on location is quite straightforward. This is accomplished by automatically feeding the supplemental or prior log at the same rate as the penetration rate log is being recorded. Further, the comparator allows simple corrections in log correlations by simply turning a knob. One may make a reasonably accurate measurement of the amount which the formation being penetrated thickens and thins as compared with nearby wells.

Various logs may be used for correlation purposes; these include the induction electric survey log, gamma ray neutron log, sonic log, and penetration rate-depth logs. As is known, these logs are useful in differentiating between shales, hard rocks and permeable beds and defining boundaries between beds; and also the qualitative discrimination between oil- or gas-bearing or water-bearing beds and quantitative evaluation of porosity and water saturation.

The selection of the right bit and the operation of it is much easier if the driller knows what formation the bit must drill. Knowing the formation, a driller is less likely to pull a "green" bit or use the wrong type. Rotary speed, hydraulic fluid pressure, bit weight, torque, etc., can also be adjusted so that lower cost of operation can be achieved. In wells where formations change abruptly, well logs and drilling rate logs can be used to determine what kind of formation is being drilled and what and where the next change in formation is likely to occur. With this knowledge, the driller can more intelligently select the bit type, bit weight and rotary speed which results in best performance.

The use of the drilling log comparator is quite simple. It has very good results in addition to those set forth above. For example, the amount of "well sitting" done by geologists can be reduced considerably. For instance, a driller can watch the continuous log comparator for a predetermined formation to change, which is marked on the supplemental log. When the designated formation change is encountered, as indicated by a change on the drilling rate shown on the log which is being run, the driller can radio or otherwise notify the geologist. Thus, unnecessary "well sitting" time by the geologist is eliminated.

While there is disclosed but one main embodiment of the system of the invention herein presented, it is possible to produce other embodiments without departing

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from the inventive concept 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. An apparatus for comparing a current log being obtained on a well while drilling with a prior log obtained from an adjacent well drilled earlier, the combination which comprises:

first means for forming a current log of the well as it is being drilled;
 second means for supporting said prior log laterally adjacent said current log being formed;
 driving means to move said current log and said prior log longitudinally as a unit;

Said driving means including means to move said prior log longitudinally independent to said current log; and transparent viewing means arranged to overlay said current log and said prior log, said transparent viewing means including at least one laterally disposed linear index whereby the longitudinal align-

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ment of points along said current log and said prior log may be compared.

2. An apparatus as defined in claim 1 including means for adjusting the position of said transparent viewing means along said current log and said prior log.

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