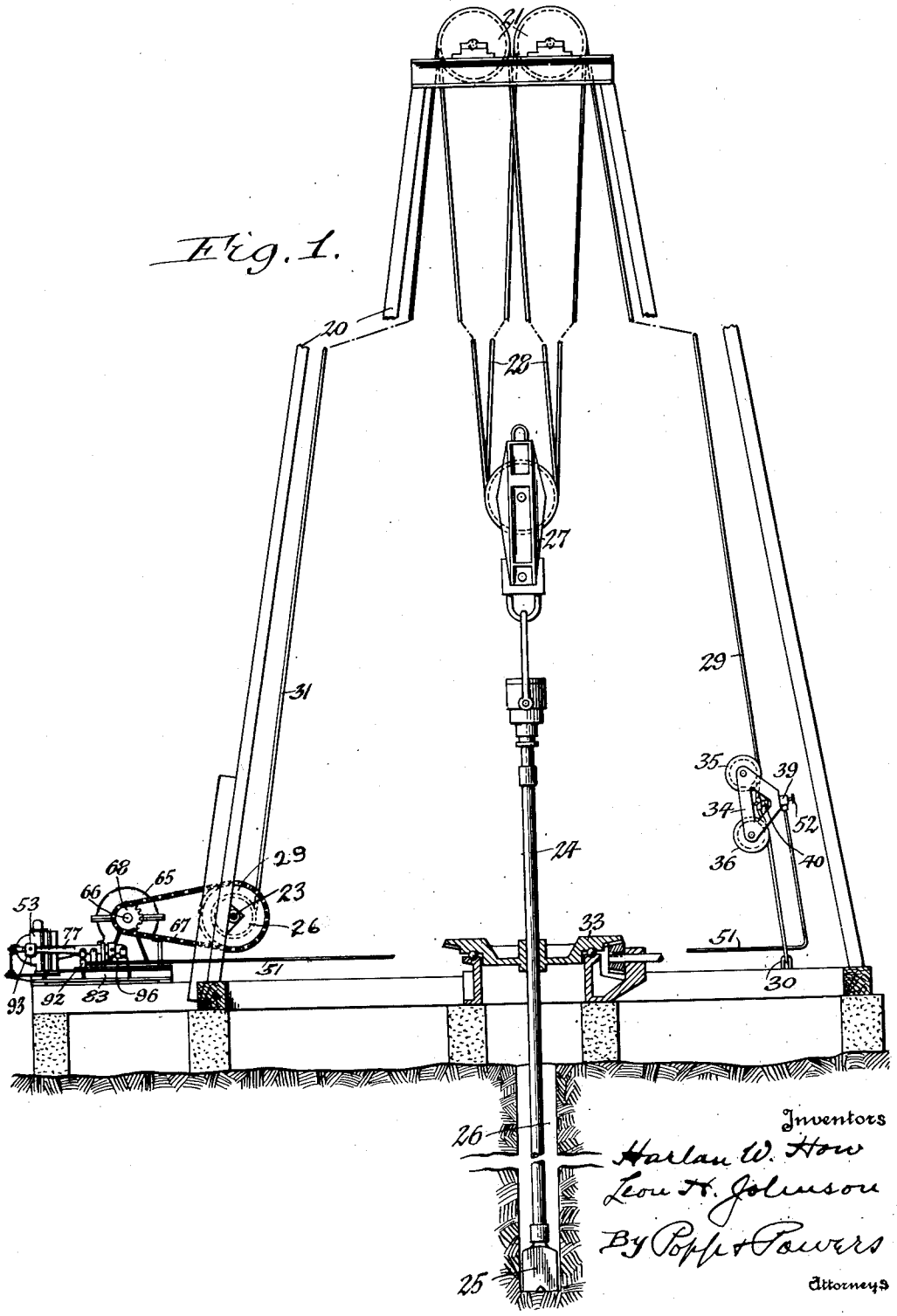
Aug. 29, 1933. H. W. HOW ET AL 1,924,317

MECHANISM FOR CONTROLLING PRESSURE AND FEED OF TOOLS OF ROTARY WELL DRILLING RIGS

Filed Oct. 9, 1929 4 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

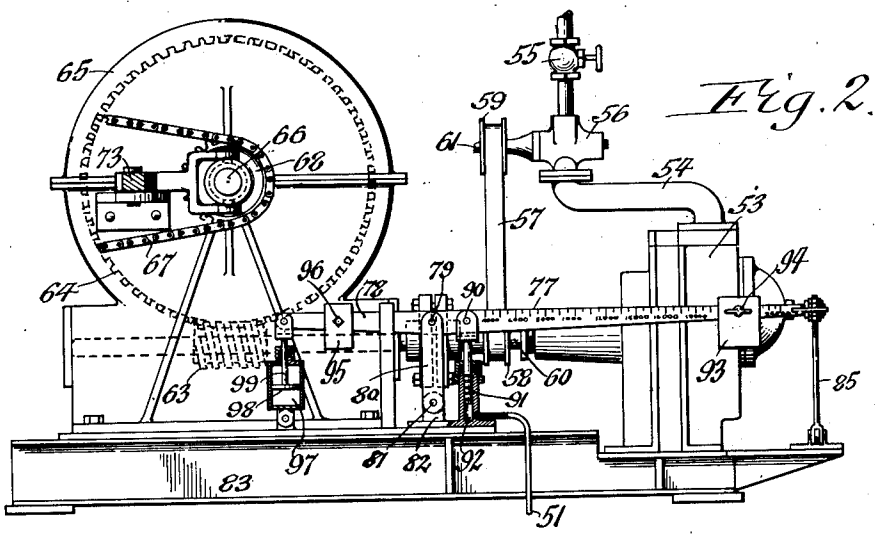


Fig. 3.

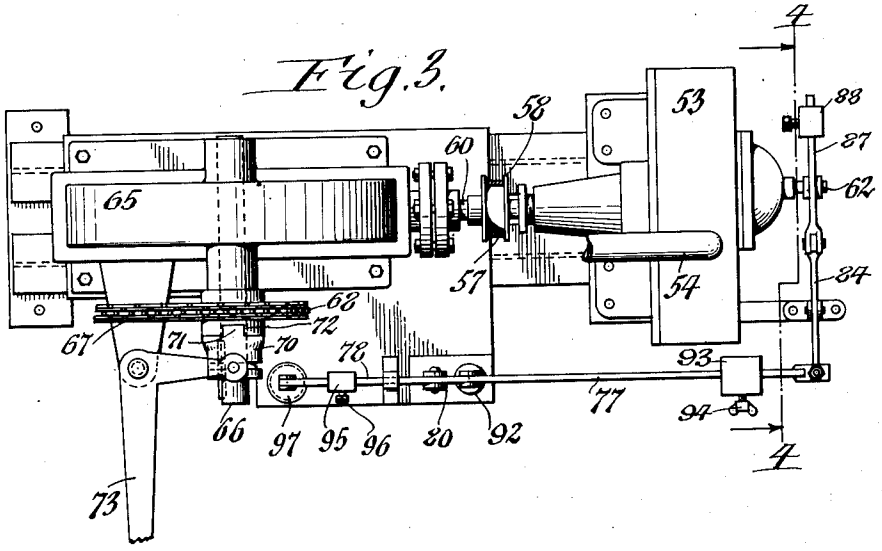
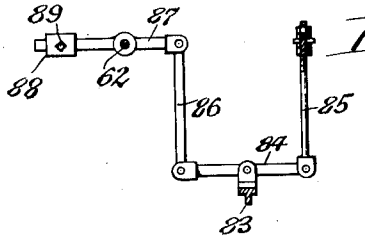


Fig. 4.



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Fig. 5.

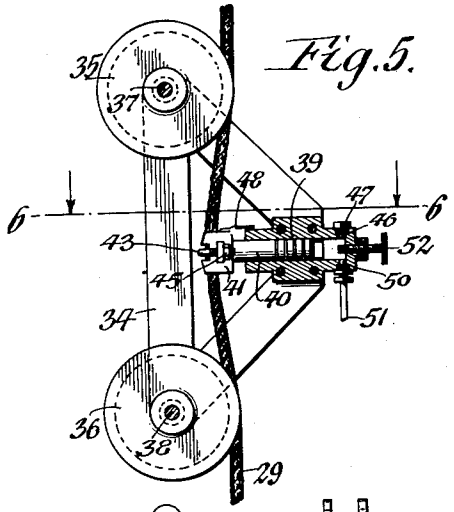


Fig. 6.

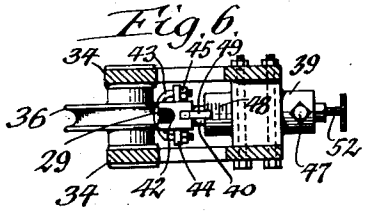


Fig. 9.

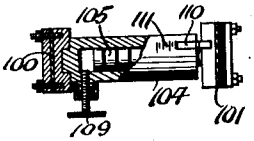


Fig. 7.

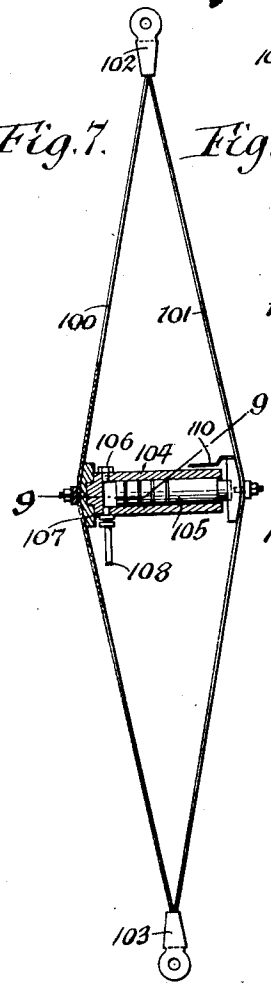


Fig. 8.

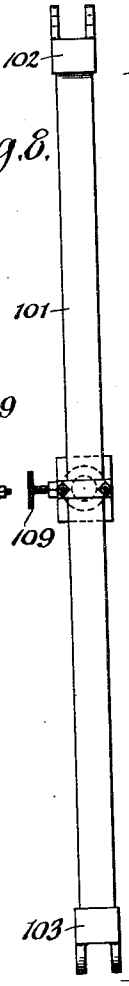


Fig. 10.

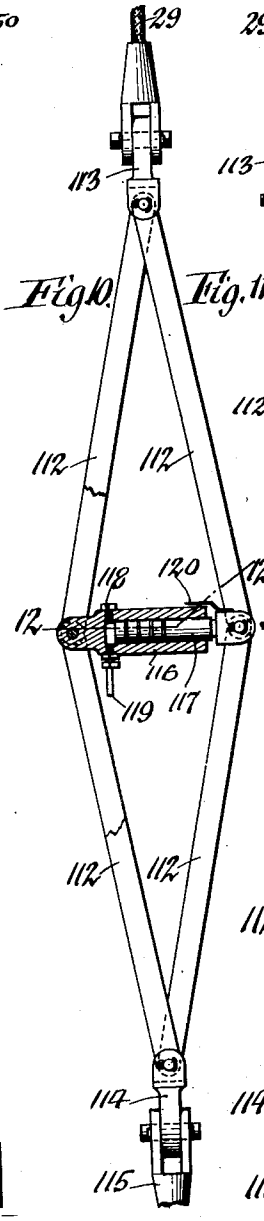


Fig. 11.

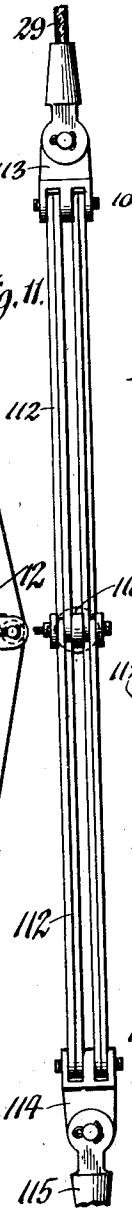


Fig. 13.

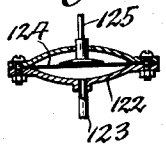
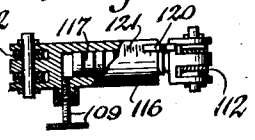


Fig. 12.



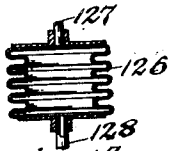


Fig. 14.

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Fig. 15.

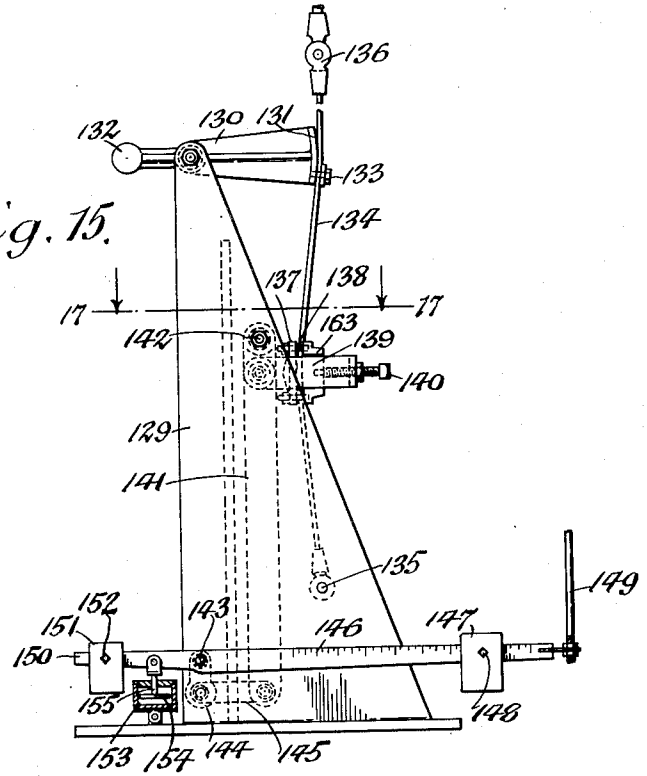


Fig. 16.

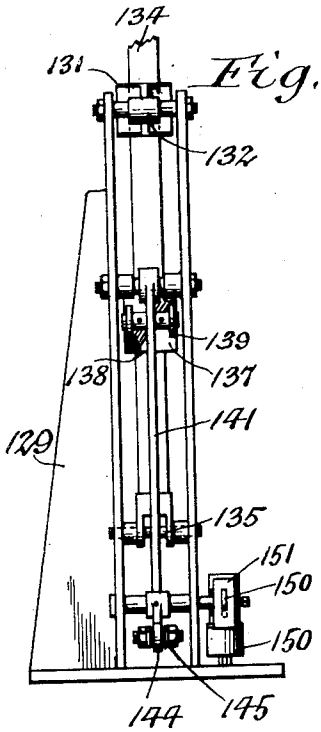
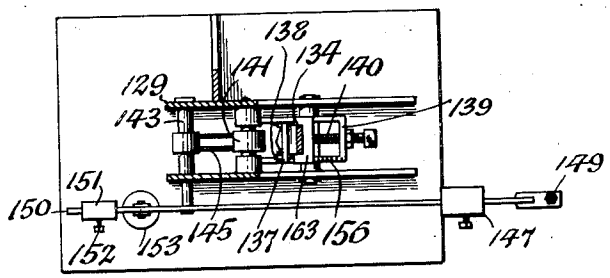


Fig. 17.



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UNITED STATES PATENT OFFICE

1,924,317

MECHANISM FOR CONTROLLING PRESSURE AND FEED OF TOOLS OF ROTARY WELL DRILLING RIGS

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Application October 9, 1929. Serial No. 398,495

19 Claims. (Cl. 255—19)

This invention relates to a mechanism for maintaining a fixed or regulated load on, or a fixed or regulated rate of feed of, the drilling tool of a rotary well drilling rig.

In the drilling of wells by the rotary tool method, the drilling tool is attached to the lower end of a drill pipe. The upper end of the drill pipe is attached to a swivel block of a set of falls, the upper sheaves of the falls being at the top of a derrick. The lead line of the falls is attached to the drum of a hoist by means of which hoist and falls the drill pipe and drilling tool are raised and lowered. The drill pipe is rotated by means of a mechanism known as the "rotary", through which the drill pipe passes freely up and down. Water is pumped through the drill pipe to the drilling tool for washing away and raising the cuttings to the ground surface.

In the drilling of wells by the rotary tool method, the load on the drilling tool comes from the weight of the drill pipe. As the hole deepens and the drill pipe becomes longer and heavier until a point is reached where this load is too great for the drilling tool. To relieve this excess load, strain is placed in the hoist sufficient, in the estimate of the driller, to relieve the load on the tool.

In the drilling of wells by the rotary tool method, the driller lowers the drill pipe and tool by means of the hoist, holding a strain in the hoist sufficient, in his estimate, to give the right load on the tool and at the same time slowly relieving the strain to give the necessary feed of the tool. The operation is entirely manual. The load on the tool and the rate of feed are controlled by the experience and judgment of the driller.

It is the object of this invention to provide a mechanism for maintaining automatically a fixed or regulated load on, or a fixed or regulated rate of feed of, the drilling tool of a rotary well drilling rig so that, when drilling in hard material, the load on the tool will be constant and the rate of cutting will be in accordance with the sharpness of and condition of the tool, the rate of cutting being less than the rate of feed for which the mechanism is set. On the other hand, if the material is relatively soft and cutting is free, the rate of feed of the tool will be such that the load on the tool will be less than that for which the mechanism is set and the rate of feed will control the drilling.

In the accompanying drawings:—

Figure 1 is a fragmentary elevation, partly in section, of a rotary well drilling rig embodying one form of this invention.

Figure 2 is a side elevation, on an enlarged scale, of the pressure and feed controlling mechanism and associated parts shown in Fig. 1.

Figure 3 is a plan view of the same.

Figure 4 is a transverse section taken on line 4—4 Fig. 3.

Figure 5 is a vertical section, on an enlarged scale, of the load measuring device shown in Fig. 1.

Figure 6 is a horizontal section thereof taken on line 6—6 Fig. 5.

Figure 7 is a side view, partly in section, of a modified form of the load measuring device in which flat metallic straps, bands or ropes are employed.

Figure 8 is an edge view of the same.

Figure 9 is a horizontal section taken on line 9—9, Fig. 7.

Figure 10 is a side view, partly in section, of another form of measuring device embodying this invention.

Figure 11 is an edge view of the same.

Figure 12 is a horizontal section, taken on line 12—12 Fig. 10.

Figure 13 is a sectional view of a flexible diaphragm which may be employed as the pressure responsive member of the load measuring device.

Figure 14 is a similar view of a siphon diaphragm which may be used as the pressure responsive member of the load measuring device.

Figure 15 is a side elevation of another form of load measuring device and the pressure and feed controlling mechanism.

Figure 16 is an end elevation of the same.

Figure 17 is a horizontal section taken on line 17—17 Fig. 15.

In the following description similar characters of reference indicate like parts in the several figures of the drawings.

This invention is applicable to rotary well drilling rigs which may be variously organized, but in the present case the same is shown in connection with a conventional form of such rigging which comprises a derrick 20 mounted on the ground in any suitable manner, crown pulley blocks 21 mounted on the top of the derrick, a hoisting drum 22 forming part of the draw works or hoisting mechanism and mounted on a shaft 23 which is journaled in suitable bearings on the lower part of one side of the derrick, an upright drill pipe or rod 24 provided at its lower end with a drill point or tool 25 whereby the vertical hole 26 is drilled in the rock or ground, a swivel pulley block 27 upon which the upper end of the drill pipe is mounted, a drill pipe falls 28 pass-

ing with its intermediate part around the crown pulley blocks and the pulleys of the swivel block and having its dead end 29 arranged along one side of the derrick and connected at its lower end with a stationary anchored or fastening 30 on a suitable part of the derrick or adjacent stationary surface while the opposite or live end 31 of this fall is wound upon the periphery of the hoisting drum 22, and a rotary 33 mounted on the lower part of the derrick and adapted to turn the drill pipe but permit the latter to move vertically.

On the dead end of the drill falls is mounted a few feet above the derrick floor a load measuring device which measures or is responsive to the tension of the load which is placed upon this line through the medium of the weight of the drill pipe, drilling tube and the swivel block associated therewith, this tension in the dead end of the falls being a part of the total load. The tension in the dead line multiplied by the number of lines passing in and out of the swivel block equals this load.

Although this load measuring device may be variously constructed so as to permit of utilizing variations in the deflections of the dead end of the falls line for controlling the pressure and feed of the tool, that form of measuring device which is shown in Figs. 1, 5 and 6 is constructed as follows:—

The numerals 34, 34 represent the two side pieces of a supporting frame which are arranged on opposite sides of the dead end 29 of the drill pipe falls, and the numerals 35, 36 two sheaves arranged between these side pieces and pivotally mounted on the upper and lower ends thereof by means of horizontal axles 37, 38. The corresponding sides of these sheaves 35 and 36 engage with the respective side of the dead end line 29 at spaced apart points, and intermediate of these two sheaves the opposite side of the dead end line is engaged by a deflecting device whereby that part of the dead end line is moved partly across these two sheaves and thereby deflected to a corresponding extent.

These deflecting means comprising a substantially horizontal hydraulic cylinder 39 arranged between the central parts of the side pieces 34 and secured thereto midway between the sheaves 35 and 36, a piston 40 slidable lengthwise in said cylinder 39 and projecting from the inner end thereof toward the dead end line 29, a bearing head 41 arranged at the inner end of the piston 40 and provided with a notch or fork 42 which receives the adjacent part of the dead end line 29, and a clip 43 which passes around the opposite side of the dead end line and has its legs detachably secured to lugs 44 on opposite sides of the bearing head 41 by means of nuts 45. The inner end of this cylinder is filled with any suitable liquid which may be introduced into the same through a filling opening 46 which is normally closed by a plug 47, and the position of the piston within this cylinder and the amount of deflection produced thereby in the dead end line may be indicated by any suitable means, for instance, by means of a pointer 48 secured to the upper side of the head 41 and traversing a scale or row of graduations 49 arranged on the upper side of the cylinder, as shown in Figs. 5 and 6.

At its extreme outer end the cylinder is provided with a vent 50 which is connected with a pipe 51 for a purpose which will presently appear.

In the rear or outer part of the cylinder a screw 52 is mounted which can be turned inwardly or outwardly for the purpose of adjusting the position of the piston 40, as indicated on the scale 48, either inward or outward to give the correct angle of deflection of the cable 29.

Adjacent to the hoisting drum 22, Fig. 1, is arranged the motor for turning the drum either forwardly or backwardly so as to either take up the hoisting line for raising the drilling pipe or letting out this line for the purpose of lowering this pipe. This motor may be of any suitable character and operate either by electric power, hydraulic power, pneumatic power or steam power, but in the present case a steam engine 53 is emlpoyed, the steam supply pipe 54, Fig. 2, of which is provided with a hand operated valve 55 for turning on or shutting off the steam, and also with a governor 56 which automatically regulates the speed of the engine and which is driven by means of a belt 57 passing around pulleys 58, 59 mounted respectively on the engine shaft 60 and the governor shaft 61. At one end of the body of the engine the same is provided with a valve mechanism whereby the steam connections may be reversed so that the engine shaft 60 will be turned in one direction or the other, which valve mechanism comprises a stem 62 projecting outwardly from the engine casing. When this valve stem is in its central position midway of the extremes of its stroke, the steam to the engine will be cut off and the shaft 60 will be at rest, but when turning this valve stem in one direction from its central position the steam is admitted to the casing so as to turn the shaft 60 in one direction, while upon turning the valve stem 62 in the opposite direction from its central position then the engine shaft 60 will also be turned in a reverse direction from that previously described.

An engine of the character just mentioned forms the subject of U. S. Patent No. 395,039 dated Dec. 25, 1888 and reference may be had to the same for a detailed explanation as to its construction and operation.

Motion may be transmitted from this engine to the hoisting drum by various means which will not be influenced by the load and therefore act as an automatic brake. The most satisfactory means for this purpose consist of a non-reversing worm gearing which in the present case includes a worm 63 mounted on the engine shaft and meshing with a worm wheel 64 arranged within a casing 65 and secured to an intermediate shaft 66 which is journaled on the casing 65, a sprocket chain belt 67 passing around a sprocket wheel 68 on the intermediate shaft 66 and a sprocket wheel 69 on the hoisting drum shaft 23, Fig. 1, and a clutch sleeve 70, Fig. 2, splined on the intermediate shaft 66 and adapted to move lengthwise upon this shaft for engaging a clutch jaw 71 on the sleeve 70 with a clutch notch 72 in the hub of the sprocket wheel 68. For this purpose the clutch sleeve may be actuated by means of a hand lever 73 mounted on the worm gear casing and engaging with the clutch collar 70, as shown in Fig. 3.

As shown in Fig. 1 the driving sprocket wheel 68 is comparatively small and the driven sprocket wheel 69 is comparatively large so that a reduction in the speed is effected between the shafts 68 of the worm gearing and the shaft 23 of the hoisting drum.

Adjacent to the power unit is arranged the mechanism whereby the pressure and feed of the drill point or tool is automatically controlled,

which mechanism, as best shown in Figs. 1, 2, 3 and 4 is constructed as follows:—

The numerals 77, 78 Fig. 2 represent the main and auxiliary arms of a scale beam which is movably mounted by means of a pivot pin 79 connecting this beam between its arms with the upper end of an upright link 80, the lower end of which link is pivoted by means of a pin 81 to a base 82 which is preferably carried by a frame 83 supporting the engine 53 and the casing 65 of the speed reducing worm gearing. At its outer end the main arm of the scale beam is operatively connected with the oscillating valve stem 62 of the steam engine by a rock lever 84 pivoted to swing vertically on the adjacent part of the base 83 and having one of its arms connected by means of a link 85 with the outer end of the main scale beam arm 77, while its other arm is connected by means of a link 86 with one arm of the valve lever 87 which is secured to the valve stem 62 and has an arm which carries a counterbalancing weight 88 adjustably secured thereto by means of a screw 89, as best shown in Figs. 3 and 4.

Adjacent to the fulcrum of the scale beam its long main arm 77 is pivotally connected by means of a pin 90 with the upper end of a piston 91 which slides vertically in a cylinder 92 mounted on the adjacent part of the motor frame, and having its lower end connected with the pipe 51 which leads to the outer end of the load measuring cylinder 39, Fig. 5. Upon the long main arm of the scale beam is mounted a weight 93 which may be slid lengthwise thereon and held in its adjusted position by means of a clamping screw 94. A similar weight 95 is mounted on the short auxiliary arm of the scale beam and held in place by means of a clamping screw 96.

Sudden movement of the scale beam in either direction is prevented and stabilized by means of a motion damping device or dash pot, which in the present instance consists of a cylinder 97 pivotally connected with the engine frame 83 and containing a liquid such as oil, and a piston or plunger 98 arranged within this cylinder and connected by means of a rod 99 with the outer end of the short scale beam arm 78, as best shown in Figs. 2 and 3.

When there is no liquid in the cylinder 92, then the main scale beam arm 77 and connecting parts, less the weight 93, is balanced by the weight 95. The cylinder 92 and piping 51 are filled with oil at the same time that oil is introduced into the cylinder 39 of the load measuring device, while the scale arm 77 is in a horizontal position and the piston 40 of the load measuring device has been set for the particular size of rope or line used in the drill pipe falls.

When the hydraulic system, including the cylinders 39 and 92 and the piping 51 connecting the same, are full and sealed further adjustments in the deflection of the dead end 29 of the drill pipe falls is effected by turning the screw 52 inwardly or outwardly until the desired deflection has been obtained in the dead line 29 between the sheaves 35 and 36 to suit the particular size of cable, line or rope which is used.

In the present organization the valve stem 62 is in its central position and steam is cut off so as to prevent the engine shaft from being turned in either direction at the same time that the long main arm of the scale beam is in a horizontal position, as shown in Fig. 2, but when this arm of the beam moves upwardly the engine is started and its shaft is turned in the direction for turning the hoisting drum backwardly so as to unwind the hoisting line therefrom and let the drilling pipe and tool descend, whereas if the long main arm of the scale beam moves downwardly from its horizontal neutral position the engine will be started and turn the shaft 60 in the opposite direction for the purpose of winding the hoisting line on the periphery of the drum and thereby cause the drilling pipe and the tool mounted thereon to be raised.

The operation of the mechanism thus far described is as follows:—

After the drilling pipe and tool have been assembled with other parts ready to start drilling in the ground and the tool is raised just off the ground or bottom of the hole, then the tension on the hoisting line, rope or cable creates pressure in the cylinders 39 and 92 Fig. 1 due to the tendency of the deflected portion of the dead end line 29 of the hoisting cable, to assume a straight position, which causes the piston 40 in the load measuring cylinder 39 Fig. 5 to be pushed outwardly and exert hydraulic pressure through the liquid in these cylinders and the connecting pipe.

The pressure on the piston 91 may be balanced by moving the weight 93 inwardly or outwardly on the long arm of the scale beam relative to the fulcrum thereof. The weight 93 may be balanced on the long arm of the scale beam by moving this weight slowly from an inner position to an outer position until a point is reached where the long main scale beam arm begins to fall. Readings of the graduations on the long main arm 77 of the scale beam are in pounds tension in the dead line of the falls. Multiplying this reading by the number of lines passing in and out of the swivel block gives the combined weight of the swivel block, drill pipe and tool.

Inasmuch as the weight of the swivel block 27 and associated parts is constant, the same is known and may therefore be deducted from the calculations as required. If the remaining weight is more than is wanted on the drilling tool and, let us say, six lines are used in the falls and a load of 18,000 pounds is wanted on the tool, then the weight 93 is retarded or moved inward 3,000 pounds on the main scale arm and locked in this position. The drill operator then connects the draw works with the automatic control by engaging the clutch collar 70. The "rotary" 33 is now started to turn the drill pipe and tool, and then the engine associated with the automatic pressure and feed control is started by opening the steam valve 55, Fig. 2, whereupon the engine will run at a rate of speed corresponding to that for which the governor 56 of the engine has been set.

As the scale beam is now out of balance equal to the amount of the load wanted on the drilling tool, the amount of the weight 93 has been retarded, the main arm of the beam being turned upwardly from its neutral horizontal position opening the engine throttle to operate the drum 22, Fig. 1, turned by the intermediate gearing and draw works so as to unwind the falls cable slowly, thereby lowering the drill pipe or stem until the tool touches the bottom of the hole and begins to cut under weight from the drill pipe.

As the load on the drill reaches 18,000 pounds, the drilling load for which the automatic control has been set, the load on the falls is reduced accompanied by a corresponding reduction in the tension on the dead line end 29 of the falls. This reduction is transmitted through the hydraulic system to the long main arm of the scale beam

which now drops, thereby closing the throttle of the engine, arresting the feed of the tool and maintaining an approximately even load on the drilling tool. Should the load on the tool increase beyond that for which the control is set, the long main arm 77 of the scale beam will drop below its horizontal normal or neutral position, thereby opening the engine throttle for movement of the engine, gears and draw works in the opposite direction so as to wind the hoisting cable on the drum 22, and thereby raise the drill pipe and tool a corresponding extent.

Should the driller desire to increase or decrease the load on the tool it is only necessary to move the weight 93 outwardly or inwardly on the main scale arm as may be desirable or necessary.

If the driller desires to increase or decrease the rate of feed, this can be accomplished by changing the speed adjustment of the engine or its governor.

When cutting hard material, the load on the tool and the speed of the tool may be such that the cutting will be either slow and less than the rate of speed for which the control has been set, in which case the control mechanism will govern the load on the tool and hold it constant. If, on the other hand, the rock cuts freely and the feed of the drilling tool for which the control is set produces such a load on the tool that it does not reach the required pressure for which the control mechanism has been set, then the rate of feed will govern the drilling. The control mechanism in either case operates automatically and shifts from a pressure transmitting effect to a feeding effect on the tool as the drilling proceeds through strata of various degrees of hardness.

In the alternate form of the load or tension measuring device shown in Figs. 7, 8 and 9, two flat wire ropes, straps or bands 100, 101 are employed the upper and lower ends of which are respectively connected with each other by clevises 102, 103, the upper clevis being connected with the dead line of the hoist falls and the lower clevis being connected to an anchorage on the derrick foundation so that these straps in effect form part of the hoist falls.

Midway between the two clevises and transversely between the flat wire ropes, straps or bands, a pressure responsive device is arranged, consisting for example of a cylinder 104 secured at its outer end to the inner side of one of the flat wire ropes, and a piston 105 moving at its inner end in said cylinder 104, while its outer end is secured to the other flat wire rope. By this means the central parts of these wire ropes are spread apart in the form of a diamond loop and this spreading effect can be increased or decreased by the presence of more or less liquid between the inner end of the piston 5 and the bottom portion of the cylinder 104. This liquid is introduced into an opening in the cylinder which is normally closed by a plug 106 and communication is established between a vent 107 adjacent to the bottom of the cylinder 104 and the cylinder 92 of the pressure and feed control mechanism by means of a pipe 108 in the same manner in which this is done in the construction shown in Figs. 1, 2, 3, 5 and 6.

The position of the piston 105 may be adjusted by means of a screw 109 working in this cylinder and adapted to be screwed in or out to move the piston 105 in or out.

When the load upon the ropes 100, 101 increases, the same tends to straighten into a more or less parallel position whereby the piston 105 is pushed into the cylinder 104 and the liquid expelled from the cylinder is caused to operate the piston 91, Fig. 2, so as to take in on the hoist falls; and as the strain upon the ropes 100, 101 decreases, the weight 93 of the pressure and feed control mechanism again forces the liquid back from the cylinder 92 into the cylinder 104, thereby moving the central parts of the flat ropes 100, 101 apart.

The extent of separation of the ropes 100, 101 and the load corresponding thereto may be indicated by a pointer 110 connected with the plunger 105 and traversing a scale or row of graduations 111 on the cylinder 104, as shown in Figs. 7 and 9.

Instead of constructing the diamond shaped tension loop of the dead line by means of flat ropes, bands or straps, the same effect can be produced, as shown in Figs. 10, 11 and 12, by four sets of toggle links 112, two sets being employed on each side and the corresponding upper ends of the upper sets being connected by means of a clevis 113 with the hoist falls and the lower ends of the corresponding lower sets of links are connected by a clevis 114 with a stationary anchor 115 secured to some part of the derrick, while a cooperating cylinder 116 and piston 117 are respectively connected with the opposing central parts of the two sets of links at one end and the two sets of links at the other end of the tension loop.

The cylinder 116 is filled with liquid through an opening which is normally closed by a plug 118 and communication between this cylinder and the cylinder 92 of the pressure and feed controlling mechanism is established by a pipe 119. The spreading of the opposing inner ends of the several pairs of links is indicated by a pointer 120 on the piston traversing a scale 121 on the cylinder 116, as shown in Figs. 10 and 12.

Instead of using the piston and cylinder construction as part of the load measuring device, and also as part of the pressure and feed control mechanism, other forms of pressure responsive devices may be employed. For example, a disk diaphragm such as the one shown in Fig. 13, in which the stationary wall 122 of the pressure chamber containing the liquid is provided with a conduit 103, and the flexible diaphragm 124 constituting another wall of this chamber is engaged with a shifting rod 125. In this form of disk diaphragm the chamber 122 may be substituted for the cylinder 92, the pipe 123 may be connected with the cylinder 39, and the rod 125 may be connected with the long arm 77 of the scale beam.

When the disk diaphragm is used to replace the piston and cylinder construction of the load measuring device, shown in Figs. 5 and 6, the chamber 122 may be used in place of the cylinder 39 and the rod 125 may be connected with the dead end 29 of the hoisting falls.

Another form of pressure responsive member capable of being substituted for the cylinder and pistons, shown in Figs. 1 to 6, is shown in Fig. 14 which consists of a bellows diaphragm 126, one end of which may be connected either with the dead end 29 of the hoisting falls or the main arm 77 of the scale beam by means of a rod 127, while the opposite end of this bellows diaphragm may be connected with the side pieces 34 of the load measuring device, or the base 83 of the engine or other parts, and also provided with a pipe 128 which will serve the same purpose as

the pipe 51 in the construction shown in Figs. 1, 2 and 5.

In the modified form of our invention shown in Figs. 15, 16 and 17 a construction is shown which may be used as a tension measuring device and part of the automatic pressure and feed control mechanism. In this construction a frame 129 is employed upon the upper end of which a vertically swinging guide lever 130 is mounted, one arm of this lever being provided with a segmental bearing head 131 while the opposite arm thereof is provided with a counterbalancing weight 132.

Engaging with this segmental head 131 and secured with its central part thereto by means of a bolt 133 is a flat tension band 134 which forms part of the dead end line of the hoisting falls, the lower end of this band being secured by means of an anchoring pin 135 to the frame 129 which is stationary, while the upper end of this band is connected by means of a clevis 136 with the hoisting falls so that this band 134 in effect forms a part of the same.

Between the segmental head 131 and the anchorage 135 the tension band 134 has secured thereto two jaws 163, 137 which are connected with each other by means of screws 138. The jaw 136 is slidably mounted on a yoke 139 which latter is of U shaped form and has its cross piece provided with a screw 140 bearing against the jaw 163, while its legs are pivotally connected with the upper parts of an upright lever 141. The latter is arranged between the side pieces of the standard or frame 129 and is pivotally connected therewith at its upper end by means of a transverse pin 142. Upon the lower part of the standard 129 is journaled a horizontal transverse shaft 143 which latter is provided with a descending rock arm 144 connected by means of a link 145 with the lower end of the lever 141.

Outside of the frame 129 a scale beam is secured to the rock shaft 143, the long main arm 146 of this scale beam being graduated and provided with a longtudinally sliding weight 147 which may be held in its adjusted position thereon by means of a clamping screw 148, and the outer end of this arm being connected by a rod 149 and intermediate levers with the valve stem 162 Fig. 3 of the steam engine or other motor, in substantially the same manner in which this is done in the construction shown in Figs. 1–4.

The other short arm 150 of this last-mentioned scale beam is provided with a counterbalancing weight 151 which is adjustable lengthwise thereon and adapted to be held in its adjusted position by means of a screw 152. Stabilizing of this last-mentioned scale beam is also effected so as to prevent sudden motion by means of a dash pot or cylinder 153 pivotally connected with the base of the frame 129 and adapted to contain a resistance liquid, and a piston 154 adapted to reciprocate in this cylinder and connected by a rod 155 with the short arm 150 of the respective scale beam.

Upon adjusting the screw 140 the tension strap 134 may be deflected more or less according to the desired load and the extent of such deflection is indicated by a row of graduations 156 arranged on the yoke and adapted to be traversed by the adjacent part of the clamping jaw or block 163, as shown in Fig. 17.

When the tension upon the strap 134 is increased due to an increase in the load, the deflection in this strap will be reduced and as it straightens the lever 141 will be drawn to the right, thereby causing the long scale beam arm 146 and the weight 148 thereof to be raised above their normal position, which movement is transmitted to the valve mechanism of the engine and causes the hoisting drum to take in some of the hoisting line and thereby relieve the pressure of the tool against the bottom of the hole which is being bored. When the pressure of the tool against the bottom of the hole drops below normal, the weight 147 produces an increased deflection in the band 134 at the dead end of the hoisting falls, thereby causing the long arm 146 of the scale beam to descend below its normal position and thereby reverse the operation of the motor so that the hoisting drum will let out some of the hoisting line and thereby lower the drilling pipe and tool a sufficient extent to restore normal conditions.

It is to be noted that the worm wheel reduction gearing is a very important feature of this apparatus, inasmuch as this device or any one having similar characteristics can be used inasmuch as this part of the apparatus must be non-reversing and serve as an automatic brake to hold the draw works drum, which function is admirably performed by the intermeshing worm and worm wheel.

We claim as our invention:—

1. An apparatus for controlling the pressure and feed of rotary well drilling rigs, comprising a supporting line adapted to carry a drill pipe, feed means adapted to let out said line, a motor for operating said feed means, a tension measuring device which deflects a part of said line out of its normal position and which includes a cylinder containing a liquid, a piston arranged in said cylinder and engaging one side of said line, supports engaging the opposite side of said line at a distance from opposite sides of said piston and a frame upon which said supports and cylinder are mounted, and a pressure and feed controlling mechanism responsive to said tension measuring device and which controls the operation of said motor.

2. An apparatus for controlling the pressure and feed of rotary well drilling rigs, comprising a supporting line adapted to carry a drill pipe, feed means adapted to let out said line, a motor for operating said feed means, a tension measuring device which deflects a part of said line out of its normal position and which includes a cylinder containing a liquid, a piston arranged in said cylinder and engaging one side of said line, supports engaging the opposite side of said line and at distance from opposite sides of said piston, an indicator for showing the relative position of said piston and cylinder, a frame upon which said supports and cylinder are mounted, and a pressure and feed controlling mechanism responsive to said tension measuring device and which controls the operation of said motor.

3. An apparatus for controlling the pressure and feed of rotary well drilling rigs, comprising a supporting line adapted to carry a drill pipe, feed means adapted to let out said line, a motor for operating said feed means, a tension measuring device which deflects a part of said line out of its normal position and which includes a cylinder containing a liquid, a piston arranged in said cylinder and engaging one side of said line, sheaves engaging with the opposite side of said line above and below said piston, a frame carrying said sheaves and cylinder and having side pieces arranged on opposite sides of said line, and pressure and feed controlling mechanism

responsive to the tension measuring device and operating to control said motor.

4. An apparatus for controlling the pressure and feed of rotary well drilling rigs, comprising a supporting line adapted to carry a drill pipe, feed means adapted to let out said line, a motor for operating said feed means, a tension measuring device engaging with said line, and a pressure and feed control mechanism including a vertically swinging beam which is responsive to said tension measuring device and which is operatively connected with said motor for controlling the same.

5. An apparatus for controlling the pressure and feed of rotary well drilling rigs, comprising a supporting line adapted to carry a drill pipe, feed means adapted to let out said line, a motor for operating said feed means, a tension measuring device engaging with said line, and a pressure and feed control mechanism including a vertically swinging beam which is responsive to said tension measuring device and which is operatively connected with said motor for controlling the same and a weight adjustable lengthwise of said beam.

6. An apparatus for controlling the pressure and feed of rotary well drilling rigs, comprising a supporting line adapted to carry a drill pipe, feed means adapted to let out said line, a motor for operating said feed means, a tension measuring device engaging with said line, and a pressure and feed control mechanism including a vertically swinging beam which is responsive to said tension measuring device and which is operatively connected with said motor for controlling the same, a weight adjustable lengthwise of said beam, and a damping device connected with said beam.

7. An apparatus for controlling the pressure and feed of rotary well drilling rigs, comprising a supporting line adapted to carry a drill pipe, feed means adapted to let out said line, a motor for operating said feed means, a tension measuring device engaging with said line, and a pressure and feed control mechanism which is responsive to said tension measuring device and which includes a vertically swinging beam operatively connected with said motor for controlling the same and having two arms extending in opposite directions from its fulcrum, and weights adjustable lengthwise of said arms.

8. An apparatus for controlling the pressure and feed of rotary well drilling rigs, comprising a supporting line adapted to carry a drill pipe, feed means adapted to let out said line, a motor for operating said feed means, a tension measuring device engaging with said line, and a pressure and feed control mechanism including a vertically swinging beam which is responsive to said tension measuring device and which is operatively connected with said motor for controlling the same, and a hydraulic actuating device operatively connected with said beam.

9. An apparatus for controlling the pressure and feed of rotary well drilling rigs, comprising a supporting line adapted to carry a drill pipe, feed means adapted to let out said line, a motor for operating said feed means, a tension measuring device engaging with said line, and a pressure and feed control mechanism including a vertically swinging beam which is responsive to said tension measuring device and which is operatively connected with said motor for controlling the same, and a hydraulic actuating device consisting of a cylinder containing a liquid, and a piston arranged in said cylinder and connected with said beam.

10. An apparatus for controlling the pressure and feed of rotary well drilling rigs, comprising a supporting line adapted to carry a drill pipe, feed means adapted to let out said line, a motor for operating said feed means, a tension measuring device for deflecting a part of said line including a cylinder containing a liquid and a piston movable in said cylinder and engaging said line, and a pressure and feed controlling mechanism including a movable beam which is connected with said motor for controlling the same, and a hydraulic unit having a piston connected with said beam and a liquid holding cylinder which receives said last mentioned piston and which is in communication with the cylinder of said tension measuring device.

11. An apparatus for controlling the pressure and feed of rotary well drilling rigs, comprising a supporting line adapted to carry a drill pipe, feed means adapted to let out said line, a motor for operating said feed means, a tension measuring device including straps having one of their corresponding ends connected with the dead end of said line and the opposite corresponding ends connected with an anchorage and a hydraulic unit interposed between the intermediate parts of said straps and having a cylinder connected with one of said straps and containing a liquid and a piston arranged in said cylinder and connected with the other strap, and a pressure and feed controlling mechanism responsive to said tension measuring device and controlling said motor.

12. An apparatus for controlling the pressure and feed of rotary well drilling rigs, comprising a supporting line adapted to carry a drill pipe, feed means adapted to let out said line, a motor for operating said feed means, a tension measuring device including a plurality of sets of links, one pair of sets of which being connected at their outer ends with the dead end of said line and the outer ends of another pair of said sets being connected with an anchorage and the inner ends of the several corresponding links being connected with one another so that together the links form a flexible loop, and a hydraulic unit interposed between the central parts of said loop and having a cylinder connected with one side of said loop and containing a liquid and a piston arranged in said cylinder and connected with the opposite side of said loop, and a pressure and feed controlling mechanism which is responsive to said tension measuring device and which controls said motor.

13. An apparatus for controlling the pressure and feed of rotary well drilling rigs, comprising a supporting line adapted to carry a drill pipe, feed means adapted to let out said line, a motor for operating said feed means, a tension measuring device including a deflectable member, one end of which is connected with the dead end of said line and the other end of which is connected with an anchorage, a guide lever having a segment connected with said deflectable member adjacent to one end thereof, and an intermediate transmitting lever connected with said deflectable member between said guide lever and said anchorage, and a pressure and feed control mechanism including a rock shaft having an arm connected with said intermediate lever, a beam connected with said shaft and with said motor for controlling the latter.

14. An apparatus for controlling the pressure

and feed of rotary well drilling rigs, comprising a supporting line adapted to carry a drill pipe, feed means adapted to let out said line, a motor for operating said feed means, a tension measuring device including a deflectable member one end of which is connected with the dead end of said line and the other end of which is connected with an anchorage, a guide lever having a segment connected with said deflectable member adjacent to one end thereof, and an intermediate transmitting lever connected with said deflectable member between said guide lever and said anchorage, and a pressure and feed control mechanism including a rock shaft having an arm connected with said intermediate lever, a vertically swinging beam having arms projecting in opposite directions from its fulcrum and having one of its arms connected with said motor for controlling the same, adjustable weights arranged on the arms of said beam, and a damping device connected with said beam.

15. An apparatus for controlling the pressure on and the feed of rotary well drilling tools, comprising a weight measuring and controlling device operated from the tension in the dead line of the drill pipe hoist, means for deflecting a fixed portion or continuation of the dead line and measuring the force required to hold this deflection by means of connected and balanced hydraulic cylinders and pistons, one cylinder piston balancing the deflection of the dead line or its extension, and the connected cylinder piston balancing a scale beam and weight or other weight measuring device on which tension and corresponding weight can be measured and adjusted, and a power holding and feeding device operated and controlled by the scale beam or associated parts and operatively connected to the live line of the drill pipe hoist.

16. An apparatus for controlling the pressure on and the feed of rotary well drilling tools, comprising a weight measuring and controlling device operated from the tension in the dead line of the drill pipe hoist, means for deflecting a fixed portion or continuation of the dead line and measuring the force required to hold this deflection by means of connected links and levers balancing a scale beam and weight or other weight measuring device on which tension and corresponding weight can be measured and adjusted, and a power holding and feeding device operated and controlled by the scale beam or associated parts and operatively connected to the live line of the drill pipe hoist.

17. In a well drilling apparatus, a draw works, a cable, a tool string suspended by said cable, a weighing device mounted on said cable adapted to indicate the weight of said tool string, comprising an arm mounted upon said cable and supported thereby, means at one end of said arm for deflecting a portion of said cable, compound lever mechanism at the other end of said arm to which said cable is connected whereby straighting said deflected portion will operate said lever mechanism and cause the same to indicate the weight of the load suspended from said cable, and means operated by said last means for setting said draw works into action to raise or lower said cable to maintain a predetermined pressure upon the drill.

18. In combination with a hoist drum including a shaft and a cable wound on said drum, said cable supporting the drilling string, an automatic drilling regulator comprising weight indicator means operatively attached to said cable, a motor, gear reduction means, drive means from the motor to the hoist drum, speed control means on the motor, and means extending from said weight indicator to the speed control means whereby said speed control means is actuated by the weight indicator.

19. In combination with a hoist drum, a shaft upon which the drum is mounted, a cable wound on the drum, said cable supporting the drilling string, of an automatic drilling regulator comprising a weight indicator attached to said cable, a motor, a reduction gear box, drive means from the motor to the gear box, a drive shaft extending from the gear box, a sprocket on the drive shaft, a sprocket attached to the hoist drum shaft, a chain encircling both of said sprockets, control means on the motor, and means extending from the weight indicator to the control means whereby the motor is started or stopped by said weight indicator.

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