Jan. 29, 1952

J. T. HAYWARD

2,583,841

APPARATUS FOR MEASURING ROTARY WELL STRINGS AND WELL DEPTHS

Filed March 2, 1948

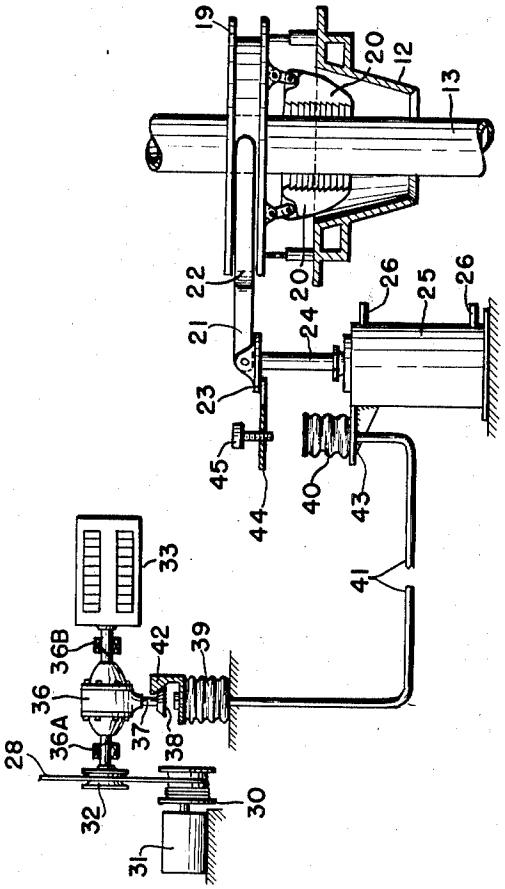


FIG. 2

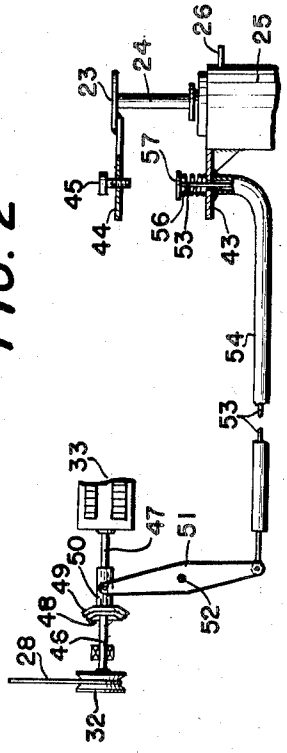


FIG. 3

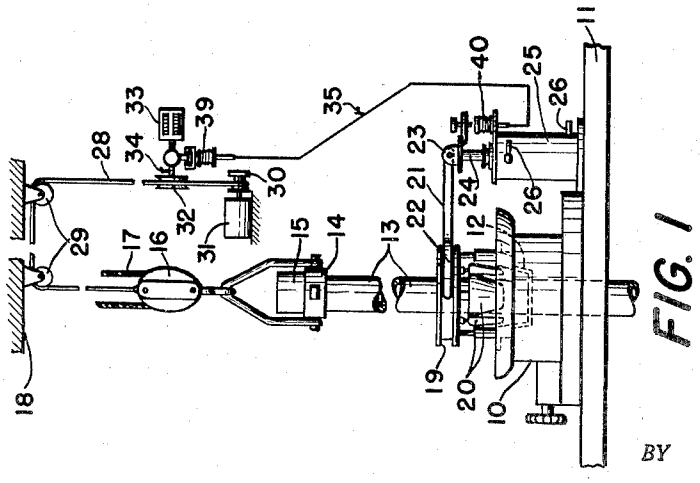


FIG. 1

J. T. HAYWARD
INVENTOR.

BY

R. E. Wesel

ATTORNEY

Patented Jan. 29, 1952

2,583,841

UNITED STATES PATENT OFFICE

2,583,841

APPARATUS FOR MEASURING ROTARY WELL STRINGS AND WELL DEPTHS

John T. Hayward, Tulsa, Okla.

Application March 2, 1948, Serial No. 12,588

1 Claim. (Cl. 33—134)

1

This invention relates to improvements in apparatus for measuring rotary drilling strings and well depths.

Measurement of the vertical movements of the hoisting mechanism for rotary drilling strings may be employed for measuring the depth of a well being drilled and the length of the drilling string in the well at various times during the drilling operation. Patent No. 2,166,212, dated July 18, 1939, to the present applicant, describes a system for measuring well depths and well strings. The present invention is directed particularly to improvements in apparatus performing the same operations.

The chief problems which arise in measurement of well depths and well strings from the movements of the hoisting mechanism result from the fact that the drilling string must be made up of relatively short sections of pipe, additional sections being added as the well is deepened. Also when the drilling string is withdrawn from the well the string must be broken down into separate relatively short pipe sections due to the limitation of the height of the derrick. In the aforementioned patent, apparatus is described whereby only those movements of the hoisting mechanism employed to raise and lower the drilling string, which actually represent changes in length of the drilling string or corresponding changes in depth of the well, are selectively employed to drive registering apparatus on which is registered the measurements of the depth of the well, corresponding to the full length of the drilling string, and measurement of the portion of the drilling string which remains in the well at any time while it is being withdrawn from, or returned to, the well.

In the conventional drilling operation, each time a section of drill pipe must be added when the well is drilling ahead or when the drilling string is being registered in the well, pipe gripping slips are dropped into the rotary table to grip the drill pipe which is in the well while the conventional operations of inserting a new section of drill pipe are performed. Similarly, when the pipe is being withdrawn from the well to change bits or for other operational purposes, as each section of the drilling string emerges from the well, the slips are dropped into the rotary table to hold the string while the withdrawn section is unscrewed, this operation being repeated until the entire string is out of the well. In performing these several operations of making up or breaking down a drilling string, the travelling block, which is connected to the upper end of the drilling string for raising and lowering it as required, will make a considerable number of vertical movements which obviously are not related to increasing depth of the well or changes in length of the drilling string. Accordingly in using an apparatus which measures the vertical movements of the hoisting mechanism to obtain a measure of the length of the drilling string and of the depth of the well, provision must be made to eliminate those non-significant movements. Since, as noted, each time a change is made in the length of the drilling string it is necessary to insert the slips in the rotary table, this operation provides a means for controlling the measurement registering or recording apparatus in such a way as to eliminate from its totals all movements of the hoisting mechanism which occur when the slips are engaged in gripping the drilling string. Similarly, when the slips are out of gripping engagement with the drilling string the measuring apparatus must be actuated to record vertical movements of the hoisting mechanism, in order to register the significant movements of the drilling string.

2

Accordingly, it is the principal object of this invention to provide a measuring apparatus which employs improved means for accurately controlling the measurement registering mechanism in relation to whether or not the slips are in pipe gripping engagement with the drilling string.

Other objects reside in the several specific embodiments of apparatus described in the following description when read in conjunction with the accompanying drawings which illustrate such embodiments.

In the drawings:

Fig. 1 illustrates an arrangement of apparatus in accordance with one embodiment of this invention for measuring a rotary drilling string;

Fig. 2 is an enlarged view, partly in section, showing some of the details of one embodiment of the apparatus in accordance with this invention; and

Fig. 3 is a view similar to Fig. 2 of the parts of an apparatus in accordance with another embodiment of this invention.

Referring to the drawing, there is shown a conventional rotary table 10 mounted on a derrick floor 11. Rotary table 10 is provided with the usual downwardly tapering, conical slip bowl 12 through which extends the usual rotary drilling string 13 constructed of series of connected pipe sections. The arrangement illustrated in Fig. 1 is that employed when withdrawing the drilling string from the well and includes conventional elevators 14 which are adapted to surround the pipe beneath the usual collar 15 em-

ployed on each section of the pipe and a conventional travelling block 16 from which elevators 14 are suspended. It will be understood that when drilling ahead elevators 14 will be replaced by the usual rotary swivel and the Kelly joint. Travelling block 16 is connected by a hoisting cable 17 to the usual crown block pulley (not shown) at the top of a derrick, indicated at 18, leading to the usual draw-works (not shown) whereby the travelling block and any equipment suspended therefrom may be raised or lowered as required. Reciprocably mounted over the mouth of slip bowl 12 is a circular slip support 19 from which is suspended a plurality of the usual wedge-shaped pipe gripping slips 20. Downward movement of slip support 19 serves to insert the slips into the slip bowl into pipe gripping engagement with drilling string 13, and upward movement of slip support 19 will withdraw the slips from the slip bowl in order to release the pipe. Slip support 19 is raised and lowered by means of a laterally extending arm 21 which is connected to slip support 19 by means of a yoke 22. The outer end of arm 21 is suitably connected to a head 23 which is carried by the upper end of a piston 24, which is vertically reciprocable in a cylinder 25, which may be operated by air or hydraulic fluid for reciprocating the piston. Such a slip support and its operating mechanism are conventional and well known in the drilling art. The pressure fluid employed for reciprocating piston 24 and the slip support is supplied through connections 26—26 in cylinder 25 from a suitable source (not shown) and the supply of pressure fluid is controlled in a conventional manner by suitable valve mechanism, also not shown, but readily understood by those familiar with the drilling art.

A measuring line 28 has one end thereof connected in any suitable manner to travelling block 16 and is led over any suitable guide pulley arrangement, indicated at 29, to a reel 30 controlled by a spring motor 31 of conventional form, which serves to maintain tension on measuring line 28 at all times. With this arrangement, measuring line 28 will faithfully follow all vertical movements of the travelling block 16. Measuring ine 28 is maintained at some intermediate point thereof in driving contact with a measuring pulley 32 which is of conventional form and of a pre-determined diameter such that each rotation thereof will correspond to a unit length of movement of the measuring line; for example, one rotation per foot of movement of the measuring line. Measuring pulley 32 drives a measurement registering device 33 through a drive connection, indicated at 34. Registering device 33 may be of any conventional form for registering or recording the vertical movements of the drilling string as reflected by the corresponding movements of the travelling block and may be of the type described in the aforesaid patent, No. 2,166,212, which is designed to exhibit cumulative measurements of the downward movements corresponding to progressive deepening of the well and also a measurement corresponding to the length of drilling string in the well at any particular time. A controlling mechanism, indicated generally by the numeral 35, to be described in greater detail hereinafter, is employed to control the drive connection between measuring pulley 32 and registering device 33 in accordance with the position of slips 20 relative to the drilling string.

Referring to Fig. 2, there is illustrated one useful embodiment of control mechanism 35. This embodiment has a conventional form of differential mechanism 36 interposed in drive connection 34, one of its side shafts 36*a* being connected to measuring pulley 32 while the opposite side shaft 36*b* is connected to recording mechanism 33. The center shaft 37 of the differential mechanism has a clutch plate 38 mounted on its outer end. In accordance with the well known mechanical characteristics of differential mechanisms, it will be understood that when center shaft 37 is held stationary, the rotations of pulley 32 will be transmitted directly through the differential to register 33, which will register all the rotations of pulley 32 in either direction. On the other hand, when shaft 37 is released the rotation of side shaft 36*a* by pulley 32 will rotate shaft 37 while side shaft 36*b* will be unaffected. Accordingly, it will be evident that when it is desired to have reigstering device 33 register the movements of measuring pulley 32, control means must be provided to clutch or hold shaft 37 against rotation, and to release shaft 37 when transmission of the movements of measuring pulley 32 to the registering device is not desired.

The control device employed in accordance with this embodiment for interrupting or restoring the transmission of the rotations of pulley 32 to registering device 33 in relation to whether or not slips 20 are in or out of gripping engagement with the drilling string, comprises a pair of expandible hollow bellows 39 and 40 connected by a tube 41. Bellows 39 and 40 and tube 41 are filled with a suitable hydraulic fluid so that, under normal or static conditions both bellows will be in their normal expanded position. Such a system, which is of conventional and well known form, is employed to transmit movement from one point to another. Thus, when one of the bellows is compressed, the compressive force will force fluid out of that bellow through the connecting tube to the other bellow which will expand correspondingly. When the pressure is relieved on the originally compressed bellows, it will expand and the expansive pressure on the other will be relieved so that it will return to its normal contracted position as the fluid pressure returns to its original equalized condition.

Bellows 39 is mounted on a solid base so that its upper end will move relative thereto in response to changes in pressure in the bellows. The upper end of bellows 39 is disposed adjacent clutch plate 38 and carries a clutch finger 42 so arranged relative to clutch plate 38 that the latter will be clutched by the finger while bellows 39 is in its normal contracted position and will be released from engagement by clutch finger 42 when bellows 39 is expanded. Bellows 40 has its lower end firmly mounted on a supporting bracket 43 which is rigidly mounted at one side of cylinder 25. The upper end of bellows 40 is free and extends vertically toward a bracket 44 which is rigidly connected to piston head 23 and extends laterally therefrom. A threaded stud 45 extends through bracket 44 toward the upper end of bellows 40. The threads on stud 45 permit adjustment of the stud in bracket 44 relative to the upper end of bellows 40 for proper actuation of the control mechanism.

The above described apparatus may be employed, by way of example, for measurements while a drilling string is being withdrawn from a well. The measurement will normally be of the length of string left in the well. One of the dials of registering device 33, as described in the afore-

mentioned Patent No. 2,166,212, will be designed to show the total length of the drilling string in the well at any time, and as the drilling string is removed, the measurement shown will be decreased in proportion to the length of the pipe sections withdrawn.

It will be assumed for purposes of this explanation that the drill pipe is in process of being withdrawn from the well, as illustrated in Fig. 1. At this stage slips 20 will be in the raised position, at which position stud 45 will be out of contact with bellows 40. Thus bellows 39 will be in its normal contracted position and finger 42 will be in clutching engagement with clutch plate 38, placing measuring pulley 32 in direct driving engagement with registering device 33, as described. As travelling block 16 moves upwardly from its lowermost position for a distance necessary to pull a section of the drill pipe out of the well, measuring line 28 will follow this movement and the length thereof will be measured by measuring pulley 32 and transmitted to registering device 33 which will show an appropriate reading on its dial.

Slips 20 will now be lowered into the slip bowl to grasp the drill pipe and hold it in its raised position while the withdrawn section is unscrewed. When piston 24 is lowered to lower the slips, stud 45 will contact the upper end of bellows 40. Ordinarily the adjustment of stud 45 will be such that it will just make contact with the bellows when the slips drop into the bowl. Then as the travelling block is lowered slightly to transfer the weight of the pipe string to the slips, the increased load on the slips will force the slips downwardly a slight additional amount and this additional downward movement will be transferred through slip support 19, arm 21 and piston head 23 to stud 45 which will then positively compress bellows 40. Compression of bellows 40 will correspondingly expand bellows 39, the upper end of which will move upwardly releasing clutch finger 42 from its engagement with clutch plate 38 and center shaft 37 of the differential mechanism. With center shaft 37 thus released, travelling block 16 may engage in any of its usual operations and its movements will not be transmitted to registering device 33, and the measurements previously registered thereon will remain unaffected.

With the withdrawn section of pipe removed, travelling block 16 will now be lowered sufficiently for attachment of elevators 14 to the upper end of the pipe string still in the well. The slips having not as yet been removed, this movement will not be reflected in the registering device. When the elevators have been attached, the traveling block will be raised sufficiently to take the weight of the drilling string and the slips are raised by suitable operation of piston 24. Raising of the slips will raise stud 45 from its compressive contact with bellows 40, relieving the pressure in the latter and allowing bellows 39 to contract correspondingly, which movement will re-engage clutch finger 42 with clutch plate 38 and hold center shaft 37 firmly against rotation. Now as travelling block 16 is again raised to pull another section of the drill pipe from the well, this movement will be transmitted directly to registering device 33 which will register the appropriate change in length of the drill pipe. This sequence of operations will be repeated as often as necessary to obtain the desired measurments.

It will be understood that corresponding operations will be performed when drilling ahead. In this case, while actual drilling is occurring, the slips will be in the raised position and consequently the downward movements of the drilling string will be recorded on registering device 33. When a section of drill pipe is to be added, the slips must be dropped into pipe gripping engagement, thus interrupting the drive connection of measuring pulley 32 to registering device 33 and all of the various movements normally engaged in by the travelling block in disconnecting the Kelly joint, laying it down, picking up a new section of drill pipe, etc. will not be transmitted to the registering device. When the new section of drill pipe has been inserted and all is ready for continued drilling, the slips are withdrawn, restoring the drive connection between the measuring pulley and the registering device for measurement of the additional deepening movement of the drilling string.

Fig. 3 illustrates another embodiment of control mechanism for drive connection 34. In this embodiment, measuring pulley 32 drives a shaft 46 which is releasably connected by a clutch to a shaft 47 which drives registering device 33. The clutch consists of one clutch plate 48 rigidly mounted on the end of shaft 46 and a cooperating clutch plate 49 mounted on the end of a sleeve 50 which is slidably but non-rotatably mounted on the end of shaft 47, as by means of a conventional splined or similar arrangement commonly used in connection with such clutches. A shift lever 51, rockably pivoted at 52, is arranged to shift clutch plate 49 into and out of engagement with clutch plate 48. The free end of shaft lever 51 is connected to one end of a conventional "Bowden" cable, which commonly consists of a wire 53 longitudinally slidable through a stationary sleeve 54. In the form illustrated in Fig. 3, the latter has one end fastened to the underside of bracket 43, and wire 53 extends through a registering opening in the bracket to a suitable height above the bracket and carries a laterally extending flange 55 on its upper end. A coil spring 56 surrounds the portion of wire 53 above bracket 43 and is mounted in compuression between the under side of flange 55 and bracket 43. The pressure of coil spring 56 acting on flange 55 will normally hold clutch plate 49 in engagement with clutch plate 48 to maintain the direct driving engagement of measuring pulley 32 with registering device 33. Depression of flange 55 will move shift lever 51 to disengage the clutch plates to interrupt the drive of the measuring pulley to the registering device. The arrangement of stud 45 on piston head 23 will be as in the previously described embodiment, so that when slips 20 are lowered firmly in gripping engagement with the drilling string, stud 45 will depress flange 55 and cause related movement of wire 53 to interrup the drive connection between the measuring pulley and the registering device, while raising of the slips will act to restore this drive connection.

It will be unlerstood that numerous changes in form, detail and arrangement of the parts may be made in the illustrative embodiments without departing from the scope of the appended claim but within the spirit of this invention. For example, the bellows arrangement described in connection with Fig. 2 may be used to actuate clutch shifting lever 51. Alternatively the Bowden cable arrangement, illustrated in Fig. 3, may be used to control the center shaft 37 of the differential connection illustrated in Fig. 2.

What I claim and desire to secure by Letters Patent is:

In a system for measuring rotary well strings and well depths including slips engageable with the well string for interrupting the movements thereof into and out of a well, a vertically reciprocable slip support for moving the slips into and out of engagement with said well string, and a register driven from the movements of the drill string feed mechanism for measuring the movements of the drill string, a device for controlling said register, comprising, a drive shaft driven by an element responsive to the movements of said feed mechanism, a clutch means connecting said shaft to said register and having a clutch release element, a pair of contact members mounted on two relatively movable portions of said slip support for compressive engagement by relative vertical movement between said portions, one of said contact members having resilient connection to said release element, and

comprising the end of a shaft forming said connection extending sildably through a stationary sleeve, and a coil spring mounted in compression between said end of the shaft and the adjacent end of said sleeve.

JOHN T. HAYWARD.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,802,156	O'Brien	Apr. 21, 1931
1,870,362	Hart	Aug. 9, 1932
1,933,877	Dillon et al.	Mar. 12, 1935
2,166,212	Hayward	July 18, 1939
2,221,767	Hayward et al.	Nov. 19, 1940
2,326,219	Hayward	Aug. 10, 1943
2,491,711	Calhoun	Dec. 20, 1949