

Nov. 8, 1932.

C. FIELD

1,886,665

MULTIPLE UNIT ELECTRIC DRIVE SYSTEM

Original Filed June 18, 1927

4 Sheets-Sheet 2

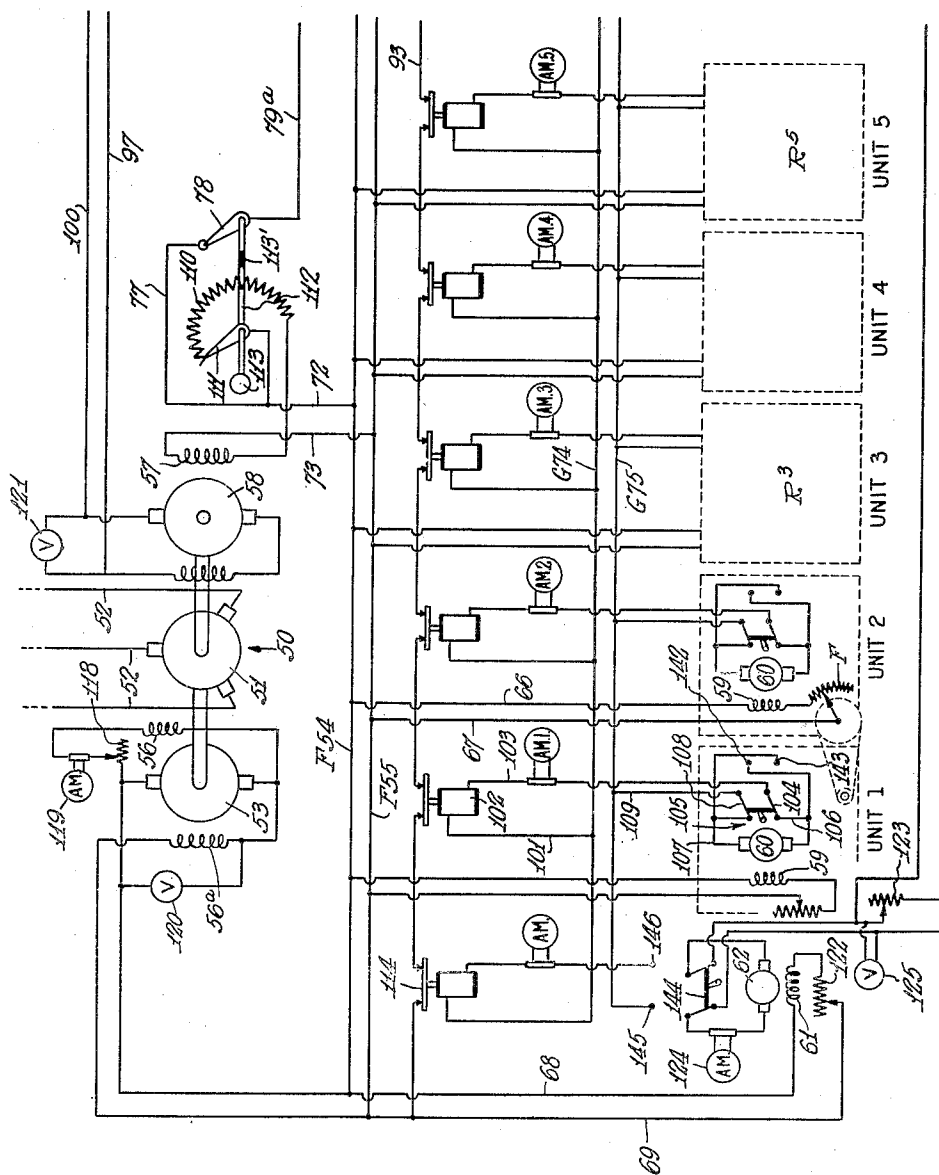


Fig. 2.

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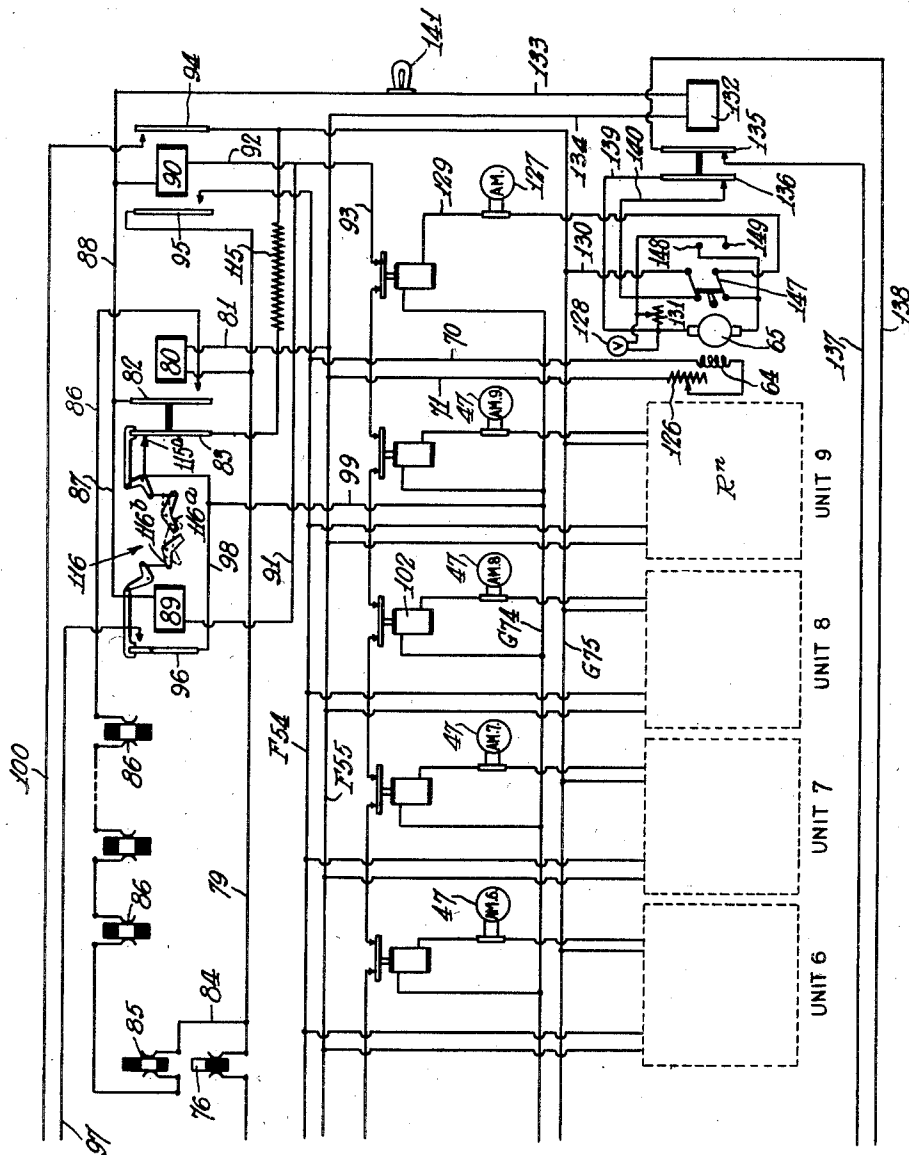
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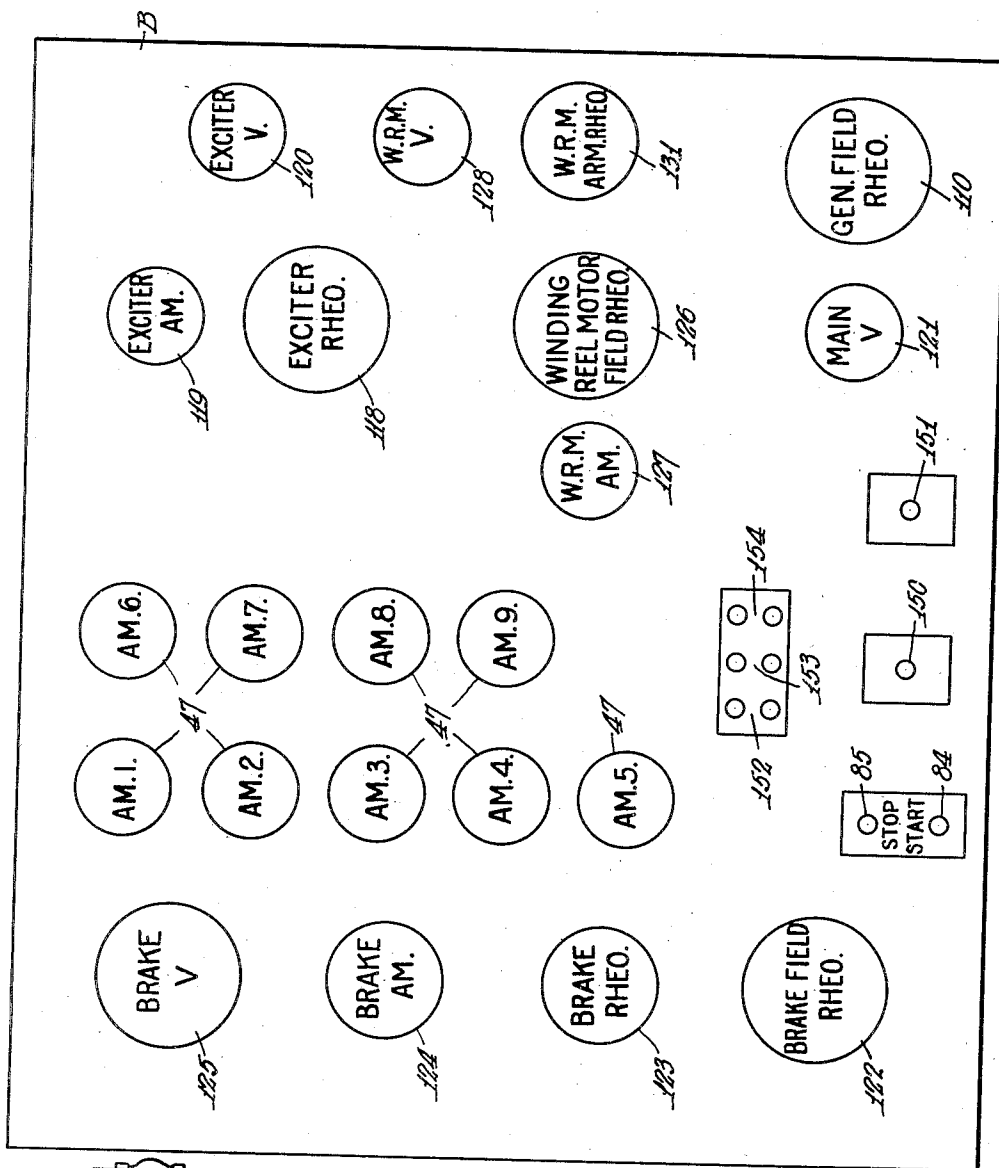


FIG. 4.

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MULTIPLE UNIT ELECTRIC DRIVE SYSTEM

Original application filed June 18, 1927. Serial No. 199,692. Divided and this application filed August 3, 1928. Serial No. 297,319.

The electrical system of my present invention has specialized utility in the operation of a manufacturing plant such as that of my prior Patent No. 1,608,478 dated November 23, 1926. While the invention is more particularly concerned with the electrical operating and control of a metal wool producing plant, such as described in my said patent, it may have application to other plants functioning in analogous manner.

Generically considered, the plant, to the electric operation of which the present invention relates, includes a series of units for successively treating or mechanically working on a continuous strand or length of material or stock, threaded, drawn or wound in tandem upon, over or through the several units, the stock being preferably fed from a supply unit and the waste remnant, if any, being preferably gathered in a terminal unit. In the specific steel wool manufacturing plant with which the invention is more especially concerned, a length of metal wire is fed from a supply reel in succession about a series of large traction rotors with each of which a series of cutting blades coacts, the thin scrap residue of wire remaining after passage over various rotors, being reeled upon a waste reel.

For operating the mechanism, separate electric motors actuate the several traction rotors and another motor preferably actuates the waste reel. The supply reel is preferably actuated by tension from the contiguous traction rotor, a braking dynamo being preferably associated with said supply reel to prevent over-running of the latter.

To avoid injury due to transient or momentary variations in the character or resistance of the stock to be treated at any one of the several units, means is provided preferably comprising "dancer" rollers associated with the respective units about which the stock is wound, each roller interlocked with a

rheostat in the field circuit of the corresponding driving motor to automatically cut out or add resistance in order to compensate for localized retardation or acceleration in speed otherwise resulting from momentary increase or decrease in load on any one or more of the machines.

It is among the objects of the invention to provide electric operating and control means for sustained smooth operation of a plant of the above type, by which the momentary speeds of the constituent plant elements are accurately inter-related to prevent on the one hand a rupturing tension upon the stock or on the other hand, a slackening, snarling or knotting of the stock, while at the same time permitting of a great range of speeds according to conditions of operation.

Another object is to provide a system of the above type in which the running plant can be rapidly accelerated to full speed on the one hand, and on the other hand brought to a stop from full speed, by uniform acceleration or retardation respectively of each of the distinct driving machines and without rupturing stress on the stock, and in which such action may be accomplished automatically upon overload on any one of the machines, or manually and at will from any part of the plant.

Another object is to provide an electric system of the above type, the operation of all elements of which can be readily controlled from a central source or board.

According to one feature of the invention, the field circuits of the various driving motors are connected in parallel to one source of current and the armatures of the various motors connected in parallel to a distinct source of current. Preferably the current for the armature is derived from the generator element of a motor generator set which includes a synchronous motor, the separate field exciter of which serves to energize in addition the fields of the various driving motors.

control is, accordingly, provided between each rotor and the next. This control comprises an adjustable field rheostat F for the driving motor, the setting of which is controlled by the tension on the wire. Specifically, the length of wire between each traction rotor and the next is looped about a floating or "dancer" roller 40 and back over a stationary roller 41 thence to the transfer guide roller 42 below the succeeding traction rotor. The floating or dancer roller 40 is urged outward away from the associated rotor by means of a weight 43 supported on a sprocket chain 44 secured at one end to the dancer roller, fixed at its opposite end 45, and passing over a sprocket wheel 46 between the weight and the dancer roller. Sprocket 46 is connected by means of a sprocket chain 47 with a sprocket wheel 48 operating the field rheostat F. In operation, when any rotor tends to be retarded, the increased tension will draw the corresponding dancer roller inward and through the sprocket connection will cut out field resistance and provide added power to the motor to compensate for the added load. The converse operation occurs with decrease of tension. The tension control arrangement per se is the subject-matter of a separate division Serial No. 297,315 filed August 3, 1928 of my parent application, Serial No. 199,692 filed June 18th, 1927, and the tension regulator is more fully described therein.

The waste reel W preferably has a driving motor quite similar to that of the traction rotors and including an armature 65 and a field 64. The field has an adjustable rheostat 126, which may be manually controlled. If desired the field resistance may be automatically controlled from a dancer roller as in the case of the traction rotors, and this feature is more fully described below in connection with Fig. 6. The armature 65 also has an adjustable rheostat 131, the purpose of which will appear below.

The wire is drawn from the supply reel S preferably by tension transmitted thereto from the first traction rotor R¹. To control the delivery from the supply reel S and prevent over-running or excessive drag of the latter, a braking dynamo is provided therefor. The braking dynamo has a field 61 with an adjustable rheostat 122, and an armature 65 with an adjustable load 123 across the terminals thereof. Both rheostat 122 and load 123 are manually adjustable in accordance with the operation of the plant. As will be described hereinafter in connection with Figs. 2 and 5, the field rheostat may be automatically controlled by a dancer roller arrangement, and the load short circuited for purposes appearing hereinafter.

In the present invention, I claim more particularly the electrical installation controlling the starting, running, stopping and su-

pervision of the plant. I also claim herein said electrical operating and supervision system in combination with the tension control above described.

The electrical system for operating the installation of Fig. 1 is illustrated in Figs. 1 to 6 and any desired speed from 5 feet to 800 feet per minute may be obtained thereby. The beds or traction rotors moreover may be brought to rest from a high speed within three feet of feed of the wire and with no slippage of the wire nor change of positions of the dancer rollers.

The machine is operated by a motor generator set 50 including a synchronous motor 51 which may be 3-phase 60-cycle and taking 4150 volts, and the machine is started by connecting this motor to the feed lines 52 from a source of electric energy in any well known manner. An exciter 53 driven by said motor 51, supplies energy to lines or busbars F54 and F55 and energizes the fields 56 and 56a of the exciter. The fields of various electrical machines of the system are preferably connected across lines or busbars F54 and F55 to be energized therefrom. These fields include field 57 of a generator 58, fields 59 of the bed driving motors 60, field 61 of the braking generator 62, connected with the wire feeding reel or supply reel S and field 64 of the motor driving the scrap winding reel W. Each field 59 of the bed driving motors 60 is connected with the lines F54 and F55 by branches 66 and 67 respectively; the field 61 of the braking-generator 62 is connected to said lines by feeds 68 and 69; the field 64 of the winding reel motor 65 is connected by branches 70 and 71; and the generator field 57 by branches 72 and 73, to lines F54 and F55.

The generator 58 supplies energy to lines or busbars G74—G75 across which the armatures of the motors are connected. The current from the generator to the busbars includes a start button or switch 76 which is normally open, but when operative, permits the current to flow from the supply line F54 through branches 72 and 77 switch 78 conductor 79a, the starting switch 76, conductor 79 and solenoid 80, to energize the latter. The current returns from solenoid 80 through conductor 81 to line F55 and to exciter 53. Upon the energization of solenoid 80, armatures 82 and 83 are operated. The armature 82 closes a circuit over which energy is supplied from the line 79 (which, it will be remembered, is connected to the supply line F54), through branch 84, normally closed stop switches 85 and 86 connected in the branch 84, through armature 82, conductors 87 and 88, coils 89 and 90 of electrically operated switches conductors 91 and 92 to a return branch 93 connected to the line F55, thus energizing the coils 89 and 90 to pull up armatures 94, 95 and 96 and thus connecting lines G74 and G75

with the generator 58. Said generator is connected to the line G74 by a conductor 97, armature 96, conductor 98, and a branch 99. The generator 58 is connected to the line G75 by a line 100, and armature 94 which is connected to the line G75. The bed driving motors 60 which may be either shunt or compound wound, are connected in parallel with the current supply lines G74 and G75, each by a conductor 101, an overload relay 102, a conductor 103, one leg 104 of a switch 105, conductor 106, motor conductor 107, leg 108 of said switch, and conductor 109, which is connected with the line G75. Thus the armatures of the bed driving motors 60 receive their energy from the generator 58.

To control the voltage on the armatures of the bed driving motors 60 and thus bring them gradually to the desired speed, which varies according to the material to be cut, there is provided a field rheostat 110 having a wiper or brush 111 on a shaft 112 rotatable by a finger piece 113 by which the resistance in the generator field circuit may be reduced gradually, to increase the voltage of the generator 58.

The switch element 78, in series with the start button 76, is secured to the rheostat shaft 112 and insulated therefrom at 113' and is arranged with respect to the wiper 111, so that the generator field 57 is at a minimum excitation when the switch closes the line 79, 79a, and thus the bed driving motors 60 may be started with a low voltage upon the closing of the start switch 76. It will be understood that if the switch 76 is closed while the switch 78 is open, the solenoid 80 is not energized and consequently the generator 58 is not connected with the lines G74 and G75 which lines, it will be remembered, are connected with the generator upon the operation of the coils 89 and 90, the latter being in turn operated by the energization of the solenoid 80.

While the switch 78 must be closed and all of the field resistances of the generator therefore cut in, before the motor armatures can be energized, cutting out of said field resistances does not open the motor circuit, by reason of the circuit relations now to be set forth.

As soon as solenoid 80 is closed through main F55, leads 79, 79a, switch 78, conductors 77 and 72 back to main F54, armature 82 is attracted thereby. This brings about energization of coils 89 and 90 through circuits closed through switch 82 and conductor 86', switches 86 and 85, leads 84 and 79, lead 79a, switch 78 and lead 72 and coils 89 and 90 attract their respective armatures 96 and 95. When switch 78 is now opened to cut resistance out of the generator field, a circuit still exists from lead F54 to switch 95, leads 79 and 84, switches 85 and 86, lead 86' and switch 82, and in parallel

through leads 87 and 88 respectively to coils 89 and 90 and conductors 91 and 92 in parallel to lead 93 which is connected to the opposite main F55. The solenoid 80 remains energized by current from lead F55 through solenoid 80, the right end of the lead 79, and switch 95 and back to lead F54.

The relays 102 serve automatically to break the generator circuit when any one of the traction rotors becomes over-loaded, said relays being connected in multiple with the lines G74 and G75 and each in series with each armature of the associated motor 60. Each relay 102 is provided with an armature 114, all of the armatures or switches 114 being connected in series in the line 93 so that the circuit through relay coils 89 and 90 may be automatically broken by an actuation of any one of the armatures 102 when there is an over-load on the associated bed or traction wheel. The generator 58 is thus disconnected from the bed driving motors.

The switches or push buttons 86 previously referred to are connected in series with the stop button 85 in the line 84, so as to facilitate the stopping of the machine manually, said switches being distributed throughout the plant in a manner so that at no time can anyone of the several attendants of the crew be out of reaching distance of at least one of the switches to stop the plant if necessary.

As soon as the current supplied to the motors is cut off, said motors continue to run due to the inertia of the connected parts such as the heavy traction rotors. The motors then operate as generators to supply current to the conductors G74 and G75. To expend the energy thus supplied and also bring the traction rotors to a stop within a short distance of travel, there is automatically connected to the conductors G74 and G75, a dynamic brake resistance 115 (Fig. 3) one end of which is connected to the conductor G75, the other end being connected to the armature 83 of the solenoid 80. While said solenoid is energized, the armature 83 is held away from contact 115a, which contact is connected, by branch 99, to the conductor G74. Upon the de-energization of the solenoid 80, as above described, the armature 83 drops back against the contact 115a, thus closing the circuit including the conductors G74, G75 and dynamic brake 115. When the solenoid 80 is energized upon the operation of the start button 76, as previously described, the armature 83 is operated to disconnect the dynamic brake 115 from the bed driving motors.

An interlocking device 116 (Fig. 3) may be provided to prevent connection of the dynamic brake resistance 115 across the main generator armature conductors 97 and 100 when the traction bed driving motors are operating as motors. Said interlocking device

may include lever elements 116a and 116b which are connected to the armatures 83 and 96 to be operated thereby to the dotted line positions so that the armature 83 cannot return to contact 115a until the coil 89 is de-energized. This device is not claimed herein and is more fully described in my prior application 199,692 aforesaid.

Various ammeters and voltmeters for the different machines are arranged on a central control board B (Fig. 4) together with adjusting instrumentalities to enable a supervisor to readily observe and correct the operation of the plant. To indicate the load on each bed, there is provided for each shaving unit, an ammeter 47. The generator field rheostat 110 and the start and stop buttons 84 and 85 may also be mounted on the control or instrument board under the control of the supervisor, as well as an exciter field rheostat 118, an exciter ammeter 119, and an exciter voltmeter 120. The voltmeter 121 of the generator 58 also is mounted on the board B.

The reel motor 62 as previously stated, runs as a generator by being run backwards, while the wire is being drawn from the reel S into the shaving machine, thus producing a braking action on the reel. There is connected in series with the field 61 (Figs. 2 and 4) a rheostat 122. A variable rheostat 123 is connected across the armature of the reel motor 62 to vary the braking effect of the reel motors as desired. An ammeter 124 and a voltmeter 125 may be connected in the armature circuit of said reel motor; the rheostats 122 and 123 being adjusted according to the readings of the ammeter 124 and voltmeter 125; the field rheostat 122, rheostat 123, ammeter 124 and voltmeter 125 all being mounted on the supervisor's control board B.

There is provided a rheostat 126 for the field 64 of the motor 65 associated with the winding or waste reel W which is adjustable in accordance with the reading of an ammeter 127 and a voltmeter 128, both mounted on the control board B, and connected in the armature circuit including the conductors 129 and 130 which conductors are connected to the lines G74 and G75 extending from the generator 58. A rheostat 131, also mounted on the control board, is connected in the armature circuit.

A relay 132 (Fig. 3) is connected, by branches 133 and 134, to branch 88 and line F55, to be energized upon the energization of the solenoid 80 which, it will be remembered, is effected by the closing of the start switch 76. The relay 132 operates two armatures 135 and 136, the armature 135 opening a circuit including leads 137 and 138 and the armature 136 opening a circuit including conductors 139 and 140, so that the current supplied to the motor 65 passes through the rheostat 131 while the machine is running.

As soon as the solenoid 80 is de-energized,

which may be effected by operating the switch 85 or any one of the switches 86, or by the operation of any one of the overload relays 102, the relay 132 is also de-energized and the armatures 135 and 136 drop back to close their respective circuits, thus shunting out the rheostat 131 and closing the armature circuit of braking generator 62 containing resistance 123, thus causing the braking generator 62 and motor 65 to come to rest at approximately the same time as the traction bed motors 60. This follows because motor 65 is then connected, in parallel with the bed motors, across the dynamic brake 115, without additional resistance, and the armature of braking generator 62 is then short-circuited. A signal, which may be in the form of a light 141, may be connected in series with the relay 132 to indicate that the armature current is on busses G74 and G75 supplying the bed driving motors.

It should be understood that, with this arrangement of dynamic brake, each of the motors 60 and 65 is acted upon individually, thus preventing over-running and breaking of the wire.

Slack usually obtained after threading the machine may be taken up by running the beds reversely to the cutting direction, or backwards. To this end, the switches 104 may be thrown to poles 142 and 143 to reverse the current through the motor armature and thus reverse the rotation of the motor to drive the connected beds backwards. To drive the supply reel braking generator 62 backward, to wind up the wire and take up slack in advance of the first bed, there is provided a switch 144 in the armature circuit, which may be thrown to poles 145 and 146 to connect the said machine with the lines G74 and G75, thus to be driven as a motor.

The winding reel W may also be rotated backward to unroll some of the wire therefrom, for instance, when the wire is to be welded to wire extending from the last bed after a break. To this end, a switch 147 may be thrown to poles 148 and 149 to reverse the current through the armature and thus drive the motor in the opposite direction.

As the wire unwinds from the delivery reel S the diameter of the coil of wire decreases and braking of the reel must be correspondingly decreased. The winding of the generator 62, then running as a braking generator, is such as to afford a certain amount of the required variation of the braking effect, but beyond certain limits the variation of the braking effect is regulated by the rheostats 122 and 123.

Similarly the diameter of the coil on the winding reel W increases while the wire is being wound thereon and more power is required to keep the same pull on the wire. The winding of the motor 65 is such as to compensate for this automatically within certain

limits, and beyond these limits the rheostats 126 and 131 may be regulated manually to assist in maintaining the constant pull on the wire, about four such adjustments being required for a long coil. Instead of such hand regulation, the speed of the winding reel W may be regulated automatically, (See Fig. 6) by arranging in series with the manually adjustable field rheostat 126, a rheostat 126' the setting of which is controlled by means of a dancer roller 40 w, substantially as in Fig. 1. The manually operated field resistance 126 and manually operated armature resistance 131 may be used with the automatically controlled rheostat 126' when cutting certain kinds of material. Resistance at 131 is very useful to steady action of winding reel which tends to give a fluctuating pull on the wire because of its traversing, latching and other internal mechanisms necessary for level winding the wire.

The braking tension of the supply reel S may also be controlled automatically by means including a dancer roll 40 s (See Fig. 5) as in Fig. 1 operating on a rheostat 122'. In this case, the variation in the size of the loop is caused by increasing effectiveness of the braking means due to diminishing radius (leverage) of the supply coil on reel S as well as by variations in surface speed of the rotor R'. The bodily movement of the dancer roller 40 s adjusts rheostat 122' which may be connected in series with the field rheostat 122 of the motor 62, which is then being rotated by the wire and functioning as a generator to afford the desired braking effect.

It will be understood that the automatic rheostat 122' may be used either with or without the manual rheostat 122 and that the entire automatic control is preferable in certain cases for cutting certain kinds of material.

Stop switch or button 150 may be mounted on the instrument board B, and connected in the power circuit of synchronous motor 51 to stop the latter at will. A stop button switch 151 may also be provided on the instrument board and connected in the circuit of a motor (not shown) to drive an air compressor (not shown) which supplies the air to the nozzles (not shown) of the traction rotors.

Push button switches 152, 153 and 154 may also be mounted on the instrument board B, and are connected to red, orange and green lights (not shown) which may be located at various stations in the plant for use in directing the crew during operations.

I claim:—

1. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the same length of wire to draw said wire through the machine from said reel, separate electric motors to rotate said units, each motor having an armature and a field, in combination

with an electrical control system including connections and a source of current for feeding the armatures thereof in parallel, a distinct source of current and connections for energizing the fields thereof in parallel, and means for setting the entire group of motors out of operation upon overload on any one of said motors.

2. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system including a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, a motor generator, said armatures supplied in parallel with current derived from the motor generator, a separate exciter for energizing the fields of said motors in parallel, and a relay energized from said exciter for closing the circuit from the generator element of the motor generator to the various motor armatures.

3. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system including a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, a motor generator, the armatures of said motors being connected in parallel thereto, a separate exciter for energizing the fields of the motor generator and of the various electric motors, a relay for controlling the circuit to the motor armatures, and manually controlled means for closing the circuit from the exciter to said relay.

4. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system including a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, a motor generator including a field having a variable resistance therein, the driving motors connected in parallel to the generator element of said motor generator, an exciting machine connected to energize the fields of said motors, a relay adapted to be energized from said exciting machine and controlling closure of the circuit from the motor generator to the driving motor armatures, and means interlocked with the field resistance of the generator element of the motor-generator, for preventing initial energization of the relay from the exciter when less than the full field resistance is in circuit.

5. In an installation for making metal wool, including a supply reel, a series of

rotatable units operating successively on the same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system including a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, a motor generator including a generator element to which the various motor armatures are connected in parallel, a separate exciter connected to energize the fields of the motor-generator and of the electric motors in parallel, an interlocking relay controlling the armature circuits of said motors from said exciter, and a separate overload relay in the armature circuit of each of said motors, the switch elements of said relay being connected in series with each other and with said interlocking relay.

6. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system including a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, a motor generator connected in parallel with said armatures, an exciter machine connected to the fields of the various motors and of the motor-generator in parallel, an interlock relay in the field exciter circuit, adapted to close the circuits to the armatures, and a set of overload relays, one for each of the driving motors, each of said overload relays having a switch, said switches all connected in series with the interlock relay to disable the various motors upon overload on any one of them.

7. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system including a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, a motor generator connected in parallel with said armatures, an exciter machine connected to the fields of the various motors and of the motor-generator in parallel, an interlock relay in the field exciter circuit, adapted to close the circuits to the armatures, and a set of overload relays, one for each of the driving motors, each of said overload relays having a switch, said switches all connected in series with the interlock relay to disable the various motors upon overload on any one of them, and a push button normally interrupting the circuit from the exciter to the interlocking relay and adapted upon depression thereof to energize said relay for starting the motors.

8. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the

same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system including a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, a motor generator connected in parallel with said armatures, an exciter machine connected to the fields of the various motors and of the motor generator in parallel, an interlock relay in the field exciter circuit, adapted to close the circuits to the armatures, and a set of overload relays, one for each of the driving motors, each of said overload relays having a switch, said switches all connected in series with the interlock relay to disable the various motors upon overload on any one of them, the generator element of said motor generator having a field rheostat provided with an adjustable arm, and means whereby the circuit to the interlocking relay cannot be closed when the arm is away from the position of maximum field resistance.

9. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system including a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, a common source of current for operating the several motors in parallel, each of said motors having an overload relay in the armature circuit thereof, means interlocking said relays with said source of current to open the connection to all of said motors upon overload upon any one thereof, and automatic means associated with the several units to selectively vary the power of the motor to compensate for local variations in load.

10. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system including a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, a common source of current for operating the same in parallel, means for interrupting the energizing circuit to all of said motors concurrently, and a dynamic brake, common to all of said motors and interlocked with said interrupting means to bring the motors to a prompt stop substantially concurrently.

11. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system including a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, an exciter for supply-

ing the various fields in parallel, a source of electric current for supplying the various armatures in parallel, a relay in said exciter circuit for controlling the energization of the various motor armatures, and a pair of relays inter-related with said first relay, one in each lead from the source of current to the motor armatures.

12. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system including a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, a dynamic brake common to the various motor armatures, a relay arranged when energized to open said brake circuit, and other relay means inter-related with said relay to energize the electric motors concurrently with the opening of said dynamic brake circuit.

13. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system including a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, a dynamic brake common to the various motor armatures, a relay arranged when energized to open said brake circuit, and other relay means inter-related with said relay to energize the electric motors concurrently with the opening of said dynamic brake circuit, the operation of said first relay controlling the energization of said relay means.

14. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system including a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, a source of current for energizing said various armatures in parallel, a distinct source of current for energizing said various fields in parallel, a dynamic brake circuit connected across the terminals of the various motor armatures in parallel, and a relay energized from the field circuit supply and arranged simultaneously to open the dynamic brake circuit and to close the circuit of each of said driving motor armatures.

15. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system in-

cluding a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, a source of current for energizing said various fields in parallel, another source of current for energizing said various armatures in parallel, a dynamic brake across the armature terminals in parallel, of the various motors, a relay inter-relating the field energizing with the armature energizing circuit, said relay being connected to concurrently effect opening of the dynamic brake circuit and closing of the armature circuit, and means correlated with the dynamic brake control to prevent closure of the latter across the terminals from which the motor armatures are energized.

16. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system including a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, the latter energized, the former carrying an electric load to serve as a current generating brake upon power operation of the associated mechanism, and means for automatically short-circuiting said armature upon disabling of the source of operative power.

17. In a plant for treatment of a continuous strand of material and comprising a supply reel, a plurality of successive treatment units and a waste or scrap reel, all connected in tandem; a braking machine with field and armature the combination therewith of electrical operating and control means therefor, including distinct electric driving means for each of the units and for the waste reel, an electric brake for the supply reel, comprising an energized field, and an armature having a closed loaded circuit, means for simultaneously opening the circuit for de-energizing said various motors; and means interlocked therewith for simultaneously short-circuiting the armature of the brake machine.

18. In a plant for treatment of a continuous strand of material and comprising a supply reel, a plurality of successive treatment units and a waste or scrap reel, all connected in tandem; the combination therewith of electric operating and control means therefor, including distinct electrical driving means for each of the units and for the waste reel, an electric brake for the supply reel comprising an energized field, and an armature having a closed loaded circuit, means for simultaneously opening the circuits to the various motors to de-energize the same, means interlocked with said last-named means for simultaneously applying a dynamic brake across the terminals of said various motors in parallel and further means interlocked with said

last-named means for short-circuiting the braking machine.

19. In a plant of the character described including a series of operating units and a terminal unit, a separate electric driving motor for each of said units, each of said motors including an armature and a field, a source of current for energizing said fields in parallel, a source of current for energizing said armatures in parallel, a control relay in said field energizing circuit controlling the circuit to the armatures of said unit driving motors, and a relay inter-related with said control relay to establish an operating circuit connection to the armature of said terminal unit driving motor.

20. In a plant of the character described including a series of operating units and a terminal unit, a separate electric driving motor for each of said units, each of said motors including an armature and a field, a source of current for energizing said fields in parallel, a source of current for energizing said armatures in parallel, a relay in said field energizing circuit, a pair of relays inter-related therewith, the latter relays controlling the feed of current from the source of current to the armatures of the various unit driving motors, and an additional relay inter-related with said first relay for controlling the feed of current to the terminal unit driving motor.

21. In an installation of the character including a stock supply unit, a waste gathering unit and intervening stock treating units, an electric operating and control system therefor including a driving motor, for the waste gathering unit, and an electric braking machine for the stock supply unit, said braking machine including an armature having a closed loaded external circuit and an energized field, a source of current for driving the motor of the waste gathering unit, means for setting the operating installation out of action, and means controlled therefrom for simultaneously short-circuiting the armature of the braking dynamo and closing a dynamic load across the terminals of the driving motor armature.

22. In an installation of the character including a stock supply unit, a waste gathering unit and intervening stock treating units, an electric operating and control system therefor including a separate driving motor for each of said stock treating units, a driving motor for said stock gathering unit and a braking dynamo for said stock supply unit, said braking dynamo having a closed loaded armature circuit, a common source of current for energizing the fields of the respective machines, a relay in said field energizing circuit, for effecting closure of the circuit to said armatures, a dynamic brake circuit across said various armatures automatically rendered inactive by said relay and a short circuit connection across the armature of said

braking dynamo, inter-related with said relay to be opened upon energization of the latter.

23. In an installation for making metal wool, including a plurality of traction rotors to feed a wire, means to drive said rotors, means to regulate the speed of said rotors, a supply reel from which the wire extends to the first traction rotor, a generator connected to the supply reel to serve as a brake therefor, a rheostat to vary the braking effect of said generator between certain limits to compensate for the gradually decreasing diameter of the coil of wire on the supply reel, a winding reel to which the wire is conducted from the last traction wheel, an electric motor to drive the winding reel, and a rheostat to vary the pulling effect of the last named motor between certain limits to compensate for the increasing diameter of the coil of wire being formed on the receiving reel.

24. In an installation for making metal wool, including a series of rotatable beds to feed a wire through the machine, the wire extending from one bed to another, electric motors to drive said beds, and a dynamic brake connectable automatically to said motors to quickly arrest the rotating beds when the power is shut off from the motors.

25. In an installation for making metal wool, including a series of rotatable beds to feed a wire through the machine, the wire extending from one of said beds to another, electric motors to drive said beds, a motor circuit to which all of the motors are connected, means to close said circuit to drive said motors, means to open said circuit to shut off the driving current, and a dynamic brake connectable automatically in the motor circuit when the driving current is shut off to quickly arrest the beds.

26. In an installation for making metal wool, including a plurality of shaving units, each feeding successive portions of the same length of wire, a central electric station, means at said central station to start and stop said units simultaneously, at approximately the same rates of feed for the wire, and means at said central station to indicate the work being done by each unit.

27. In an installation for making metal wool, including a plurality of shaving units, each feeding successive portions of the same length of wire, a central electric station, means at said central station to start and stop said units simultaneously, at approximately the same rates of feed for the wire, and automatic means for separately regulating the speeds of successive units, to cause the speed of one to vary in accordance with the speed of another.

28. In an installation for making metal wool, including a supply reel, a series of rotatable units operating successively on the

same length of wire to draw said wire through the machine from said reel, in combination with an electrical control system including a set of driving motors, one for each of said rotatable units, each motor having an armature and a field, a common generator for supplying current to the motors, said generator having a field of adjustable resistance, a brush controlling said field resistance, a control relay for said motors in series with the terminal contact of said brush, to assure full resistance in the generator field circuit when the motors are started, and means under control of said relay for maintaining the latter energized independently of the position of said brush.

29. In a metal wool producing installation of the type comprising a series of traction rotors adapted to have a strand of wire wound thereabout; the combination of an electrical operating and control system therefor, comprising a separate electric motor for each traction rotor, a common generator for energizing the armatures of said various motors in parallel, and manually controlled means for reversing the rotation of said various motors to take up any slack in the wire incurred in threading the installation.

30. In an installation of the character described an electrical operating and control system therefor comprising a group of driving motors, each having an armature and a field, each field having a variable resistance, an exciter for energizing said fields in parallel, means responsive to operating conditions of the installation for automatically controlling the field resistances of the several motors, a source of current feeding the various armatures of said motors in parallel, and means for varying the voltage of said source.

31. In an installation of the character described an electrical operating and control system therefor comprising a group of operating motors, each having an armature and a field, each field having a variable resistance, an exciter for energizing said fields in parallel, means responsive to operating conditions of the installation for automatically controlling the field resistance of the several motors, a source of current feeding the various armatures of said motors in parallel, means for varying the voltage applied to said armatures, each of said armatures having a switch for reversing the direction of rotation of the respective motors.

32. In a wool cutting installation of the character described comprising a supply reel and a succession of traction rotors, the combination therewith of electric operating and control means therefor comprising a separate electrical motor for each of said traction rotors, a supply circuit for energizing said motors in parallel and a dynamo connected to the supply reel, each of said motors and

said dynamo having a field, the armature of said dynamo having an external circuit to act as a brake for controlling the rate of feed from the reel, and means for reversing the direction of rotation of said motors in order to take up slack at the traction rotors, and for connecting the armature of said supply reel dynamo across said supply circuit to operate said dynamo as a motor for taking up the slack at the supply reel.

Signed at New York, in the county of New York and State of New York, this 31st day of July, 1928.

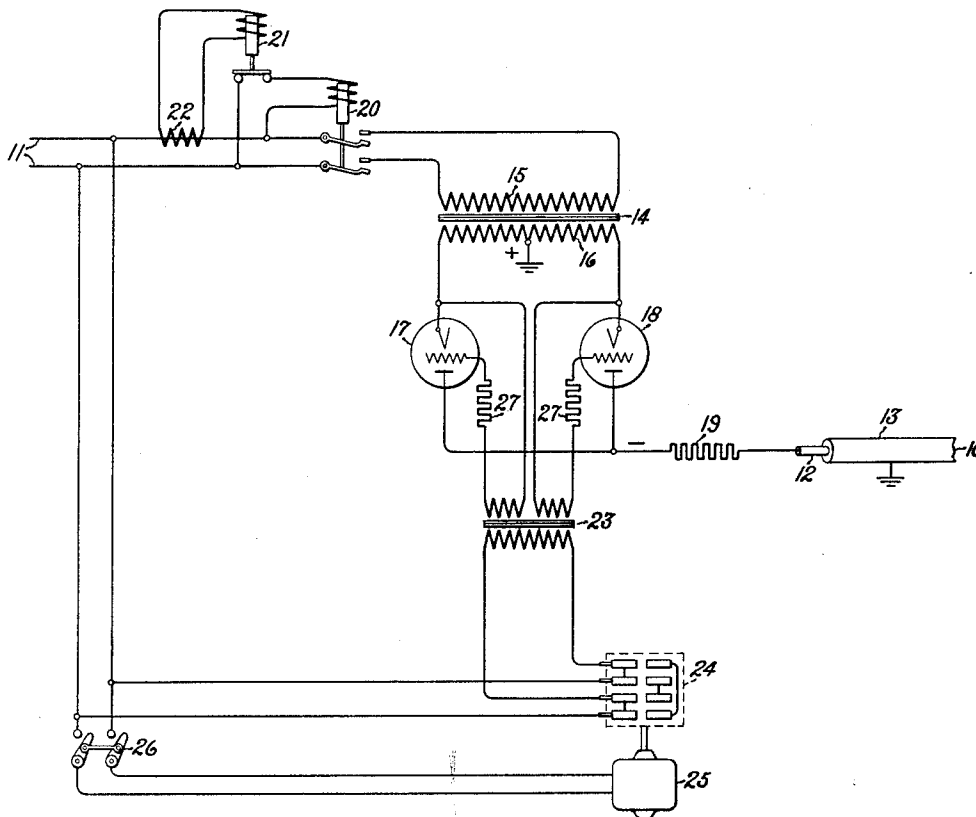
CROSBY FIELD.

H. S. HUBBARD
CABLE TESTING EQUIPMENT
Filed March 24, 1932

1,886,682

CABLE TESTING EQUIPMENT

Filed March 24, 1932



Inventor:
Horace S. Hubbard,
by *Charles E. Tuller*
His Attorney.

