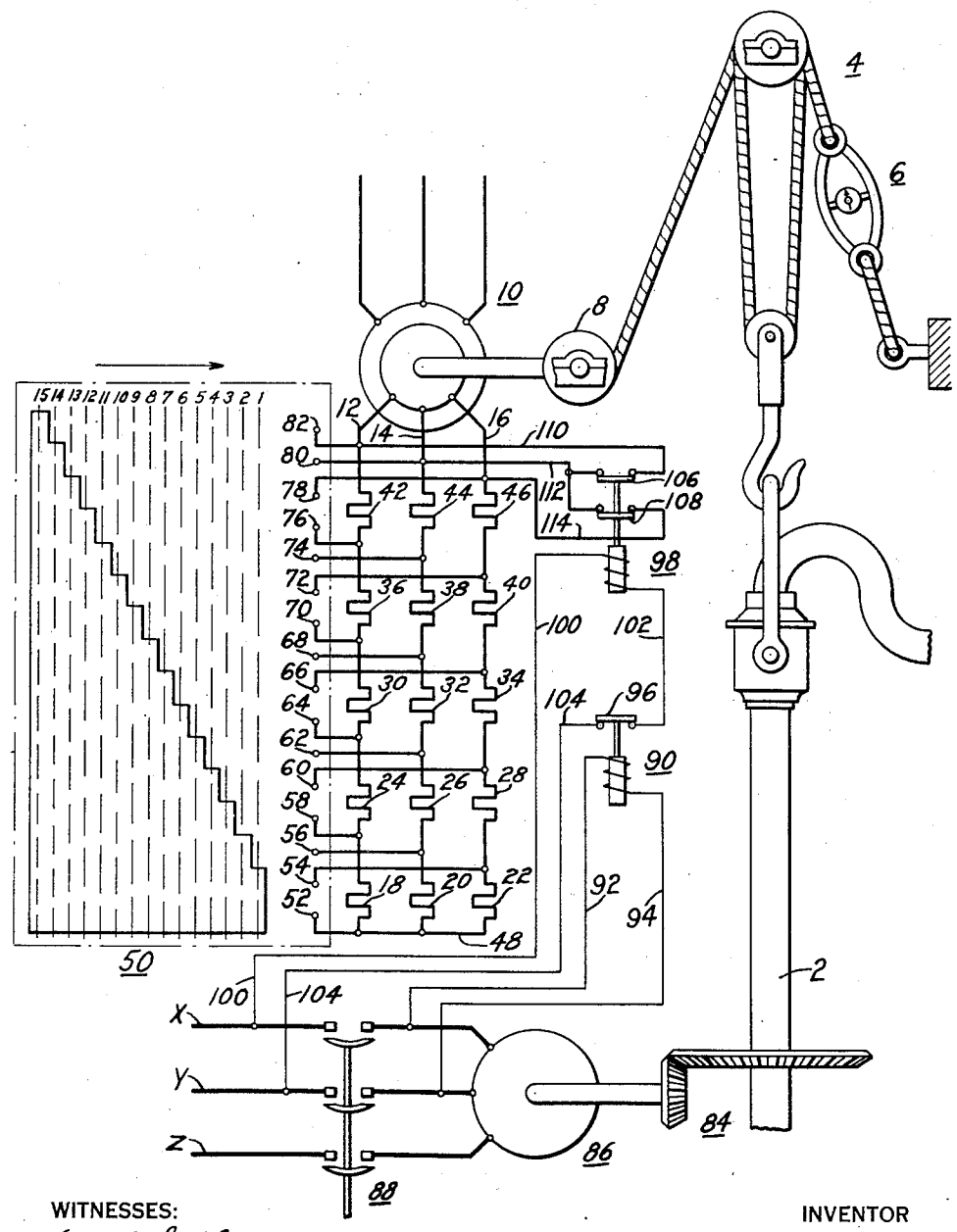
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AUTOMATIC DRILLING MACHINE

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AUTOMATIC DRILLING MACHINE

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My invention relates, generally, to drilling machines such as are used in drilling oil and gas wells and, more particularly, to a mechanism for automatically maintaining a constant pressure on the drilling bit of such machines.

In the operation of drilling machines the most efficient drilling action takes place at certain pressures of the drilling bit on the bottom, the particular pressure depending upon the nature of the stratum upon which the bit is working. The drilling operation comprises rotating the drill bit on the end of lengths of drill pipe joined together and adding lengths of pipe as the bit progresses downward into the earth. As the drilling progresses and lengths of drill pipe are added, the weight of the pipe, which is borne by the bit, becomes greater than the most efficient drilling pressure. This excessive drill bit pressure may cause damage to the drill bit and may result in the application of such excess torque to the drill pipe as to damage it.

An object of my invention is to provide a system of control which shall function to maintain a constant drilling pressure on the drill bit of a drilling machine.

Another object of the invention is to provide a control system for an earth drilling machine which shall function to maintain a predetermined pressure on the drill bit and which may be adjusted to so compensate for the addition of drill pipe as to maintain the desired drill bit pressure regardless of the amount of drill pipe added.

These and other objects and advantages of the invention will be apparent from the following detailed description taken in connection with the accompanying drawing in which the single figure is a diagrammatic representation of the preferred embodiment of my invention showing the cooperative relationship of the various elements of the invention.

In practicing my invention, I provide a torque motor for maintaining a back tension on the drill pipe suspending sheave tackle. This back tension is provided by the stalled torque of the torque motor and is varied at will to give the desired net drill bit pressure by varying the impedance in the rotor circuit of the motor to vary the stalled torque of the motor. Thus when an additional length of drill pipe is connected the additional weight added thereby is compensated for by decreasing the torque motor rotor circuit impedance to produce a higher motor stalled torque and hence a higher back tension on the drill pipe suspending tackle. By the same method the stalled torque may be varied to vary the drill bit pressure when desired to provide the proper drill bit pressure for the various strata of earth encountered by the drill.

Referring now to the drawing, I have shown a drill stem 2 of a drilling machine such as is commonly used in drilling oil and gas wells, having the usual block and tackle hoisting equipment 4 connected thereto. A tension measuring device 6 may be connected in the dead end of the tackle and the other end of the tackle is wound on a drum 8 which is mechanically connected to the rotor of the motor 10 in any suitable manner.

The motor 10 is a three-phase wound rotor induction motor having rotor winding taps 12, 14 and 16. The tap 12 is connected through resistance elements 18, 24, 30, 36 and 42 in series circuit relation, to the common conductor 48. The tap 14 is connected to the common conductor 48 through the resistances 20, 26, 32, 38 and 44 in series circuit relation. The tap 16 is connected to the common conductor 48 through the resistance elements 22, 28, 34, 40 and 46 in series circuit relation. The controller 50 has step contacts arranged to cooperate with contact points 52 through 82 to provide shorting or shunting circuits for the individual resistance elements 18 through 46 to successively decrease the resistance in the rotor circuit of the motor 10 as the controller 50 is moved in the direction indicated to successively engage the contact elements 52 to 82.

The drill stem 2 is rotated by the usual beveled gear arrangement 84 which is driven by a suitable motor 86. Motor 86 may be connected by any suitable circuit breaker 88 to a suitable source of alternating current power through conductors X, Y and Z, shown. A relay 90 is connected by conductors 92 and 94 to one phase of the alternating current power source on the motor side of the circuit breaker 88. The contact element 96 of relay 90 is normally biased to the closed circuit position and is connected in series circuit relation with the coil of relay 98 to complete an energizing circuit for relay 98 which extends from the conductor X through conductor 100, the coil of relay 98, conductor 102, contact element 96 and conductor 104 to the conductor Y. The contact elements 106 and 108 of relay 98 are biased to the open circuit position and are arranged to close a circuit between conductors 110 and 112 and 114 and 112, respectively, when the coil of relay 98 is energized to provide shorting circuits for the taps 12, 14 and 16 and to thereby cut

out the external resistance in the rotor circuit of motor 10.

In the operation of the device, the controller 50 may be moved to the right to cut out substantially all of the resistance in the rotor circuit of motor 10, then with the circuit breaker 88 in the open circuit position, it will be seen that relay 98 will be energized and its contact elements 106 and 108 will be moved to the closed circuit position to provide a shorting circuit for the taps 12, 14 and 16 of the rotor circuit. Under these conditions, the motor 10 will be exerting its maximum torque and will be providing its maximum lifting force on the drill stem 2. The pressure on the drill bit will be a minimum under these conditions. If, now, circuit breaker 88 is moved to the closed circuit position, motor 86 will be started and the drill pipe 2 will be rotated to perform the drilling operation. With the closure of circuit breaker 88 the coil of relay 90 will be energized to cause the movement of its contact element 96 to open circuit position to in turn deenergize the coil of relay 98 and cause its contact elements to open the hereinbefore described shorting circuits of the rotor winding. Under these conditions the torque exerted by the motor 10 in its stalled condition will be determined by the amount of resistance in its rotor circuit, and this, in turn, will be determined by the position of the controller 50. The tension indicating device 6 may be calibrated to indicate the lifting force exerted on the drill pipe 2 by the motor 10. By subtracting the indicated force from the known weight of the drill pipe 2, the amount of pressure on the drill bit may be obtained. If, now, it is desired to apply a particular pressure to the drill bit, the controller 50 may be adjusted to connect such resistances in the rotor circuit of motor 10 as will cause the tension indicator 6 to indicate the difference between the total known weight of drill stem 2 and the pressure which is desired to apply to the drill bit.

It will be seen that with the controller 50 properly set to cause motor 10 to exert such a stalled torque as will provide a desired pressure on the drill bit, this desired pressure will be maintained constant so long as the total length of drill pipe remains the same and the torque motor will permit the drill pipe to be lowered as the hole is drilled for maintaining the drill bit pressure substantially constant.

If, now, it is desired to apply a different drill bit pressure because of the change in the nature of the stratum upon which the drill bit is working, the controller 50 is adjusted to supply a stalled torque for motor 10 which will provide a lifting force on the drill pipe 2 which is the difference between the weight of the drill pipe 2 and the desired drill bit pressure.

As the drilling operation progresses and it becomes necessary to add lengths of drill pipe, the total drill pipe weight will increase, and, if it is desired to maintain the same drill bit pressure before and after adding lengths of drill pipe, it is only necessary to adjust the controller 50 to decrease the rotor circuit resistance such an amount as will result in a motor torque sufficient to supply a lifting force on the drill pipe equal to the difference in the new total weight of the drill pipe and the desired drill bit pressure.

It will be apparent that a constant pull on the drill may be maintained while the drill is being pulled up and the hole is being reamed. With such constant pull upon the drill, it will be seen that the drill will feed up at a rate depending upon the ease of cutting of the stratum through which it is passing. To provide the desired pull, the motor torque is adjusted by means of the controller 50 to provide a pull on the drill stem which is greater than the drill stem weight by the amount of net pull that it is desired to exert upon the drill.

It will be seen that I have provided a system for establishing and maintaining a constant drill bit pressure for a drilling machine which may be adjusted to provide the desired drill bit pressure for any given length of drill pipe, which may be adjusted to maintain a desired drill bit pressure for different lengths of drill bit pipe, which is simple and effective in operation, and which is inexpensive to manufacture.

In compliance with the requirements of the patent statutes, I have shown herein the preferred embodiment of my invention. It is understood, however, that the invention is not limited to the precise construction shown and described but is capable of modification by one skilled in the art, the embodiment herein shown being merely illustrative of the principles of my invention.

I claim as my invention:

1. In a system for controlling the pressure on the drill bit of an earth boring machine having a drill stem and a drill bit, means including a motor for rotating the drill bit, a wound rotor induction motor connected to tend to hoist the drill stem in the stalled condition of the induction motor, means for selectively varying the resistance in the rotor circuit of the motor to vary the stalled torque of the motor, and means responsive to the deenergization of the drill rotating motor for decreasing the resistance in the rotor circuit to increase the induction motor torque.

2. In a system for controlling the drill stem of an earth boring machine having drill stem rotating means and drill stem lifting means, means for causing the lifting means to provide lifting forces of two different values, and means for automatically causing the greater of the two lifting forces to be applied to the drill stem while the rotating means is not actuated and for causing the lesser of the two lifting forces to be applied to the drill stem while the rotating means is actuated.

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