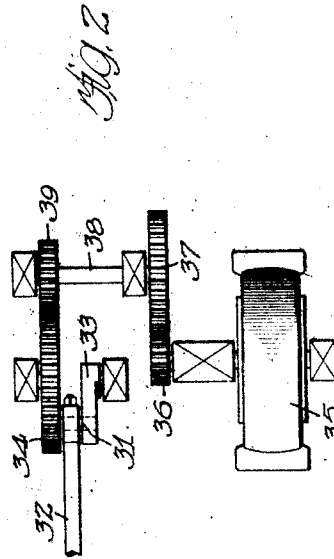
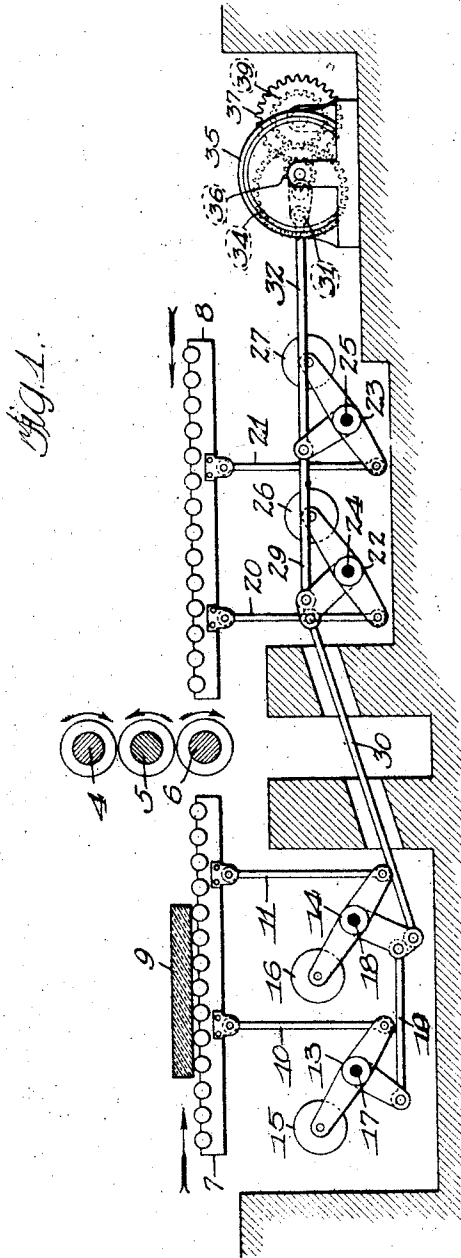


C. T. HENDERSON.
MOTOR CONTROLLER.
APPLICATION FILED OCT. 17, 1908.

1,062,589.

Patented May 27, 1913.

2 SHEETS-SHEET 1.



Witnesses:
Robert H. Kirk
Shipler & Co. Attorneys

Inventor:
Clark T. Henderson
By: Edwin B. H. Tower, Jr.
Attorney

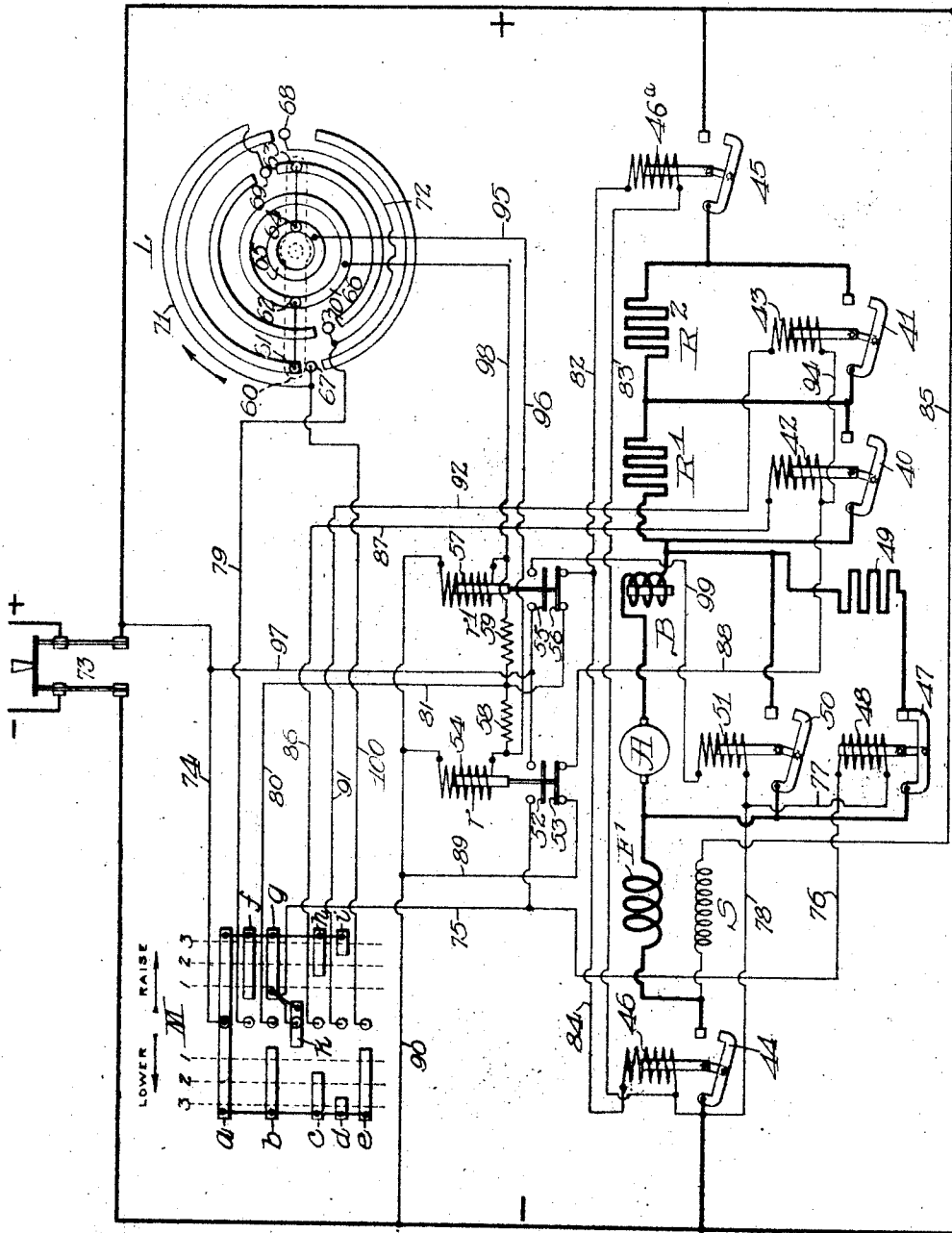
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2 SHEETS—SHEET 2.



Witnesses:
Robert H. Weir
Shipler W. Fitzgerald

Fig. 3.

Inventor:
Clark T. Henderson
By: Edwin B. H. Tower, Jr.
Attorney

UNITED STATES PATENT OFFICE.

CLARK T. HENDERSON, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO THE CUTLER-HAMMER MFG. CO., OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

MOTOR-CONTROLLER.

1,062,589.

Specification of Letters Patent.

Patented May 27, 1913.

Application filed October 17, 1906. Serial No. 458,267.

To all whom it may concern:

Be it known that I, CLARK T. HENDERSON, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented new and useful Improvements in Motor-Controllers, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention relates to table elevating mechanisms for rolling mills.

In three-high rolling mills tables are provided to carry the bloom, which tables are lowered to pass the bloom through the lower rolls and raised to pass it through the upper rolls.

My invention has for one of its objects to provide means whereby the table elevating mechanism may be operated by an electric motor.

It has for a further object, to provide the motor controller with certain improved means whereby it will automatically stop the motor after it has run through a predetermined cycle.

In order to more fully explain the nature of my invention, I have illustrated the general features thereof in the accompanying drawing, in which—

Figure 1 illustrates schematically a three-high rolling mill. Fig. 2 shows a plan view of the motor and the crank, and Fig. 3 illustrates diagrammatically one form of my control system.

These drawings merely illustrate the general features of my invention and other apparatus, which may be used in practice in connection with that which I have illustrated. Much has been eliminated for the purpose of simplifying the disclosure which I make herein, and, therefore, the drawings should be considered in an illustrative sense and not in a limiting manner.

I shall first describe the mechanical mechanism for operating the elevating tables.

The mill is provided with three rolls, 4, 5 and 6. On one side of these rolls is arranged a table 7, and on the other side a table 8. These tables carry the bloom 9 and pass it back and forth through the rolls. The tables are shown in the lower position, in which position the bloom is passed through the lower rolls. The bloom

is shown as now located upon the table 7, 55 from here it is passed through the lower rolls 5 and 6 to the table 8, then the tables are raised and the bloom passed through the upper rolls 4 and 5 back to the table 7. When the tables are again lowered this 60 same cycle of operation is repeated. The table 7 is mounted upon rods 10 and 11, the lower ends of which are connected to bell crank levers 13 and 14 respectively, which carry counter weights 15 and 16. These 65 levers are mounted upon pivots 17 and 18 and are connected by a link 19. The table 8 is mounted upon rods 20 and 21, the lower ends of which are connected to bell crank levers 22 and 23 respectively, which are 70 supported upon pivots 24 and 25. These levers carry counter weights 26, 27, and are connected by a link 29. The bell crank levers 22 and 14 are connected by a link 30. The bell crank lever 23 is connected to a 75 crank 31 by means of pitman 32. The crank may be formed by an arm 33 and a gear 34, between which extends the crank pin to which the pitman 32 is connected. The crank is driven by a motor 35 which drives 80 the gear 34 through pinion 36, gear 37, jack-shaft 38, and pinion 39. In order to elevate the table the crank is rotated 180 degrees, thereby operating the bell cranks to raise the rods 10, 11, 20 and 21. When the 85 motor rotates the crank 180 degrees it is stopped. When it is desired to again lower the tables the motor is again started and runs until the crank has been rotated another 180 degrees, or back to the position 90 which is illustrated in the drawing. The elevating mechanism is thus operated to raise and lower the tables. Of course, the mechanical structure which is employed to raise and lower the tables, may assume various 95 different forms and may be applied to mills of different types. The peculiar mill and table elevating mechanism which is illustrated in the drawings, have been selected merely for the purpose of illustration. 100 I shall now describe the controller, by means of which the motor is started and then automatically stopped after it has operated the crank 180 degrees, or performed some other definite cycle of operation. The 105 controller is illustrated diagrammatically in Fig. 3. The drawing merely shows the general features of the control system in a sche-

matic way, and various devices, which would be used in connection therewith in practice, have been discharged so as to illustrate my invention in a simple manner.

I have illustrated a compound motor, having an armature A, a series field F, and shunt field S. In the motor circuit is arranged a brake solenoid B, which controls in any suitable manner, the operation of a mechanical brake for holding the table elevating mechanism in a stationary position. Also in the motor circuit are resistances R¹ and R², which are controlled by switches 40 and 41, adapted to short-circuit the same. These switches are actuated by solenoids 42 and 43 respectively. The main motor circuit is controlled by main line switches 44 and 45, one on each side of the motor, which switches are actuated by solenoids 46 and 46^a, respectively. I provide a switch 47, actuated by solenoid 48, for the purpose of connecting a resistance 49 around the motor armature. I also provide a switch 50, actuated by solenoid 51, for the purpose of connecting the short-circuit around the motor armature. The circuits controlled by the switches 47 and 50 serve to cause the motor to become a generator and act as a dynamic brake when it is running under the inertia of its load, hence, these circuits would be called the dynamic braking circuits, and in these circuits may be included such instrumentalities as may be desired. The circuits of the operating solenoids of the aforesaid switches are controlled by relays *r* and *r'*. The relay *r* has two contacts, 52 and 53, which are actuated by solenoid 54. When the relay is deenergized contact 53 is closed, and when it is energized contact 52 is closed. Relay *r'* is provided with contacts 55, 56, which are actuated by solenoid 57. When relay *r'* is deenergized contact 56 is closed, and when it is energized contact 55 is closed. The contacts of relay *r* and *r'* control circuits leading to the operating solenoids of the several switches. In circuit with the solenoids 54 and 57 are resistances 58 and 59, which prevent sufficient current flowing through solenoids 54 and 57 for them to raise their plungers. When these resistances are short-circuited, solenoids 54 and 57 will raise their plungers and then the resistances 58 and 59 may again be inserted in circuit with the solenoids 54 and 57, as these resistances will permit sufficient current to flow through the solenoids to hold their plungers in a raised position.

The operation of the switches to start the motor is directed by means of a master controller M. It is assumed that the master controller is of the drum type, and a plan of this controller is illustrated in the drawing. Extending on both sides of the drum is a segment *a*, on the left hand side of the drum are segments *b*, *c*, *d* and *e*, and on the

right hand side segments *f*, *g*, *h* and *i*, in the middle of the drum a segment *k*. These segments are adapted to engage stationary contact fingers, which are shown by circles arranged in alinement down the center of the controller. The controller is illustrated in the central or off position. It may be moved to bring either the right or left hand segments into engagement with the fingers. If it be moved to bring the right hand segments into engagement with the fingers, the tables will be raised, and if it be moved to bring the left hand segments into engagement with the fingers the tables will be lowered. The drum has three positions on each side of the central position. These positions are indicated by dotted lines.

The motor is automatically stopped by means of a limit switch L, which is diagrammatically illustrated in the drawing. The limit switch has a rotatable arm 60, which is illustrated by dotted lines. This arm is connected or geared to the motor, or mechanism operated thereby, so as to be rotated in unison with the motor. The arm carries on one side of its pivot two electrically connected brushes 61 and 62, and on the other side two electrically connected brushes 63 and 64. The brush 64 engages ring 65, and the brush 62 ring 66. These rings are connected to solenoids 54 and 57 respectively of the relays. In the path of brush 61 is button 67 and button 68, arranged on opposite sides. The segments between these buttons 67 and 68, on which brush 61 travels, are dead; in the path of brush 63 are buttons 69 and 70, arranged upon opposite sides. The segments between these buttons on which the brush travels, are dead. Buttons 67 and 69, through conductor 71, are connected together, both are connected to the contact finger of segment *e* of the drum controller. Buttons 70 and 68 are likewise connected by conductor 72, both are connected to the contact finger of segment *f* of the master controller. When the contact arm of the limit switch is in the position shown in the drawing, no circuits are closed thereby.

Current for operating the motor is taken from the line through a suitable line switch 73.

I shall now describe the operation of the controller.

Let it be assumed that it is desired to run the motor to raise the table. Accordingly the master switch is moved to bring the right hand segments into engagement with the contact fingers. While the controller is in the central or off position, the central contact *k* makes contact with its finger, which closes the circuit of solenoid 48, which closes switch 47. The contact finger which is engaged by segment *a* is connected to the positive line through conductor 74; hence all

the segments of the master controller are electrically connected to the positive line. The circuit of solenoid 48 extends from segment *k* through conductor 75, conductor 76, solenoid 48, conductor 77, and conductor 78 to the negative line. Switch 47 connects resistance 49 across the motor armature when the master controller is in the off position. One of the purposes of this switch is to make the motor act as a dynamic brake whenever the master controller is turned to the off position to stop the motor before the motor is stopped by the limit switch. When the controller is moved to the first right hand position, segments *f* and *g* engage their respective segments. Segment *f* connects buttons 68 and 70 of the limit switch to the positive line through conductor 79. Segment *g* connects solenoids 46 and 46^a in circuit, thereby closing main switches 44 and 45. The circuits of these solenoids extend from segment *g* through conductor 80, conductor 81, relay contact 56, and here divides, one branch extending through conductor 82 and solenoid 46^a, conductor 83, to the negative line, and the other branch extends through conductor 84, solenoid 46, to the negative line. The switch 47 is now open. The motor circuit extends from the positive line through switch 45, resistance R² and R¹, brake solenoid 46, armature A, series field F, switch 44, to the negative line. The motor is thus started with all the resistance in circuit. The brake solenoid is energized and releases the mechanical brake. The shunt field circuit extends from the positive line through conductor 85 and shunt field S, switch 44, to the negative line. As the master controller is moved to the second and third positions, the segments *h* and *i* connect solenoids 42 and 43 in circuit, thereby closing switches 40 and 41 successively, and short-circuiting resistances R¹ and R². The circuit of solenoid 42 extends from segment *h* through conductor 86, conductor 87, solenoid 42, conductor 88, relay contact 53, conductor 89, conductor 90, to the negative line. The circuit of solenoid 43 extends from segment *i* through conductor 91, conductor 92, solenoid 43, conductor 94, conductor 88, relay contact 53, conductor 89 and conductor 90, to the negative line. The motor is now running at full speed.

If it be desired to stop the motor at any time before the motor is automatically stopped by the limit switch, the master controller may be returned to the off position, thereby first reinserting the starting resistance, then opening the motor circuit, and finally closing switch 47 to connect the resistance 49 across the motor armature to make the motor act as a dynamic brake.

When the motor is running, the arm 60 of the limit switch is rotated clock-wise in unison with the motor. It is so operated that

when the crank 31 has been rotated 180 degrees, thereby raising the tables, it will have rotated 180 degrees and stopped the motor.

I shall now describe the manner in which the limit switch stops the motor.

As the arm 60 approaches the end of the 180 degree movement, the brush 63 momentarily engages button 70, thereby bridging said button and contact ring 65. Accordingly the resistance 58 is bridged and relay *r* operated. The circuit of solenoid 54, or relay *r*, extends from contact segment *f* of the master switch, through conductor 79, button 70, brushes 63 and 64, ring 65, conductor 95, conductor 96, solenoid 54, conductor 90, to the negative line. Contact 53 now opens the circuit of solenoids 42 and 43, thereby causing the opening of switches 40 and 41. The resistances R¹ and R² are thus reinserted in the motor circuit, thereby slowing down the motor. Contact 52 of relay *r* now closes the circuit of solenoid 48, thereby closing switch 47. This switch connects resistance 49 across the motor armature, thereby forming a dynamic braking circuit. The circuit of solenoid 48 extends from positive line through conductor 97, contact 52, conductor 76, solenoid 48, conductor 78, to the negative line. Further movement of the arm of the limit switch causes button 61 to momentarily engage button 68, thereby causing brushes 61 and 62 to bridge said button and contact ring 66. The resistance 59 is now short-circuited, thereby causing relay *r'* to close. The circuit of solenoid 57 of this relay extends from segment *f*, of the master switch, through conductor 79, conductor 72, button 68, brushes 61 and 62, ring 66, conductor 98, solenoid 57 and conductor 90, to the negative line. Contact 56 is now open and contact 55 closed. Contact 56 thus opens the circuit of solenoids 46 and 46^a, and accordingly main switches 44 and 45 are opened, thereby breaking the motor circuit. Contact 55 closes the circuit of solenoid 51, thereby closing switch 50, which connects a short-circuit across the motor armature, thereby causing the dynamic braking action of the motor to be increased. The circuit of solenoid 51 extends from the positive line through conductor 97, contact 55, conductor 99, solenoid 51, conductor 78, to the negative line. The brushes 63 and 61 simply momentarily engage buttons 70 and 68, respectively, as the arm approaches the limit of 180 degrees movement. After the circuits of the solenoids of relays *r* and *r'* are broken at the limit switch, the solenoids 54 and 57 remain energized, the same being connected in circuit from segment *g*, of the master switch, through conductor 81, thence dividing through resistance 58 and 59, and solenoids 54 and 57, and then through conductor 90 to the negative line. These

resistances allow sufficient current to flow through the relay solenoid to retain the plungers of said solenoids. The limit switch thus acts to bring the motor to rest. The motor is first slowed down by resistances R^1 and R^2 , then resistance 49 is connected across the motor and finally the motor circuit is opened and the armature short-circuited. Of course, various other arrangements of the dynamic braking circuits may be provided. The dynamic braking circuits cause the motor to become a generator, whereby it is quickly brought to rest. The motor is stopped when the crank and the limit switch arm completes a 180 degree movement, and then the table is elevated. The master switch is now returned to the initial or off position, thereby deenergizing solenoids 54 and 57 and dropping relays r and r' . To lower the tables, the master controller is turned to bring the left hand segments of the master switch into contact with the fingers. The segment b in the first position establishes the circuits which were previously established by the segment g ; accordingly the motor circuit is closed. As the controller is moved to the second and third left hand positions, the segments c and d cause the operation of the resistance switches 40 and 41 in the same manner as segments h and i . The motor is thus started, and as the crank is rotated through 180 degrees movement the tables are lowered. The segment e engages its contact, thereby closing circuit from the positive line through conductor 100 to contact buttons 67 and 69. The contact button 69 is momentarily engaged by the brush 63, and contact button 67 is similarly engaged by brush 61, as the contact arm of the limit switch approaches the limit of 180 degrees movement. Accordingly relays r and r' are again operated in the manner previously described, thereby stopping the motor at the end of 180 degrees movement. The tables are thus lowered.

Of course, various changes may be made in the control system which I have illustrated in the drawing without in any way departing from my invention as defined by the claims presented herewith.

The drawings merely show one form which the controller may assume in practice, and it is obvious that various other structures may be devised to accomplish the same results.

What I claim as new and desire to secure by Letters Patent is:—

1. The combination with an elevating table of a rolling mill, of means for raising and lowering said table, a motor for operating said means, an electromagnetically operated switch for starting said motor, an electromagnetically operated switch for connecting a dynamic braking circuit

around said motor, a relay for controlling the operation of said switches, and a limit switch for causing said relay to operate to stop said motor when said table is in its upper or lower position.

2. The combination with an elevating table of a rolling mill, of means for raising and lowering said table, a motor for operating said means, an electromagnetically operated switch for starting said motor, an electromagnetically operated switch for connecting a dynamic braking circuit around said motor, a relay for controlling the operation of said switches, a limit switch for causing said relay to operate to stop said motor when said table is in its upper or lower position, and a master switch for controlling said electromagnetically operated switches.

3. The combination with an elevating table of a rolling mill, of means for raising and lowering said table, a motor for operating said means, electromagnetically operated switches for starting said motor, electromagnetically operated switches for establishing a dynamic braking circuit for the motor, and a limit switch movable in unison with the motor in a single direction for causing said switches to stop the motor to bring said table to rest in its extreme upper and lower positions, said limit switch being adapted to first cause certain of said switches to operate to slow down the motor and then cause other of said switches to operate to stop the motor.

4. The combination with an elevating table of a rolling mill, of means for raising and lowering said table, a motor for operating said means, electromagnetically operated switches for starting said motor, electromagnetically operated switches for establishing a dynamic braking circuit for the motor, relays for controlling said switches, one of said relays being adapted to cause certain of said switches to slow down the motor, and the other relay being adapted to cause other of said switches to stop the motor, and a limit switch movable in unison with the motor for causing said relays to operate successively to stop the motor when said table is in its upper or lower position.

5. The combination with an elevating table of a rolling mill, of means for raising and lowering said table, a motor for operating said means, electromagnetically operated switches for starting said motor, electromagnetically operated switches for establishing a dynamic braking circuit for the motor, relays for controlling said switches, one of said relays being adapted to cause certain of said switches to slow down the motor, and the other relay being adapted to cause other of said switches to stop the motor, and a limit switch movable in unison with the motor for causing said relays to op-

erate successively to stop the motor when said table is in its upper or lower position, and a master switch for controlling said electromagnetically operated switches.

5 6. In a controller for electric motors, in combination, an electromagnetically operated switch for controlling the motor circuit, an electromagnetically operated switch for establishing a dynamic braking circuit
10 for the motor, a relay for controlling said switches, and a limit switch movable in unison with the motor, said limit switch, when moved a predetermined distance, being adapted to cause said relay to operate to
15 stop the motor.

7. In a controller for electric motors, in combination, electromagnetically operated switches for starting the motor, electromagnetically operated switches for establishing
20 a dynamic braking circuit, relays for controlling said switches, one of said relays being arranged to cause certain of said starting and braking switches to slow down the motor, and the other of said relays being arranged to cause other of said starting and
25 braking switches to stop the motor, and a limit switch movable in unison with the motor, said limit switch, when moved a predetermined distance, being arranged to cause said relays to operate successively.
30

8. In a controller for electric motors, in combination, electromagnetically operated switches for starting the motor, electromagnetically operated switches for establishing
35 a dynamic braking circuit, relays for controlling said switches, one of said relays being arranged to cause certain of said starting and braking switches to slow down the motor, and the other of said relays being arranged to cause other of said starting and
40 braking switches to stop the motor, and a limit switch movable in unison with the mo-

tor, said limit switch, when moved a predetermined distance, being arranged to cause said relays to operate successively, and a
45 master switch for controlling the circuits of the operating windings of said electromagnetically operated switches.

9. In combination a motor, a crank operated thereby, an electromagnetically operated switch for starting the motor, an electromagnetically operated switch for establishing a dynamic braking circuit for the motor, a relay for controlling said switches, and a limit switch movable in unison with
55 the motor and arranged to cause said relay to operate to stop the motor when said crank is in a predetermined position, and a master switch for controlling said electromagnetically operated switches.
60

10. In combination a motor, a crank operated thereby, electromagnetically operated switches for starting the motor, electromagnetically operated switches for establishing dynamic braking circuits for the
65 motor, a pair of relays for controlling said switches, one of said relays being arranged to cause certain of said starting and braking switches to slow down the motor, and the other of said relays being arranged to
70 cause other of said switches to stop the motor, and a limit switch movable in unison with the motor, said limit switch being arranged to cause the successive operation of said relays to stop the motor when said
75 crank is in predetermined positions.

In witness whereof, I have hereunto subscribed my name in the presence of two witnesses.

CLARK T. HENDERSON.

Witnesses:

F. S. WILHOIT,
R. M. VAN VLEET