

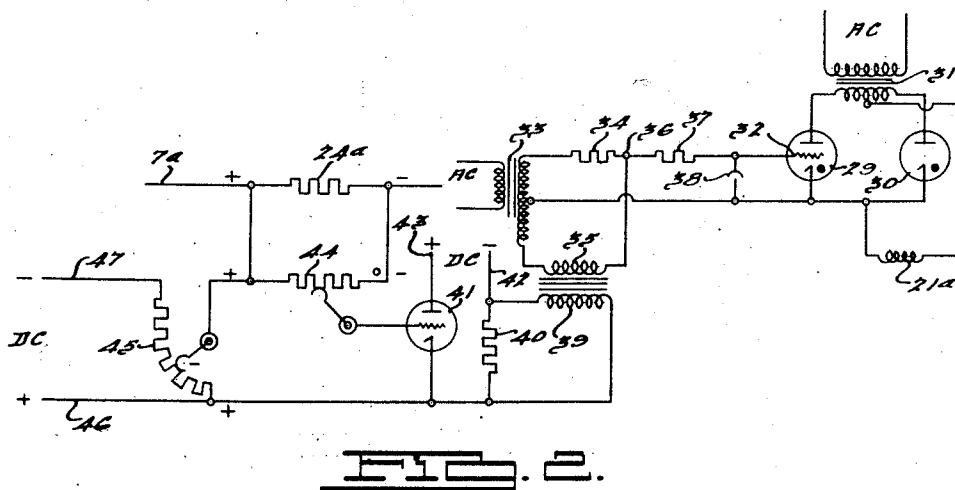
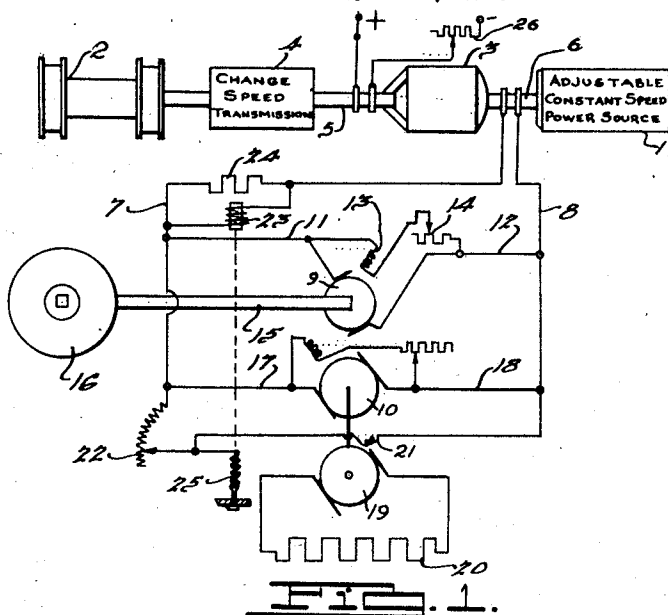
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ELECTRIC DRILLING MECHANISM

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ELECTRIC DRILLING MECHANISM

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3 Claims. (Cl. 255—19)

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The present invention relates to a rotary well drilling apparatus incorporating means to control the pressure of the drill bit during the drilling operation. In applicant's copending applications, Serial No. 602,620 now Patent No. 2,589,118 and No. 702,539 apparatus is disclosed for varying the pressure of the drill bit inversely with respect to the torque required to rotate the drill bit. A feature common to the several forms of apparatus disclosed in the said copending applications is the fact that the drill bit pressure is controlled by a control of the torque applied to the hoisting drum which supports the major portion of the weight of the drill stem. This torque is automatically varied in accordance with the torque required to rotate the drill stem but at a smaller percentage magnitude of change in order to obtain the desired control of the drilling operation.

It is the general object of the present invention to control the drill bit pressure by electrical means.

Another object of the present invention is to utilize a substantial portion of the power required to maintain the desired drill stem supporting torque on the hoisting drum to rotate the drill stem during the drilling operation.

Other objects and advantages of the invention will become apparent from the following specification, the accompanying drawing and the appended claims.

In the drawing:

Figure 1 is a diagrammatic illustration of one form of the present invention; and

Figure 2 is a wiring diagram of an alternative form of an electrical control circuit which may be employed in lieu of that illustrated in Figure 1.

In accordance with the present invention, any suitable source of motive power, such as an internal combustion engine 1, is connected to the conventional hoisting drum 2 through a torque transmitting device 3 and a change-speed transmission 4 which is effective to multiply the torque applied to the drum by the torque transmitting device 3. The torque transmitting device 3 is an electric generator, preferably a D. C. generator, having its armature or inner element connected to the engine shaft 6 and having its field poles or outer element connected to the shaft 4, both elements being journaled for rotation independently of each other. The construction and arrangement of the generator, being similar to that of conventional electric dynamometers, form no part of the present invention and hence need not be further illustrated or described.

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The armature circuit of the generator 3 includes the lines 7 and 8, which are connected to slip rings on shaft 6. A pair of motors 9 and 10 is connected in parallel between the lines 7 and 8 and hence is operated by the electric current from the generator 3. Thus, motor 9 is connected between the lines 7 and 8 by a pair of lines 11 and 12. A field coil 13 of the motor 9 is likewise connected across the lines 11 and 12 through an adjustable resistance 14. The motor 9 is connected in any suitable manner, as by the shaft 15, to a conventional rotary table 16 of the well drilling machine, and thus serves to rotate the drill stem during the drilling operation. The motor 10 is similarly connected by the lines 17 and 18 across the lines 7 and 8 and is mechanically connected to a generator 19, the output of which contains an energy dissipating resistance 20. The field coil 21 of the generator 19 is connected across the lines 7 and 8 through an adjustable resistance 22 which is controlled by a solenoid 23 connected across a relatively low resistance 24 in the line 7.

As a result of this arrangement, the current flowing through the solenoid 23 is proportional to the current in line 7 and thus to the current generated by the generator 3. A spring 25 normally acts upon the variable resistance 22 in such a direction as to reduce the resistance and thereby increase the current flowing through the field coil 21 of the generator 19, while solenoid 23 applies an opposing force proportional to the current in line 7.

In operation, any desired drill stem supporting torque is imposed upon the hoisting drum 2 by adjusting the speed of the engine 1, the excitation of the field coil of the generator 3 by the adjustable resistance 26, which is connected in the circuit of the field coil by slip rings on shaft 5, or the setting of change-speed transmission 4. However, the speed of the engine 1 is always maintained at such a value that variations in the speed of shaft 5 incident to variations in the rate of penetration of the drill bit will be negligible as compared with the speed of the shaft 6. Consequently, for any given setting of the engine speed, the generator excitation and the change-speed transmission 4, the generator 3 will deliver to the lines 7 and 8 a constant voltage, which, in turn, is applied to the motors 9 and 10.

The system is preferably so designed and adjusted that under normal drilling conditions approximately half of the current delivered by generator 3 is utilized in motor 9 and the remainder in motor 10. So long as the table torque remains at a constant value, the current flow-

ing through the motors 9 and 10 will remain unchanged, and so, likewise, the torque applied to the drum 2 will remain unchanged. If, however, the drill stem encounters an increased resistance to rotation, the added torque applied to the motor 9 will decrease its speed and cause it to draw a heavier current. If all of this increased current were to be supplied by the generator 3, the result would be to unduly increase the torque applied to the drum. However, any tendency of the current in line 7 to increase will increase the current flow through the solenoid 23 and thereby increase the resistance in the circuit of the field coil 21 of the generator 19. This reduction in the excitation of the generator 19 reduces the load imposed upon the motor 10 and, consequently, reduces the current drawn by the latter motor sufficiently to partially compensate for the increased current drawn by the motor 9. As the result, a substantial increase in the torque required to rotate the drill stem will cause only a small increase in the current flowing through the lines 7 and 8 and, consequently, a small increase in the torque applied to the hoisting drum 2.

While the apparatus may be adjusted to meet any desired conditions, an understanding of the operation of the mechanism may be facilitated by an illustrative example. Thus, if under any given set of conditions the generator 3 delivers 200 amp., the motors 9 and 10 each draw 100 amp., and it is desired to increase the drum torque by ten per cent in the event that the table torque becomes twice the normal table torque, then solenoid 23, resistances 22 and 24, and spring 25 are so chosen and adjusted that the motor 10 will draw 100 amp. as long as the current through resistance 24 remains at 200 amp., but will draw only 20 amp. when the current through resistance 24 reaches 220 amp. Under the latter conditions, the increased torque imposed on motor 9 will have caused it to draw 200 amp., but the simultaneous decrease in the current drawn by the motor 10 will result in only a ten per cent increase in the total current delivered by the generator 3 and, therefore, only a ten per cent increase in the reaction torque imposed upon the hoisting drum 2.

It should be noted that motor 10 and generator 19 together act as a current consuming means connected across the generator 3 in parallel with motor 9, and that adjustments in the resistance of the field circuit for the generator 19 change the electrical resistance of the current consuming means as a whole. The rate of change in the resistance of the current consuming means with respect to changes in the armature current of generator 3 may be varied by adjustment of the resistance of the field circuit of motor 9 or motor 10 or by adjusting the tension of spring 25.

The solenoid operated resistance employed in the form of invention shown in Figure 1, while operable for the purpose described, may not be sufficiently accurate and sensitive to meet all requirements; accordingly, it is preferred to employ in lieu thereof the alternative control circuit illustrated in Figure 2.

Referring to Figure 2, the resistance 24a in line 7a corresponds to the resistance 24 in line 7, and the coil 21a is the field coil for the generator 19 of Figure 1 and hence corresponds to the coil 21 in that figure. The electrical circuit of Figure 2 performs the function of reducing the current in the field coil 21a in proportion to any increase in the current flowing through the line 7a and the relatively low resistance 24a. Thus, the coil

21a is supplied with direct current through a conventional rectifying circuit comprising rectifiers 29 and 30, which are supplied with alternating current from a transformer 31. The rectifier 30 is a diode, whereas rectifier 29 is of the grid controlled type. It will be appreciated that by varying the phase of the alternating current potential impressed between the grid 32 of rectifier 29 and its cathode with respect to that of the alternating current potential impressed between its anode and its cathode, the magnitude of current output of the rectifier 29—30 may be varied between relatively wide limits. If desired, both rectifiers 29 and 30 may be triodes and the phases of both their grids may be shifted simultaneously with respect to their cathodes.

While any suitable means may be utilized to vary the above mentioned phase relationship, the conventional arrangement illustrated comprises a transformer 33 having a secondary winding provided with a center tap that is directly connected to the cathode of rectifier 29. The terminals of the secondary winding of the transformer 33 are connected by an impedance network comprising a resistor 34 and a variable impedance 35 of the saturable reactor type. The junction 36 of elements 34 and 35 is connected to the grid 32 of rectifier 29 through a resistor 37. A filter condenser 38 is directly connected between the grid and cathode of the rectifier 29. It will be understood that by varying the impedance of element 35, the phase of the potential of terminal 36 and, consequently, of that of the grid 32 may be varied from an in-phase relation to the cathode potential to any desired degree of out-phase relation to the cathode potential, thereby varying the output of the rectifier, as previously mentioned. The relative polarities of transformers 31 and 33 are such that the excitation of field winding 21a varies inversely with respect to the impedance of winding 35.

Changes in the impedance 35 are accomplished by variably exciting the direct current winding 39, which is wound upon the same core as element 35. Element 39 is connected across a resistance 40 which, in turn, is connected in the anode circuit of a usual grid controlled vacuum tube 41 which is supplied with anode current from any suitable direct current source, represented by the conductors 42 and 43. The grid of vacuum tube 41 is variably connected to a potentiometer resistor 44 which, in turn, is directly connected across the previously mentioned resistance 24a. The cathode of the vacuum tube 41 is connected to one terminal of a potentiometer resistor 45 which is supplied from any suitable direct current source, indicated by the lines 46 and 47. The effective portion of potentiometer 45 thus serves to provide a bias voltage for the grid of vacuum tube 41, which normally maintains this grid at a desired negative potential with respect to its cathode. As a result, increases in the voltage across resistor 44 increase the current flow through tube 41 and winding 39 and thereby decrease the impedance of coil 35. This, in turn, increases the current through field winding 21a. Decreases in the voltage across resistor 44 have the reverse effect.

The above described system is so adjusted that for a given normal table torque and a given current delivered by the generator 3, the voltage imposed across the field winding 21a of the generator 19 will cause the motor 10 to draw the desired amount of current, in accordance with the principles outlined above. For any given adjust-

ment of the circuit, any increase in the table torque will increase the current drawn by the motor 9 and thereby increase the current flowing through the resistance 24a. This, in turn, will increase the negative potential of the grid of vacuum tube 41 and thereby reduce the current conducted through the tube. This, in turn, increases the impedance 35 and thereby increases the degree of out-of-phase relationship of the grid potential of tube 29 with respect to its cathode potential. This results in a decrease in the current flowing through the field circuit 21a.

The general level of current flowing through the field circuit 21a may be readily adjusted by adjusting the potentiometer resistor 45. Likewise, the rate of change of the current in the field circuit for a given change in the current flowing through the resistance 24a may be adjusted by adjusting the potentiometer resistor 44 to produce any desired operating conditions.

It should be noted that not only does the apparatus of the present invention provide a very flexible table drive for a rotary drilling machine which is fully effective to vary the hoisting drum torque in accordance with but at a smaller percentage magnitude of change than that of the variations in the table torque, but that a substantial portion of the energy required to drive the weight balancing generator 3 is usefully employed to rotate the drill stem. The only power which is wasted is that delivered by the generator 19 and, if desired, all or any part of the power developed by that generator may be utilized for illumination or for other purposes, so long as the resistance remains constant.

The mechanism of the present invention may also be used as a brake during the operation of lowering the drill stem into the hole. This is accomplished by disconnecting motor 9 at lines 11 and 12, breaking the circuit to solenoid 23 in the form of invention shown in Figure 1, and placing the transmission 4 in its lowest gear ratio. The braking torque applied to the drum may then be regulated by manually adjusting the speed of engine 1 or by manually adjusting resistance 22 or the resistance in the field circuit of the generator 3. The same result may be achieved with the alternative control circuit of Figure 2 by disconnecting potentiometer 44 from line 7a and manually adjusting the grid bias of tube 41 from any suitable direct current potential or by adjusting the speed of engine 1. The braking torque supplied by the apparatus is superior to that obtainable with conventional hydrodynamic or electric dynamometer brakes because it is independent of drum speed and hence may bring the drum to a complete stop.

It will be apparent that variations in the design, construction and arrangement of the parts may be indulged in without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. Apparatus for driving the rotary table of a rotary well drilling mechanism and balancing the drill stem supporting torque applied to the hoisting drum, said apparatus including an electric generator having relatively movable inner and

outer elements both journaled for rotation about a common axis, one of said elements being adapted for connection to a source of power and the other to the hoisting drum, an electric table driving motor driven by the current delivered by said generator, an electrical current consuming means connected in parallel with said motor across the output of said generator, means for varying the electrical resistance of said current consuming means, automatic means for so operating said resistance varying means as to reduce the resistance when the current drawn by said motor decreases and vice versa, and means for adjusting said automatic means to vary the rate of change of said resistance with respect to the rate of change of said current.

2. Apparatus for driving the rotary table of a rotary well drilling mechanism and balancing the drill stem supporting torque applied to the hoisting drum, said apparatus including an electric generator having relatively movable inner and outer elements both journaled for rotation about a common axis, one of said elements being adapted for connection to a source of power and the other to the hoisting drum, an electric table driving motor driven by the current delivered by said generator, an electrical current consuming means connected in parallel with said motor across the output of said generator, and means responsive to the total current delivered by said generator for decreasing the electrical resistance of said current consuming means when the current delivered by said generator decreases and vice versa.

3. Apparatus for driving the rotary table of a rotary well drilling mechanism and balancing the drill stem supporting torque applied to the hoisting drum, said apparatus including an electric generator having relatively movable inner and outer elements both journaled for rotation about a common axis, one of said elements being adapted for connection to a source of power and the other to the hoisting drum, an electric table driving motor driven by the current delivered by said generator, a motor-generator having the motor thereof connected in parallel with said table motor across the output of said first mentioned generator, a constant resistance electrical load connected to said second generator, and means responsive to the current delivered by said first mentioned generator for varying the resistance of the field circuit of the second generator.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
758,293	Bentley -----	Apr. 26, 1904
1,703,234	Halliburton -----	Feb. 26, 1929
1,745,094	Hild -----	Jan. 28, 1930
1,785,163	Wilkins -----	Dec. 16, 1930
1,836,998	Thullen -----	Dec. 15, 1931
1,838,956	Nottage -----	Dec. 29, 1931
1,859,814	Wyckoff -----	May 24, 1932
2,032,155	Staeger -----	Feb. 25, 1936
2,193,683	Beck -----	Mar. 12, 1940
2,462,747	Jacobs -----	Feb. 22, 1949