March 4, 1952 J. H. MEIER 2,587,638

AUTOMATIC FEED FOR CABLE TOOL DRILL

Filed Sept. 27, 1945 3 Sheets-Sheet 1

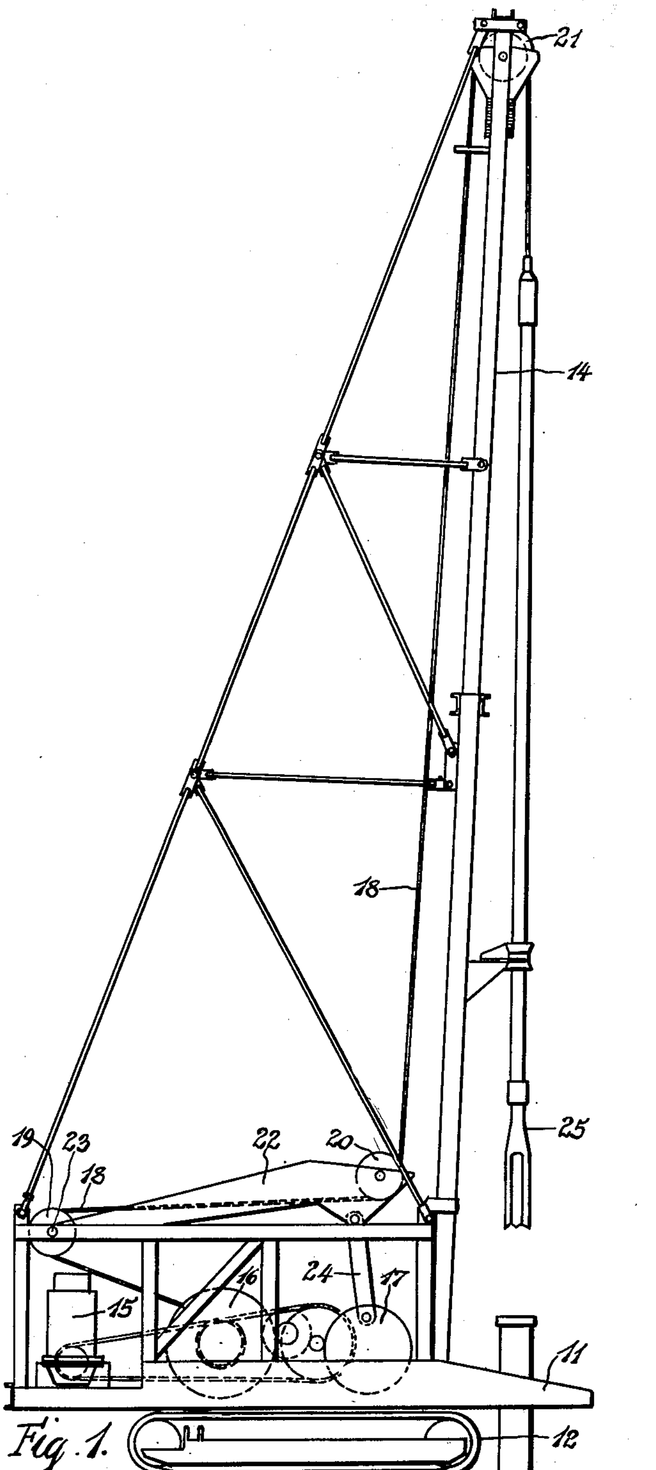

Fig. 1.

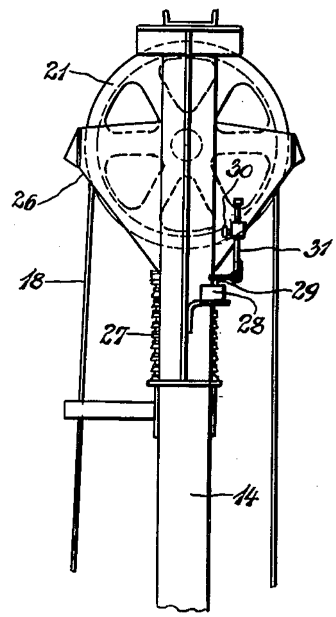

Fig. 4.

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AUTOMATIC FEED FOR CABLE TOOL DRILL

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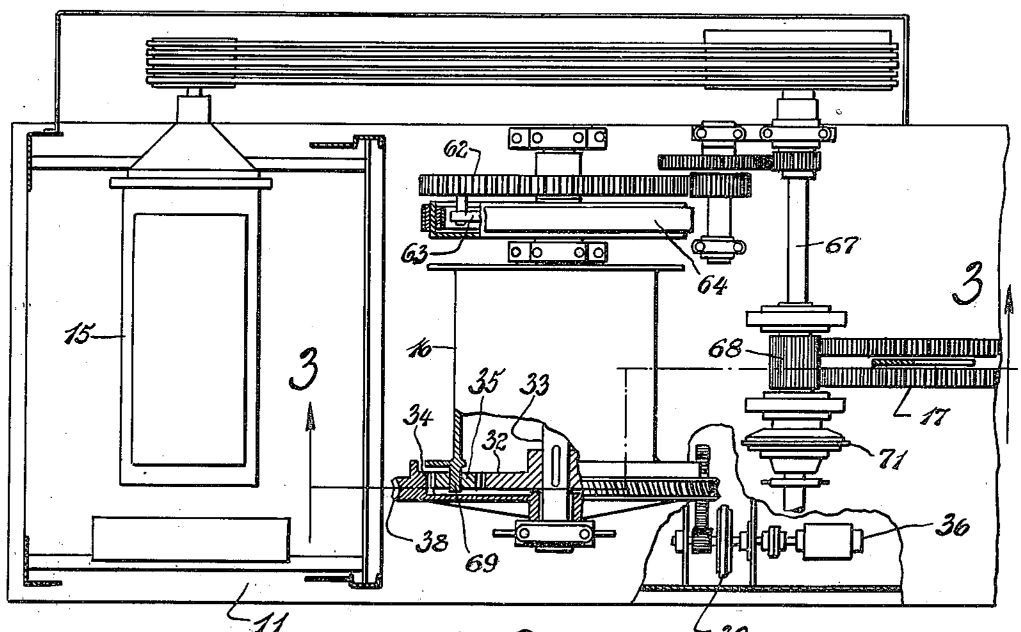

Fig. 2

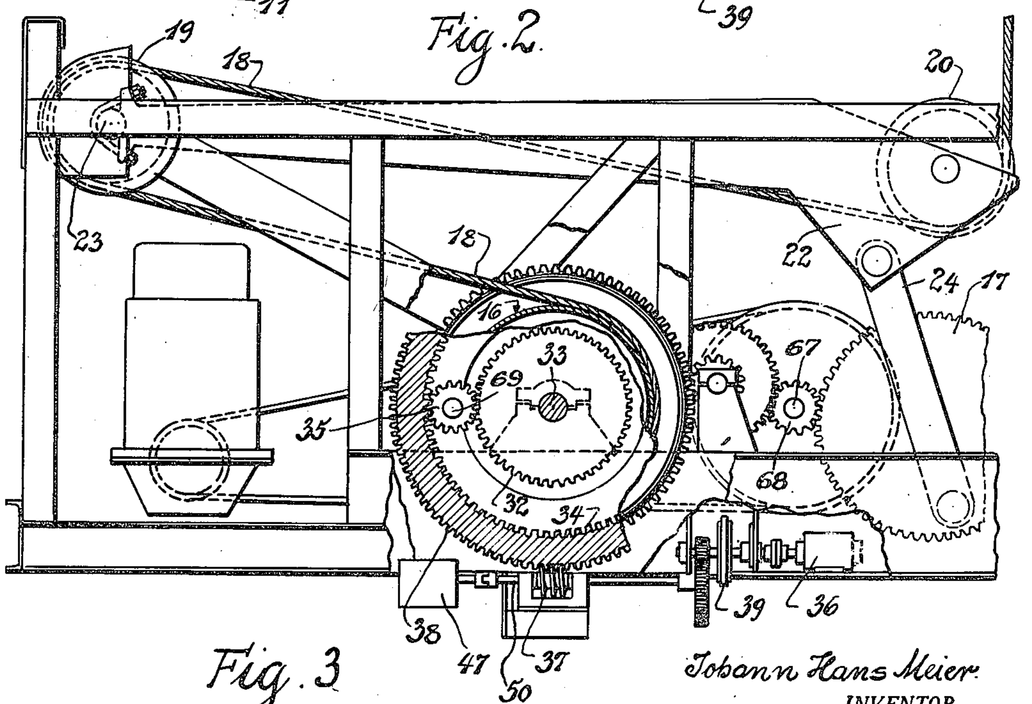

Fig. 3

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AUTOMATIC FEED FOR CABLE TOOL DRILL

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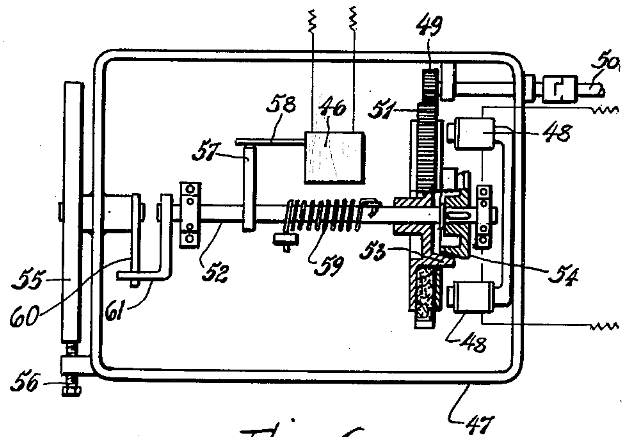

Fig. 6.

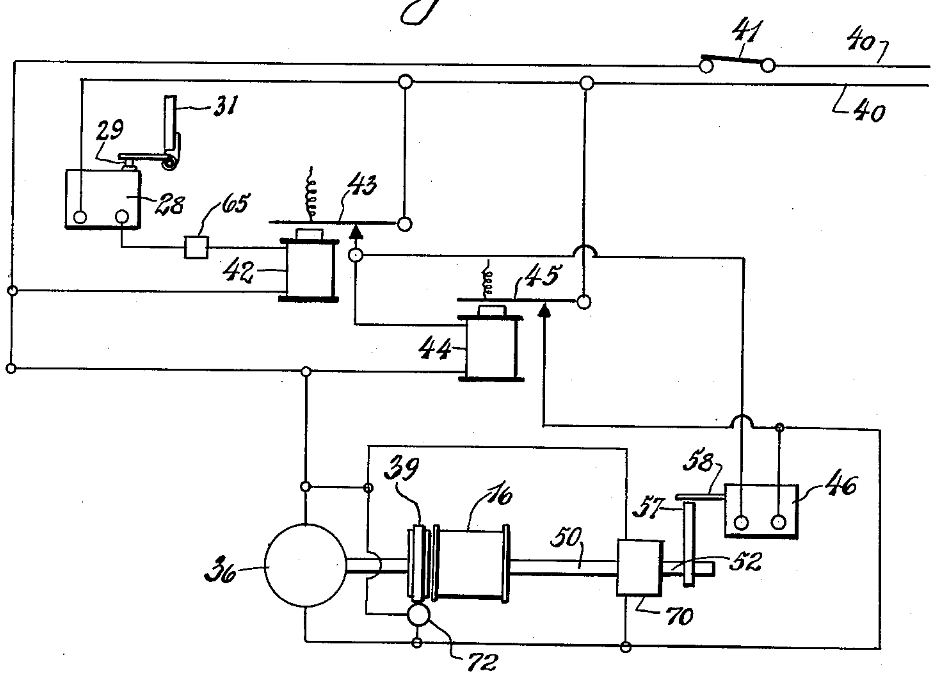

Fig. 5.

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2,587,638

UNITED STATES PATENT OFFICE

2,587,638

AUTOMATIC FEED FOR CABLE TOOL DRILL

Johann H. Meier, South Milwaukee, Wis., assignor to Bucyrus-Erie Company, South Milwaukee, Wis., a corporation of Delaware

Application September 27, 1945, Serial No. 618,843

12 Claims. (Cl. 255—15)

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My invention relates to new and useful improvements in automatic feeds for cable-tool drills.

Such drills, per se, are well known.

In such drills a rope passes, from a winch drum on the main frame, around a heel sheave at or near the pivot of a spudding beam, thence under a sheave at the oscillating end of the spudding beam, thence over a sheave at the upper end of a mast and thence vertically downward into the hole which is being drilled in the ground. At the lower end of this rope is a string of percussion drilling-tools, terminating in a bit. The spudding beam is oscillated by a pitman, actuated by a rotating crank. Other means reciprocating the rope are sometimes employed.

As the hole grows deeper, it is necessary that the winch drum shall unwind to pay out more rope. In the past, this paying-out has been effected in one of the following three ways: (1) Time control, in which the winch steadily or intermittently unwinds with the mere elapse of time. (2) Non-automatic, the operator voluntarily running the winch whenever more rope was needed. (3) Shock control, a brake being set on the winch to yield at a certain predetermined torque, so that the shock of the tools falling and not striking bottom would jerk out a trifle more of rope.

Method 1 was wholly unsatisfactory, except in very uniform steady drilling. Method 2 required too much careful attention by the operator. Method 3 required too precise an adjustment of the brake, the proper adjustment depending too much on various variable conditions, such as atmosphere, lubrication, etc., and furthermore requires that that precise adjustment be exactly maintained.

Accordingly it is the principal object of my invention to devise a feed which shall pay out additional rope, when and as needed, without being open to any of the above objections.

My invention involves a wholly new principle, which I call "depth control." This new principle somewhat resembles the "shock control" mentioned above, in that the paying-out of rope, is effected by the tension of the rope, but in my invention it is effected indirectly through compression of the resilient support, rather than directly by jerking on the winch. In my invention, the winch is softly, smoothly and positively unwound, whenever this is necessary, rather than yanked around against the resistance of a partially-set brake. Under the "shock control" of the prior art, the winch did not pay out as often as is ought, in order to maintain substantially uniform percussion; and each time that it did pay out, it would pay out too much, and an unpredetermined amount.

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It is to be noted that, in different types of resilient support, the control may be effected by tension and/or pure travel of the rope. In addition to my principal object, above stated, I have worked out a number of novel and useful details, which will be readily evident as the description progresses.

My invention consists in the novel parts and in the combination and arrangement thereof, which are defined in the appended claims, and of which one embodiment is exemplified in the accompanying drawings, which are hereinafter particularly described and explained.

Throughout the description, the same reference number is applied to the same member or to similar members.

Figure 1 is a side elevation of a drill embodying my invention.

Figure 2 is an enlarged plan view, partly in section, of the main machinery of my drill.

Figure 3 is an enlarged side elevation of said machinery, taken along the line 3—3 of Figure 2.

Figure 4 is an enlarged side elevation of the mast head of my drill, showing the travel-responsive contactor of my invention.

Figure 5 is an electric wiring diagram of my invention, with certain of the associated mechanical parts shown conventionally, in order that this one figure shall show all the elements of the complete invention as claimed.

Figure 6 shows the details of that part of my invention whereby, after each initial impulse, further paying out of cable is stopped after a certain amount of cable has been payed out.

Turning now to Figures 1 to 3, we see that 11 is the main frame of a drill, supported by creeping traction 12.

The frame 11 supports a mast 14 (called "derrick" in the art), a motor 15, a winch 16, a drive shaft 67, a spudding pinion 68, a spudding gear 17, and associated driving connections, not numbered.

From the winch 16, a rope 18 runs around a heel sheave 19, thence under a spudding-sheave 20, thence over a sheave 21 at the top of the derrick 14, thence down to the tools 25.

The spudding pinion 68, which drives the spudding gear 17, is clutched to and unclutched from drive shaft 67 by means of a clutch 71. This clutch may be of any convenient sort, adapted to perform its recited function, and may be actuated at will in any convenient manner, all of which is well known in the art, and need not be detailed here, inasmuch as the control of the spudding means has nothing to do with the winch and hence constitutes no part of the present invention.

There is also a spudding-beam **22**, which in turn is pivoted on horizontal pivots **23** on the frame **11**.

The spudding-beam **22** is rocked up and down by the rotation of the spudding gear **17**, acting through pitman **24**. The foregoing detailed description of my spudding means has been given for clearness of understanding only, and no unnecessary limitation should be understood therefrom.

The winch **16** is controlled by means which will hereinafter be described.

The operation of all these conventional parts will be readily understood.

Turning now to Figure 4, we see that head sheave **21**, at the top of the derrick **14**, is mounted in a housing **26**, which is arranged in any convenient manner to slide up and down with respect to the derrick **14**. This housing **26** rests upon a pile **27** of alternate steel and rubber discs, which thus furnish a resilient support, for the head sheave **21**. See U. S. Patent No. 1,750,826, granted March 18, 1930, to George R. Watson. Any alternative form of support would be satisfactory for the purposes of my present invention, provided it compresses with each stroke, and then expands again. Sheave **21**, housing **26**, and pile **27**, are thus seen collectively to constitute a yieldable member, supporting line **18**.

The derrick **14** carries a normally open contactor **28**, which is a well-known commercial article, and hence will not be shown in detail. The housing **26** carries a cooperating actuator **31**, the position of which is adjustable by setscrew **30**, or in any other convenient manner. This actuator **31** is to be so adjusted that it will actuate the button **29** of the contactor **28**, whenever the dropping of tools **25** compresses resilient support **27** to a predetermined extent, i. e., more than the optimum for percussion drilling. This is apt to occur whenever, due to the drilling, the bottom of the hole recedes sufficiently so that the bit no longer makes proper impact against the bottom of the hole.

Any travel of the bit which compresses the resilient support to the predetermined extent above mentioned, will (for want of a better term) be called "excessive," regardless whether it be thought that this degree of compressing is due to the mere distance of travel of the bit, or is due to the increased tension in the rope.

Let us now consider the succession of instrumentalities which are actuated by the brief closing of contactor **28**; and how when those instrumentalities have operated to pay out a predetermined quantity of rope, their actuation is automatically caused to cease.

Turning to Figures 2 and 3, we see main frame **11**, motor **15**, winch-drum **16**, spudding gear **17**, rope **18**, heel sheave **19**, spudding sheave **20**, spudding beam **22** pivoted at **23**, and pitman **24**, all as already described hereinabove.

Sun-gear **32** is keyed to shaft **33**. Internal ring-gear **34** floats on said shaft **33**. Planet gears **35** are carried by winch-drum **16**, which in turn floats on said shaft **33**.

Winch-drum **16** can be rotated in either of the following two manners.

First, drum **16** can be rotated continuously to wind up or pay out rope **18**, by means of holding ring-gear **34** (in a manner as described in the next paragraph) and rotating sun-gear **32** in one direction or the other by main motor **15**, acting through intermediate gearing which need not be detailed, except to state that gear **62** can be clutched to shaft **33** by clutch **63**. When shaft **33** is not thus being rotated, it can (and normally would) be braked by brake **64**.

Secondly, drum **16** can be rotated intermittently to pay out rope **18**, by means of holding sun-gear **32** (in the manner as described above) and running small motor **36** which operates through intermediate gearing to rotate worm **37**, and hence worm gear **38**, which is integral with internal ring-gear **34**. Integral gears **34** and **38** are journaled for free rotation about shaft **33**. The rotation of ring-gear **34** is normally braked by brake **39**. This brake is highly advisable, not only because, in a machine so subjected to jarring as a drill, even a self-locking worm is almost certain to slip, but also so as to prevent the motor **36** from overrunning and thus destroying the fine predetermination of the amount of each pay-out.

Due to the fact that drum **16** can be selectively driven by driving either sun-gear **32** or ring-gear **34**, the other being held, the combination of these two gears with planet-gears **35** (which are journaled on pins **69**, projecting from the end of drum **16**) will readily be seen to constitute a differential gearing. Inasmuch as it is not essential that this particular sort of differential gearing be employed, the foregoing detailed description of my differential gearing has been given for clearness of understanding only, and no unnecessary limitation should be understood therefrom.

Let us turn now to Figure 5, which illustrates the essence of my invention. Here we find winch-drum **16**, small motor **36**, and brake **39**, conventionalized and symbolically represented. All other elements in this figure are likewise conventionalized and symbolically represented, inasmuch as all except one of them are well-known commercial articles, and the one exception (comprising elements **46**, **52**, **57**, **58**, and **70**, in Figure 5) is collectively designated as **47** in Figure 6, where it is considerably detailed.

To facilitate an understanding of Figure 5, the elements there shown will be enumerated as the operation is described.

Wires **40** lead to a source of power, **41** being the main switch of the system which is about to be described. It is advisable that switch **41** be attached to the main switch employed for drilling or to the control-lever of the spudding-gear clutch, so that this feeding system will be shut off whenever the drill is not running.

The closing of normally open contactor **28** by actuator **31** (both of which have already been described in connection with Figure 4) energizes magnet **42** during the brief time that contactor **28** is held closed, thus closing normally open switch **43** for the same brief period.

This brief closing of switch **43** energizes magnet **44**, thus closing normally open switch **45**. Once this switch **45** has been closed, the current which passes through it, passes through normally closed contactor switch **46**, and thence through magnet **44**, thus holding switch **45** closed.

Magnet **42** and its switch **43** might well be omitted, and the current from contactor **28** be led direct to magnet **44**; but I consider the interposition of magnet 42 and switch 43 (together constituting a fast-closing slow-release relay) to be advisable, due to the fact that the brief impulse given by contactor 28 might not be of sufficient duration to close switch 45. This brief impulse may be as short as 1/100 of a second, whereas some 1/10 of a second (afforded by the relay) is necessary to be certain to close switch 45, which is to be equipped with heavy-duty power contactors.

65 is a duration-of-current responsive safety cut-out which will be hereinafter described.

The current passing through switch 45 also branches, bypassing contactor 46, to perform the following three functions: First, it rotates motor 36. Secondly, it actuates solenoid 72, thus releasing normally set brake 39, thus permitting motor 36 to rotate winch-drum 16. And, thirdly, it sets a clutch to be hereinafter mentioned, thus starting the operation of the apparatus which will now be described, which apparatus, as already stated, is collectively designated as 47.

Turning to Figure 6, we see that 48 are magnets energized by the current just mentioned. Pinion 49 is rotated by shaft 50, driven by motor 36 of Figure 5. Pinion 49 rotates gear 51, which is freely rotatable and slidable on shaft 52. Integral with gear 51 is the female member 53 of a cone-clutch, the male member 54 of which is rigidly attached to shaft 52. The energizing of magnets 48 attracts gear 51, thus setting cone-clutch 53—54, and thus causing shaft 52 to rotate.

This entire magnetic clutch mechanism (comprising elements 48, 49, 51, 53, and 54, and parts of shafts 50, and 52) is symbolically represented in Figure 5 by a square, numbered collectively 70. The two wires shown in Figure 5 as leading to this symbolic square, are the same as the two wires shown in Figure 6 as leading to magnets 48.

Shaft 52 carries cam 57. When this cam has rotated from its initial setting the predetermined distance to nearly its major radius, this cam touches the control-arm 58 of normally closed contactor 46 (already mentioned in connection with Figure 5), thus opening this switch. This opening deenergizes magnet 44, thus permitting switch 45 to open, thus stopping motor 36, permitting brake 39 to set, and deenergizing magnets 48 of clutch 47. Spring 59 thereupon counter-rotates shaft 52 and cam 57 back to their initial angular position. It is to be noted that contactor 46 remains open until this chain of events, which its opening has initiated, begins the counter-rotation of cam 57. Accordingly, by the time that contactor 46 has thus closed again, the circuit through it is open at switch 45.

The operator, by selectively setting hand wheel 55 and locking the wheel in position by tightening set screw 56, determines the position of the stop 60 which is carried by hand wheel 55. The position of the stop determines the arc through which shaft 52 and cam 57 are to rotate during each feeding operation, for at the cessation of each feeding operation, shaft 52 and cam 57 are returned by spring 59 which counter-rotates the elements until finger 61 carried by the shaft 52 rests against the stop 60. The elements then occupy their original relative position.

The whole system has now reverted to status quo, and is ready to start the whole feeding operation over again when the next momentary impulse is received from contactor 28.

But, during this feeding operation, motor 36 (see now Figures 2 and 3) has rotated winch drum 16 slightly, to pay out a small amount of rope 18.

Thus whenever, due to the increase in the depth of the hole which is being drilled, the resilient support 27 compresses more than normally, the resulting contact of element 31 with button 29 of contactor 28 at the derrick head (see Figure 4) results in the paying out of a predetermined amount of rope, thus restoring the opportunity for optimum impact between tools 25 and the bottom of the hole.

Sometimes when the drill is not drilling, and the tools have been raised somewhat, their mere weight on the rope might close switch 28 constantly for a considerable period. This would, of course, cause motor 36 to operate intermittently to pay out line, until the tools become grounded at the bottom of the hole. But meanwhile the constant current through coil 42 might burn it out. So I provide means such as a heat-responsive or time-responsive cut-out 65 in the line between switch 28 and coil 42. A cam-operated normally-closed switch, similar to switch 46, to be opened whenever shaft 52 departs from its rest position, would be an acceptable alternative.

It is obvious that my invention, with merely minor modifications, could be used to wind-in the rope, rather than pay it out, when the machine is being used to exert an upward, rather than a downward, impact, as (for instance) in pulling piles.

Having now described and illustrated one form of my invention, I wish it to be understood that my invention is not to be limited to the specific form or arrangement of parts herein described and shown.

I claim:

1. In an automatic feed for a cable-tool drill, which drill includes a main frame, a percussion bit, a line operatively supporting the bit, a yieldable member on the main frame supporting the line, a winch-drum on the main frame operatively connected to the line whereby to wind up and pay out said line, and spudding means on the main frame operatively connected to the line whereby to actuate said line to raise and drop the bit; the combination, supportable on the main frame, of: a motor; such drive-connection between the motor and the winch-drum as to cause the motor, whenever running, to drive the winch-drum slowly to pay out line; at least one power-source; a normally-open switch; electrically-actuable means for closing said switch; an operative connection between the yieldable member and the normally-open switch, actuable by and during the yielding of said member beyond a predetermined amount to close said switch; a normally-closed switch; a shiftable member, operatively associated with the normally-closed switch in such manner as to open said normally-closed switch as soon as said member has shifted a predetermined amount; an electrically actuable clutch to operatively connect the motor to the shiftable member, to shift said member; an electric circuit from an electric power source through the normally-closed switch and the normally-open switch in series relation, to the electric closing means for said normally-open switch, whereby when this circuit has been closed by the closing of the normally-opened switch, the electric closing means will maintain it closed until the normally-closed switch opens; an electric circuit from an electric power-source, through the normally-open switch, to the motor; an elec-

tric circuit from an electric power source, through the normally-open switch, to the clutch; and means to restore the shiftable member to its original position whenever the clutch is released.

2. An automatic feed according to claim 1, further characterized by the fact that the operative connection between the yieldable member and the normally-open switch comprises; an electrical contactor; a cooperating contact carried by the yieldable member; and an electric circuit from an electric power source, through the contactor, to the electric closing means for the normally-open switch.

3. An automatic feed according to claim 2, further characterized by having, in the last-mentioned circuit, an electric relay interposed between the contactor and the electric closing means for the normally-open switch.

4. An automatic feed according to claim 1, further characterized by the fact that the operative connection between the yieldable member and the normally-open switch comprises: an electrical contactor; a cooperating contact carried by the yieldable member; a heat-responsive safety cut-out; and an electric circuit from an electric power source, through the contactor and the cut-out in series relation, to the electric closing means for the normally-open switch.

5. An automatic feed according to claim 1, further characterized by the fact that the operative connection between the yieldable member and the normally-open switch comprises: an electrical contactor; a cooperating contact carried by the yieldable member; a duration-of-current responsive safety cut-out; and an electric circuit from an electric power source, through the contactor and the cut-out in series relation, to the electric closing means for the normally-open switch.

6. An automatic feed according to claim 1; further characterized by having: a normally-set brake for the motor; electrically-actuable means for releasing said brake; and an electric circuit from an electric power means, through the normally-open switch, to the releasing means.

7. An automatic feed according to claim 1, further characterized by the fact that the shiftable member is rotatable; that the normally-closed switch is a closed contactor; that there is a cooperating contact rotatably carried by the shiftable member, to open said contactor by contact therewith; that there is an adjustable stop, and a contact for said stop, one being carried by the shiftable member and the other being fixed with respect to the rotation of the shiftable member; and that the means to restore the shiftable member to its original position is a spring so attached to the shiftable member as to bias said member to reversely rotate until the stop and its contact abut each other.

8. In the winch of a cable-tool drill, the combination of: a winch-drum; a planetary drive therefor, comprising planet gears and three coaxial rotating elements, namely, two non-planet gears and a spider on which the planet gears are journaled; a constant drive-connection between one of the three coaxial rotating elements and the winch drum; means to drive a second one of said three elements at will; means alternatively to brake said second element at will; an electric motor coupled to the third one of said three elements to drive said third element slowly, and in the direction to cause the winch-drum to pay out; and control-means for the electric motor, said control-means comprising: a normally-open switch; electrically-actuable means for holding said switch closed; a normally-closed switch; an electric circuit from an electric power-source, through the normally-closed switch and the normally-open switch in series relation, to the electrically-actuable means, whereby when this circuit has been closed by the closing of the normally-open switch, this electrically-actuable means will maintain it closed until the normally-closed switch opens; a shiftable member, operatively associated with the normally-closed switch in such manner as to open said normally-closed switch as soon as said member has shifted a predetermined amount; an electrically-actuable clutch to operatively connect the motor to the shiftable member, to shift said member; an electric circuit from an electric power-source, through the normally-open switch, to the motor; an electric circuit from an electric power-source, through the normally-open switch, to the clutch; and means to restore the shiftable member to its original position whenever and as soon as the clutch is released.

9. In an automatic feed for a cable-tool drill, which drill includes a main frame, a percussion bit, a line operatively supporting the bit, a yieldable member on the main frame supporting the line, a winch-drum on the main frame operatively connected to the line whereby to wind up and pay out said line, and spudding means on the main frame operatively connected to the line whereby to actuate said line to raise and drop the bit; the combination, supportable on the main frame, of: a driver to drive the winch-drum slowly to pay out line; a control operatively connecting the yieldable member and the driver, and actuable by the yielding of the yieldable member beyond a predetermined amount to start the driver; and a drive-limiting device, actuable by the driver having driven a predetermined amount, to stop the driving and to reset the control into the condition it was in before it was actuated by the yielding of the yieldable member.

10. An automatic feed according to claim 9, further characterized by the fact that the drill includes a mast; and that the yieldable member comprises a sheave for the drill line, and a resilient support for the sheave on the mast.

11. An instrumentality for maintaining a once-closed electric motor circuit until the motor has rotated a predetermined amount, and for thereupon resetting the entire instrumentality into a condition to repeat the cycle whenever and as soon as the circuit is again closed, which instrumentality comprises: the electric motor; a normally-open switch; electrically actuable means for holding said switch closed; a normally-closed switch; an electric circuit from an electric power-source, through the normally-closed switch and the normally-open switch in series relation, to the electrically actuable means, whereby when this circuit has been closed by the closing of the normally-open switch, this electrically-actuable means will maintain it closed until the normally-closed switch opens; a shiftable member, operatively associated with the normally-closed switch in such manner as to open said normally-closed switch as soon as said member has shifted a predetermined amount; an electrically-actuable clutch to operatively connect the motor to the shiftable member, to shift said member; an electric circuit from an electric power-source, through the normally-open switch, to the motor; an electric circuit from an electric power-source, through the normally-open switch, to the clutch;

and means to restore the shiftable member to its original position whenever and as soon as the clutch is released.

12. A winch according to claim 8, further characterized by having: a normally-set brake to brake the third coaxial rotating element; electrically-actuable means for unsetting this brake; and an electric circuit from an electric power-source, through the normally-open switch, to this electrically-actuable means, whereby, so long as the normally-open switch is open, the brake will remain set, and whenever the normally-open switch is closed, the brake will be unset.

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