

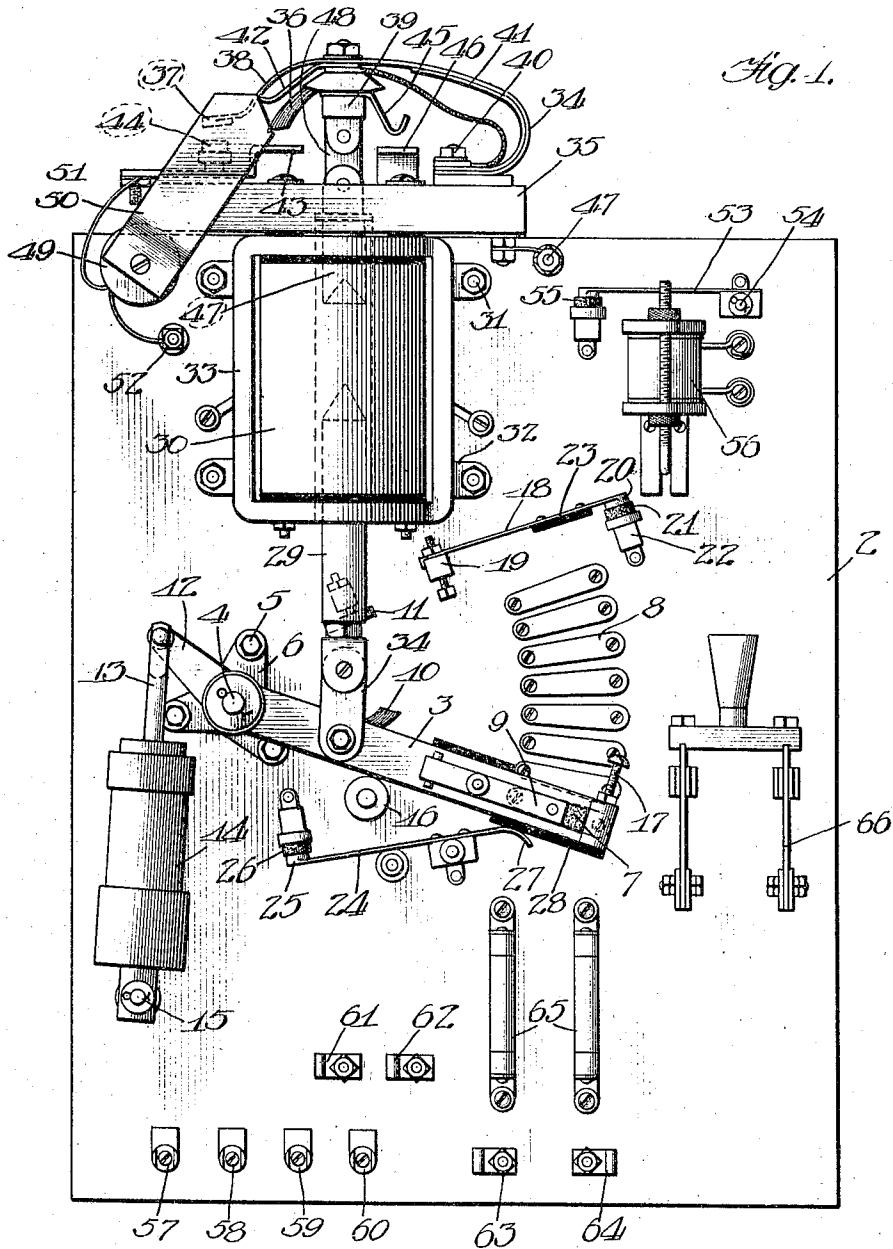
C. T. HENDERSON.
STARTING DEVICE.

APPLICATION FILED MAR. 14, 1907. RENEWED OCT. 22, 1910.

1,042,791.

Patented Oct. 29, 1912.

3 SHEETS—SHEET 1.



Witnesses:
Robert H. Weir
W. Perry Hahn

Inventor:
Clark T. Henderson
By: E. C. Brown, Jr.
att'y:

C. T. HENDERSON.

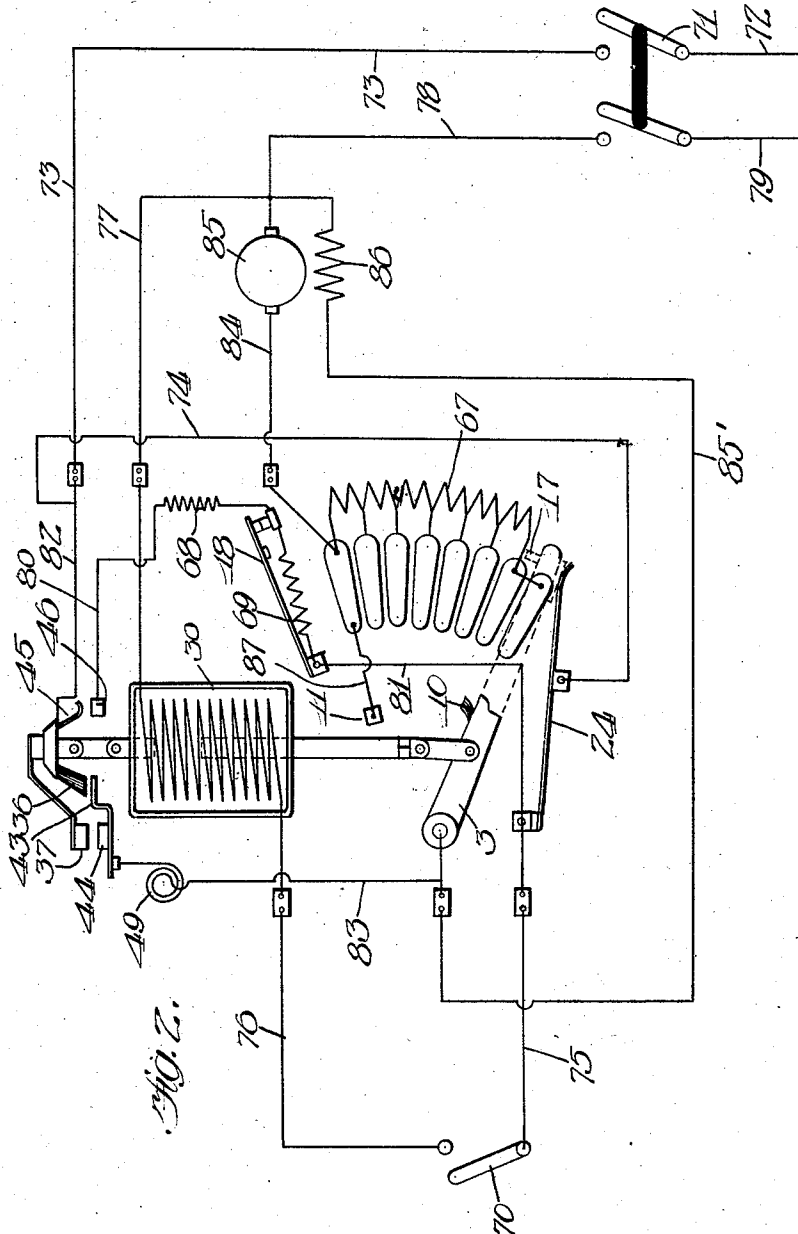
STARTING DEVICE.

APPLICATION FILED MAR. 14, 1907. RENEWED OCT. 22, 1910.

1,042,791.

Patented Oct. 29, 1912.

3 SHEETS—SHEET 2.



Witnesses:
Robert H. Weir
W. Perry Hahn

Inventor:
Clark T. Henderson
By: E. L. Davis, B. H. & Sons
attys.

C. T. HENDERSON.
STARTING DEVICE.

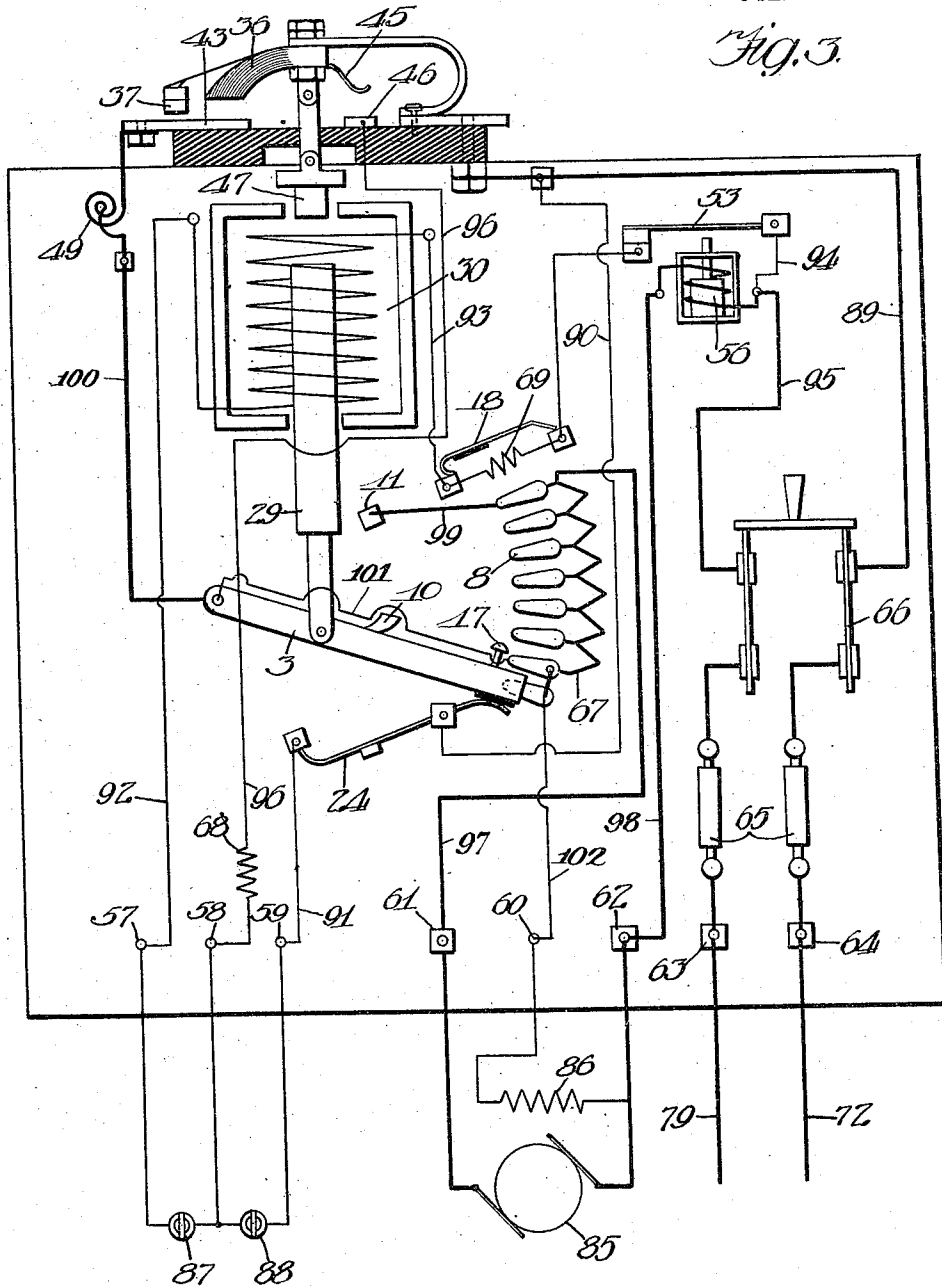
APPLICATION FILED MAR. 14, 1907. RENEWED OCT. 22, 1910.

1,042,791.

Patented Oct. 29, 1912.

3 SHEETS—SHEET 3.

Fig. 3.



Witnesses:
Robert H. Weir
W. Perry Halin

Inventor:
Clark T. Henderson
By: Edwin B. Hoover, Jr.
attor:

UNITED STATES PATENT OFFICE.

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

STARTING DEVICE.

1,042,791.

Specification of Letters Patent.

Patented Oct. 29, 1912.

Application filed March 14, 1907, Serial No. 362,386. Renewed October 22, 1910. Serial No. 588,537.

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 Starting Devices, 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 improvements in starting devices for electric motors.

In the preferred form of my invention, I provide a main switch for controlling the motor circuit and a movable element for controlling a starting resistance for the motor, both operated by a single solenoid; and so interlocked that the solenoid cannot operate to close the main switch, unless all of the resistance is in the motor circuit. While this is the preferred embodiment of my invention, viewed from another stand point however, my invention contemplates an interlock between a main switch and a resistance controlling member which prevents the closing of the main switch unless the resistance controlling member is in a predetermined position.

For the purpose of disclosing my invention I have illustrated in the accompanying drawings a motor starting device showing one embodiment of my invention.

Figure 1 is an elevation of my motor starting device. Fig. 2 is a simplified diagrammatic view showing the circuit arrangements, and Fig. 3 is a diagrammatic view applicable particularly to the device illustrated in Fig. 1.

In the structure illustrated in Fig. 1 of the drawings, upon a suitable panel or base 2, preferably formed of soapstone or other insulating material, the various operating parts of the starter are mounted. The resistance controlling arm 3 is mounted upon a suitable stud 4, secured to the base by means of bolts 5 passing through the base and arms 6 of said stud. At its outer end the arm 3 is provided with a contact brush arranged to sweep over and engage a plurality of contact plates 8 circularly arranged upon the base 2. The brush is held in close engagement with the contact plates 8 by means

of a spring pressed arm 9. The arm 3 also carries an auxiliary contact 10, which may be in the form of leaves or laminations of copper or the like arranged to engage stationary contact 11, for a purpose more fully hereinafter described. The opposite end of the arm 3 is provided with a suitable projection 12 having pivotably secured thereto a piston rod 13, the piston of which operates in a dash-pot 14 pivotably supported at 15 upon the base 2. The dash-pot is preferably filled with oil to retard the downward movement of the piston and prevent a too rapid movement of the controller arm when moved to the "on" position. A suitable buffer 16 is provided against which the arm 3 will strike when it drops to its lowermost position. The arm at its outer end is also provided with a projection 17, which may take the form of a screw, arranged to engage, when the arm is in the full "on" position, a pivoted switch arm 18 pivoted at 19 and provided at its outer end with a contact member 20, arranged to engage with the carbon contact 21, mounted upon a supporting plate 22, also secured upon the face of the base. An insulating buffer 23 is provided on the lower side of the arm 18 against which the projection or screw 17 impinges and which insulates the arm 18 from the arm 3. The arm 3 at its lowermost position maintains closed a switch arm 24 having at its outer end a contact 25 which engages a carbon contact 26, and having at its rear end a projection 27 arranged to be engaged by the arm 3 when it is in its lowermost position. The arm 3 is provided with an insulating buffer 28 to insulate the switch arm 24 therefrom. The arm 3 is operated by the core 29 of the solenoid 30 which is supported upon the panel or base by screws 31 passing through lugs 32 on the frame 33 thereof. A fiber link 34 connects the arm 3 with the core 29.

The main switch of the starting device is mounted upon an insulating base 35 secured upon the top of the frame of the solenoid 30. This switch comprises a main contact member 36 and an arcing contact 37 which is mounted upon a spring arm 38 secured to the support 39 of the main contact, and extended to form a curved supporting

arm secured to the base 35 by a bolt or nut 40. To aid the spring arm 38 in opening the main switch, a short curved arm 41 is combined therewith. The arm 38 is prevented from coming into contact with the main contact 36 by a curved stiff arm 42. The main contact 36 and the arcing contact 37 are arranged to engage respectively with a contact plate 43 and a carbon contact 44. Also carried by the support 39 is a contact 45 which is arranged to engage the contact 46 mounted upon the base 35.

The main switch is operated by a core 47 of the solenoid 30, and is connected thereto by a fiber link 48 secured to the support 39 and core 47.

A blowout magnet 49 is mounted on the face of the panel 2 and has polar extensions 50 which, at one end are arranged upon either side of the arcing contact 37, whereby any arc formed at this point, when contact is broken may be disrupted. One terminal of the blowout magnet is connected with a binding post 51 on the contact plate 43, and the other terminal is connected to a binding post 52.

An overload switch 53, pivoted at 54 and arranged to make contact with the carbon 55, is operated by an overload magnet 56 and protects the motor from abnormal increase in current.

Suitable binding posts 57 to 64 are provided for connecting the starter with the motor and supply lines, and blowout fuses 65 are provided to protect the main line. A line switch 66 is also provided for controlling the admission of current to the device.

In the simplified diagrammatic view illustrated in Fig. 2 a resistance 67, divided in sections, is connected with the various contact plates 8 of the starting device. The winding of the solenoid 30 is connected to the main circuit through the switch 24 and a shunt circuit including resistance 68 and 69. This shunt circuit is controlled by the contact 45 of the main switch and the switch 18 is located therein to control the resistance 69.

In operation assuming that the arm 3 is in its full "off" position and is resting on the last of the series of contacts 8, and that the switch 70 is closed; when the line switch 71 is closed, current will flow from the main line 72, by conductor 73 and conductor 74, across the switch 24, by conductor 75, through switch 70, by conductor 76 through the winding of the solenoid 30, thence by conductors 77 and 78 to the opposite side 79 of the main line. The solenoid is thus energized and attracts its cores, moving the arm 3 upwardly, and at the same time closing the contacts 36 and 37 of the main switch. As soon as the arm 3 is moved a

short distance, the switch 24 is released and opens by gravity, and the circuit through the winding of the solenoid 30 by way of conductor 74 is opened. The closing of the main switch, however, closes switch 45 and a shunt circuit through the winding is closed by the way of contact 46 and conductor 80, through the resistance 68, across switch 18, by conductor 81, switch 70, conductor 76, through the winding of the solenoid and back by way of conductors 77 and 78 to the opposite side 79 of the line. The solenoid 30 does not need as much current to raise the arm 3 after it is started as it does to start the arm and the resistance 68 is therefore inserted in series with the solenoid to cut down the current passing therethrough and prevent overheating the same. It will thus be seen that the circuit of the solenoid is initially closed through the switch 24, but as soon as the arm 3 commences to rise, the switch 24 is opened, thereby opening the energizing circuit of the solenoid. In the meantime however, the main switch is closed, thereby completing the solenoid circuit through contacts 45 and 46. The solenoid is thus shifted from one circuit to the other, the first being closed independently of the main switch and the second being closed with the main switch. It is obvious, therefore, that if the main switch is opened the solenoid circuit is opened and consequently the main switch cannot again be closed, until the energizing switch 24 is closed.

The closing of the main switch contacts 36 and 37, closes the circuit through the motor which may be traced as follows: main 72, conductors 73 and 82, through the main switch, contacts 36 and 37, through the winding of the blowout magnet 49, conductor 83, resistance controlling arm 3, resistance 67, conductor 84, armature 85 of the motor and by conductor 78 to the opposite side 79 of the main line. Current also passes from conductor 83 by conductor 85', through the shunt field 86 of the motor. The motor is thus started with all resistance in circuit and as the arm 3 gradually moves over the contacts 8, it cuts out the resistance 67, section by section, until it has reached its final or full "on" position. When the arm reaches its final or full "on" position, the contact 10 engages the contact 11 which is connected with the last of the series of contact plates 8, and circuit instead of passing through the brush 7 of said arm, will pass through conductor 87 relieving the contact brush 7 from carrying full current while the motor is running. As the arm 3 moves to its full "on" position, the projection 17 opens the switch 18 and the resistance 69 is inserted in the solenoid circuit, thereby reducing the strength of the solenoid to further prevent over heating the

solenoid as it does not require as much current for holding the arm in its raised position as it does to move it to that position.

Assuming now that the current falls below a predetermined point or fails entirely, then the winding of the solenoid will be de-energized and permit the main switch to open and the arm 3 to drop to its "off" position, which stops the motor. In event the current falls below a predetermined point or fails altogether and then immediately rises to normal again it will be noted that it will be impossible for the solenoid to raise the arm 3 from an intermediate point, as the circuit therethrough will not be closed until the arm 3 drops to full "off" position and closes the switch 24.

In Fig. 3 I have shown a diagrammatic view illustrating in detail the circuit arrangement of the device shown in Fig. 1. The two binding posts 63 and 64 are connected to the two sides 79 and 72 of the main line. The binding posts 61 and 62 are connected to the opposite terminals of the armature 85 of the motor. The binding post 60 is connected with one terminal of shunt field 86 of the motor. The binding posts 57, 58 and 59 are connected with terminals of two switches 87 and 88, which may be located at a distant point, and which may be used for starting and stopping the device without operating the line switch 66. The circuit of this device may be traced as follows: Assuming that the line switch 66 is closed and that the small switches 88 and 87 are closed, and that the starter is in the position illustrated or "off" position; then current will flow from the main 72, through one of the fuses 65, through the line switch 66, by conductor 89, through the conductor 90, switch 24, conductor 91, the two switches 88 and 87, conductor 92, through the winding of the solenoid 30, by conductor 93, across switch 18, across the overload switch 53, by conductors 94 and 95, to the opposite side 79 of the line. The solenoid is thus energized and attracts its cores 29 and 47 closing the main switch and moving the arm 3 upward to cut out the resistance from the motor circuit. As soon as the arm 3 has moved off the first of the contacts 8, the switch 24 will open by gravity and the circuit through winding of the solenoid by the path just described will be opened. The main switch, however, has been closed and the switch 45 closed therewith. A new circuit for the winding of the solenoid 31 will therefore be established from the conductor 89, through the switch 45, by conductor 96, through the resistance 68, switch 87, conductor 92, through the winding of the solenoid and back to the main side as has previously been described. It will be noted that the closing of this new circuit inserts the resistance 68 in circuit

with the winding of the solenoid 30 thereby cutting down the current traversing the winding. It is not necessary that the solenoid have as much strength to raise the arm 3 as it requires to start the arm and close the main switch. The closing of the main switch contacts 36 and 37, establishes the motor circuit from the line 72 through the line switch 66, conductor 89, main switch contacts 36 and 37, through the winding of the blowout magnet 49, by conductor 100, arm 3, resistance 67, conductor 97, armature 85 of the motor, conductor 98, through the overload magnet 56, thence by conductor 95 to the opposite side 79 of the line. As soon as the main switch is closed current will also flow from conductor 100 by conductors 101 and 102 through shunt field winding 86 to conductor 98 and thence back to the main line. As the arm 3 continues to travel over the contacts 8 it cuts out the resistance 67 section by section until the motor is running under full current. When the arm 3 reaches its full "on" position contact 10 engages the contact 11 and current instead of traversing the brush 7 traverses the conductor 99.

When the arm reaches its full "on" position, the projection 15 engages the switch 18 and opens the same, inserting the resistance 69 in circuit with the winding of the solenoid. This cuts down the flow of current through the solenoid winding and prevents said winding from over heating. By the provision of two auxiliary switches 87 and 88 the operation of the starter may be controlled from a distant point, as it will be seen that the switch 88 controls the circuit through the winding of the solenoid 31 when the arm 3 is in its full "off" position, and the switch 87 controls the winding of the solenoid when the arm is in its full "on" position.

While I have shown and described one specific form of my invention it will be understood that various changes and modifications may be made without departing from the spirit thereof, as set forth in the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a starting device for electric motors, the combination with a resistance, of a member for controlling said resistance, a main switch, an electro-magnet common to said main switch and resistance controlling member, for operating the same, a switch for controlling the circuit of said magnet, closed only when all the resistance is in the motor circuit, and a second switch for controlling the circuit of said magnet closed only when the main switch is closed.

2. In a starting device for electric motors, the combination with a resistance, of a re-

sistance controlling member, a main switch, an electro-magnet common to said main switch and resistance controlling member, for operating the same, a switch controlling the circuit of said magnet, closed only when all the resistance is in circuit and a shunt circuit around said switch arranged to be closed only when the main switch is closed.

3. In a starting device for electric motors, the combination with a resistance, of a controlling member therefor, a main switch, an electromagnet winding for actuating said switch, a switch in circuit with said winding tending to stand in open position and adapted to be closed by said controlling member while in a predetermined position, a shunt circuit around said last mentioned switch, including a resistance, and a switch movable with said main switch for controlling said shunt circuit.

4. In a starting device for electric motors, the combination with a resistance, of a resistance controlling member, a main switch, an electro-magnet common to said resistance controlling member and main switch for operating the same, a switch controlling the circuit through said magnet, a second switch arranged to close an operating circuit for said magnet when the main switch is closed, and upon the opening of said first mentioned switch, said first mentioned switch being arranged to render said electro-magnet inoperative to close the main switch except when all the resistance is in the motor circuit.

5. In a motor starter, the combination with a resistance, of a resistance varying element, a main switch, a single electro-responsive winding for operating said main switch and resistance varying element, and means for preventing the energization of said winding, unless all of the resistance is in the motor circuit, said main switch being free to open irrespective of the position of said element.

6. In a motor starter, the combination with a main switch of a resistance, of a resistance varying element, a single electro-responsive device for operating said main switch and resistance varying element, a switch opened when said main switch is opened to open the circuit of said electro-responsive device, and a second switch closed when said resistance varying element is in its initial position to close the circuit of said electro-responsive device.

7. In a starting device for electric motors, the combination with a starting resistance, of a controlling member therefor, a main switch, an electromagnetic winding having two movable plungers, one of said plungers being connected to said controlling member and the other to said switch, a switch in circuit with said winding tending to stand in

open position and adapted to be closed by said controlling member while in a predetermined position, a shunt circuit around said last mentioned switch, including a resistance, a switch movable with said main switch for controlling said shunt circuit, a second resistance connected in said shunt circuit, and a switch tending to short circuit said second resistance and arranged to be opened by said controlling member upon the removal of said starting resistance from the motor circuit.

8. In combination, two switches, a single electromagnetic winding for actuating said switches, and means controlled by one of said switches upon opening for causing the deenergization of said winding to insure the release of the other switch.

9. In combination, two switches, a single electromagnetic winding for actuating said switches, a plurality of independent controlling switches for said winding, one of said controlling switches tending to deenergize said winding when one of said first mentioned switches is actuated, and another of said controlling switches being arranged to operate with the other of said first mentioned switches to establish a maintaining circuit for said winding, said last mentioned controlling switch being arranged to cause the deenergization of said winding when one of said first mentioned switches opens.

10. In a controller for electric motors, in combination, a main switch, a resistance controlling element, a single electroresponsive winding for actuating said switch and said element, means insuring the return of said element to initial position before said switch is closed, and means insuring the deenergization of said winding to permit said element to return to initial position when said switch is opened.

11. In a controller for electric motors, in combination, a main switch, a resistance controlling element, a single electroresponsive winding for actuating said switch and said element, a plurality of controlling switches for said winding, one of said controlling switches being arranged to be controlled by said element to prevent energization of said winding to close said main switch, except when said element is in initial position, and another of said controlling switches being arranged to be controlled by said main switch to cause the deenergization of said winding to insure the return of said element to initial position when said main switch is opened.

12. In a controller for electric motors, in combination, a main switch, a resistance varying element, a single electroresponsive winding for actuating said switch and said element, circuit connections for said winding controlled by said element to insure the

return of said element to initial position
prior to the energization of said winding to
close said switch, and circuit connections for
said winding controlled by said switch, to
5 insure the deenergization of said winding to
permit said element to return to initial posi-
tion when said switch is opened.

In witness whereof, I have hereunto sub-
scribed my name in the presence of two wit-
nesses.

CLARK T. HENDERSON.

Witnesses:

T. E. BARNUM,
L. D. ROWELL.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents,
Washington, D. C."
