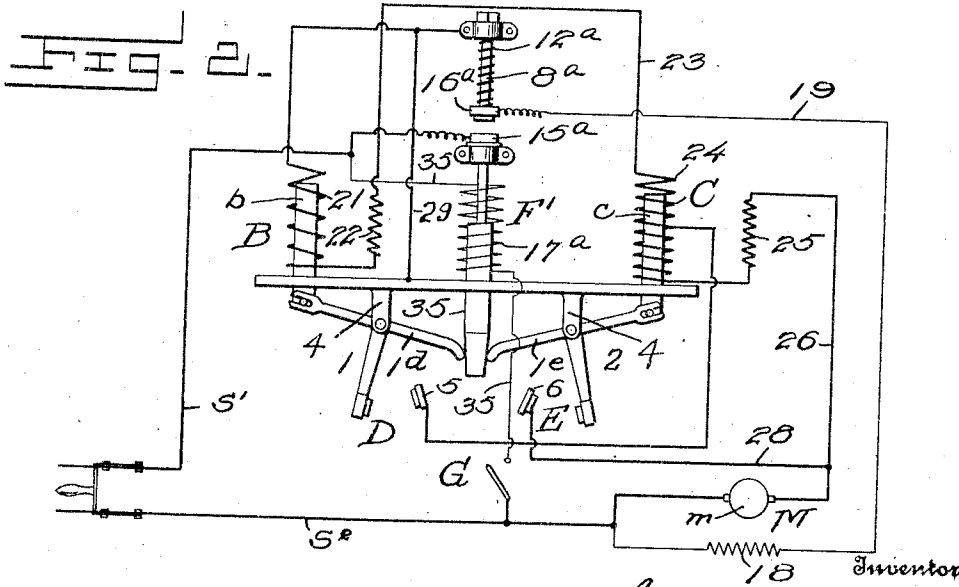
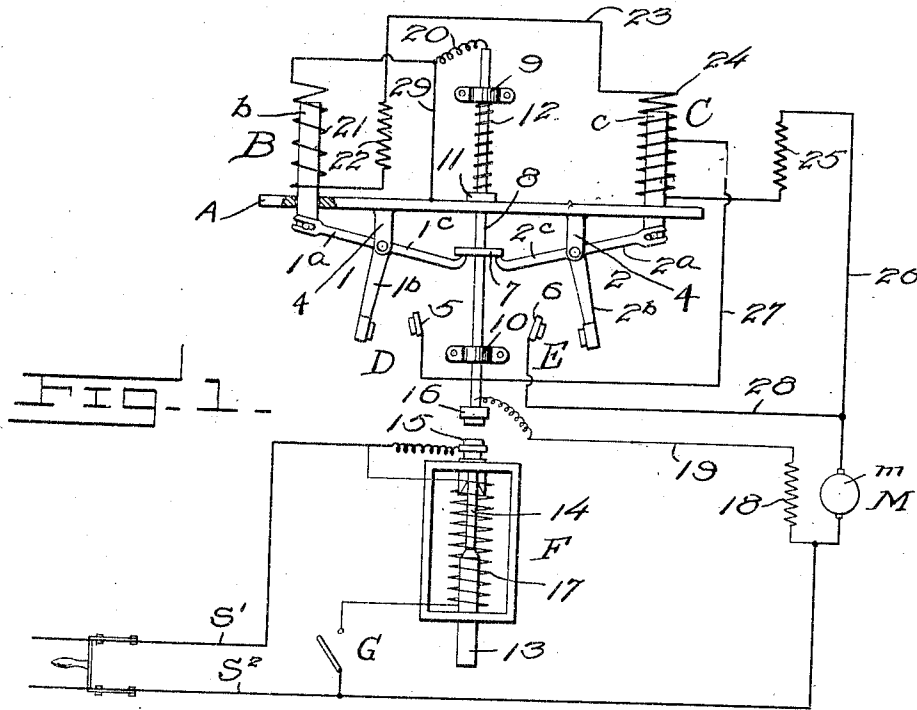


G. H. WHITTINGHAM.
 STARTER FOR ELECTRIC MOTORS.
 APPLICATION FILED MAR. 28, 1911.

1,023,979.

Patented Apr. 23, 1912.



Witnesses
C. L. Cunningham
Newton P. Williams

Inventor
Geo. H. Whittingham

By *Watson & Boyden*

UNITED STATES PATENT OFFICE.

GEORGE H. WHITTINGHAM, OF PIKESVILLE, MARYLAND, ASSIGNOR TO MONITOR
MANUFACTURING COMPANY, OF BALTIMORE, MARYLAND, A CORPORATION OF
MARYLAND.

STARTER FOR ELECTRIC MOTORS.

1,023,979.

Specification of Letters Patent.

Patented Apr. 23, 1912.

Application filed March 28, 1911. Serial No. 617,389.

To all whom it may concern:

Be it known that I, GEORGE H. WHITTINGHAM, a citizen of the United States, residing at Pikesville, in the county of Baltimore and State of Maryland, have invented certain new and useful Improvements in Starters for Electric Motors, of which the following is a specification.

This invention relates to starting apparatus for electric motors and it comprises a resistance controlling mechanism and a main switch for closing and interrupting the armature circuit, said main switch and mechanism being so related that, in starting, the main switch first closes the armature circuit and then coöperates mechanically with said mechanism to permit the resistance to be cut out of the armature circuit, and, in stopping, the main switch first coöperates with said mechanism to cause resistance to be inserted in the armature circuit, and then interrupts said circuit.

The invention is particularly applicable to starters of the type in which the time of cutting out resistance, after the completion of the armature circuit, is controlled by the current flowing in said circuit and the arrangement is such that so long as the main switch remains in its final closed position the resistance, in such a starter, cannot be re-inserted in the armature circuit by reasons of variations of current flow. In order to control the apparatus from a distant point one of the main switch members is operated by an electromagnetic device which is arranged in a circuit independent of the armature circuit, and a manually controlled switch is provided for closing and opening the circuit through said device to start and stop the motor.

The improvements are applicable to various forms of starters, but I have here shown it in connection with a starter of the type shown in the patent to William C. O'Brien, No. 965,649, in which one or more switches are provided for cutting out the starting resistance, these switches being mechanically held in open position when the motor is stopped and controlled in their closing movements, when the support is removed, by regulating solenoids which are controlled by the quantity of current flowing in the armature circuit. In this type of starter it is

customary to connect the coils of the holding solenoid in series with the coils of the regulating solenoids and armature in order that when the supply circuit switch is closed, in starting, all of the solenoids will be energized at the same time, and in order that when the supply circuit switch is opened to stop the motor the holding solenoids will be deenergized simultaneously with the interruption of the current through the armature. This avoids removing the support from the switches controlling the starting resistance before the admission of current to the armature and insures the return of said switches to normal positions as soon as the admission of current to the armature is cut off. If the windings of the holding solenoid are connected in shunt to the supply switch terminals, the current generated by the armature, while slowing down, after the opening of the supply circuit switch, will keep the holding solenoid energized for a short time thereafter, and permit the starter switches, controlling the resistance, to close so that upon the immediate reclosing of the supply switch the armature would be unprotected. An additional contact on the supply circuit switch may be provided for one terminal of the shunt wound holding solenoid, so that upon opening said switch the connection between said winding and the armature will be broken; but this necessitates arranging the supply switch contacts so that the blades of the switch will engage all of the contacts at practically the same instant. Therefore, as the most satisfactory way of accomplishing the desired end it is customary to connect the windings of the holding solenoid in series with the windings of the regulating solenoids, so that opening and closing of the supply switch opens and closes the circuits through all of the solenoids at the same time. While a starter thus connected is satisfactory for all ordinary purposes, there are situations where the series holding solenoid is apt to become practically deenergized during the operation of the motor and in such case its core is released and the switches controlling the resistance are opened, causing the resistance to be inserted in the armature circuit notwithstanding the main switch is closed and the motor is run-

ning. Thus, with certain types of motors now very commonly employed for running individual machines or tools, speed regulation is accomplished by moving the armature endwise into and out of the magnetic field, the field strength of the motor remaining practically constant. When the armature is moved partly out of the field its speed increases, and if it is suddenly moved back, owing to its own inertia and also, perhaps, owing to the inertia of the load, the counter electromotive force of the armature may approximate, for a few moments, the electromotive force of the supply circuit, in which case practically no current will flow through the starter and the holding solenoid will release its core and the resistance will be inserted in the armature circuit until the armature current again rises sufficiently to energize the holding solenoid.

When my present improvements are applied to current controlled starters, the several difficulties above mentioned are satisfactorily overcome.

In the accompanying drawing which illustrates my invention, Figure 1 is a diagrammatic view illustrating the invention; and Fig. 2 is a similar view showing a modification.

Referring to Figs. 1 and 2 of the drawing, A indicates a suitable metal cross piece which supports the coils of regulating solenoids B and C, and also supports pivoted switch members 1 and 2 which are connected to the cores of said solenoids and operate to remove and insert the starting resistance, by closing and opening the switches D and E. The switch members 1 and 2 in the drawing, are in the form of three-armed levers, pivoted at the junction points of the arms, in lugs 4, depending from the cross piece A, and electrically connected to said cross piece. The arms 1^a and 2^a are pivotally connected to the cores b and c; the arms 1^b and 2^b are contact arms adapted to engage the stationary contacts 5 and 6, respectively, and the arms 1^c and 2^c project beneath a collar 7 on a metal rod 8 which extends through a suitable opening in the center of the cross piece and is movable vertically in stationary guides 9 and 10. The rod 8 carries another collar 11, fixed thereto above the cross piece A, and a coiled spring 12, interposed between said stop and the guide 9, normally compresses the collar 11 against the cross piece and the collar 7 against the free ends of the arms 1^c and 2^c of the switch levers, thereby normally holding the switch arms 1^b and 2^b out of engagement with the stationary contacts 5 and 6.

Below the rod 8 is arranged a holding solenoid F, having attached to its core 13 a rod 14, of non-magnetic material, upon the upper end of which is arranged a suitable contact piece 15, movable with the core into

and out of engagement with a contact piece 16 on the lower end of the rod 8. The members 15 and 16 constitute the main switch through which the supply circuit to the motor is opened and closed.

The supply wire S' is connected by a suitable flexible connection 17 to the contact 15, and the coil 17 is connected at one end to said supply wire, and at its opposite end to a hand switch G, through which it may be connected to the opposite supply wire S², as shown.

The shunt field 18 of the motor M is connected at one end by conductor 19 to the rod 8, and at its opposite end to the supply wire S². The armature circuit of the motor extends from the rod 8 through flexible connection 20 to the coil 21 of regulating solenoid B, thence through a section 22 of starting resistance, thence through connection 23 to the coils 24 of solenoid C, thence to section 25 of starting resistance, thence by conductor 26 to the armature m, and thence to the supply wire S². The switch contact 5 is connected by conductor 27 to a point intermediate the ends of the solenoid winding 24, and the contact 6 is connected by conductor 28 to the conductor 26. The switch arms 1 and 2 are electrically connected to the rod 8 by a conductor 29 which is grounded upon the frame.

Normally the parts are in the positions shown in the drawing. When the hand switch G is closed, to start the motor, the solenoid F is energized, and its core, moving upward, causes the contact 15 to engage the contact 16, thus closing the armature circuit through the starter and also closing the shunt field circuit at the moment of contact. The continued upward movement of the core of the solenoid F causes the rod 8 to lift against the action of the spring 12, and raise the collar 7 off of the switch levers 1 and 2, which are then free to drop, in succession, when the current flowing in the coils of the regulating solenoids falls to a predetermined amount. The solenoid C has a greater length of winding than the solenoid B. The core of the solenoid B will first drop and cause the switch D to close, shunting the coils of solenoid B, the section 22 of starting resistance, and a portion of the windings of the solenoid C, through a shunt circuit which extends from the rod 8 through conductor 29, cross piece A, switch D and conductor 27. When the solenoid C releases its core, the remaining windings of said solenoid and the starting resistance are shunted through a circuit extending from rod 8, conductor 29, frame A, and switch E to conductor 28 and the armature. Both of the regulating coils and both sections of the starting resistance will thus be cut out of circuit and the spring pressed rod will be held up off of the free ends of the switch

levers, by the solenoid F, as long as the switch G remains closed and said solenoid is energized.

As has been shown, when the switch G is closed, the first action of the solenoid F is to close the circuit through the motor and the starter, and after the motor circuit is complete and the regulating solenoids energized, the mechanical support is taken away from the switch arms by the movement of the rod 8 which is forced upward by the solenoid F.

To stop the motor, the hand switch G is opened, causing the solenoid F to become deenergized, whereupon the spring 12 forces the rod 8 downwardly. As the rod moves downward, its collar 7 rocks the switch arms 1 and 2 to open position, thus inserting the resistance in the armature circuit, and immediately after these switches have been opened, the connection between the contacts 15 and 16 is broken by the further downward movement of the core of the solenoid F which carries the live contact 15.

In Fig. 2, the switch arms are held open by the weight of a solenoid core, instead of being held open by a spring as in Fig. 1. In Fig. 2 the live contact 15^a of the main switch is mounted upon a solenoid F' having a core 35 provided with an extension at its lower end which normally enters between and rests upon the free ends of the arms 1^a and 1^b of the switches D and E and holds the switches open. When the core lifts a certain distance the arms are free to move to closed position, controlled by the cores of the regulating solenoids, but the arrangement is such that the arms are not free to close until after the contact 15^a has been brought into engagement with a contact 16^a upon a spring depressed rod 8^a arranged above the solenoid, and when the solenoid F' is deenergized, the contacts 15^a and 16^a will not separate until the solenoid core has rocked the switch arms to open position.

When the solenoid F' is energized by the closing of the hand switch G, to start the motor, its core moves upward, first causing the contact 15^a to engage the contact 16^a, and then moving further against the action of the spring 12^a and lifting clear of the switch arms 1^a and 1^b. The establishment of connection between the contacts 15^a and 16^a completes the circuit to the armature from the side S' of the supply circuit to contact 15^a, thence through contact 16^a and rod 8 to conductor 36, thence through coils of solenoid B, resistance section 22, connection 23, coils of solenoid C, resistance section 25 and conductor 26 to the armature m, and thence to the side S² of the supply circuit. The shunt held winding 18 is shown connected to the supply wire S², and to the contact 16^a by conductor 19.

The operation of the device is substan-

tially the same as in the previously described figure. When the switch G is opened to stop the motor, the solenoid F' is deenergized, its core drops, first opening the switch arms, and the contacts 15^a and 16^a then separate, breaking the electrical connection to the side S' of the supply circuit at that point.

While I have shown the improvements in connection with a particular form of starter, it will be understood that I do not intend to limit the application of the invention to this particular form.

What I claim is:—

1. The combination with a motor starter having a movable member normally in starting position, and movable from said position to the running position, of a main switch adapted to establish and interrupt the flow of current through the armature circuit, said switch comprising a contact secured to said member and a cooperating contact connected to the supply circuit, and an electromagnetic device adapted to first move said latter contact into engagement with the contact on said member, and then move said member into the running position.

2. The combination with a motor starter having a movable member normally in starting position, and movable from said position to the running position, and a main switch contact secured to the member, of a cooperating contact connected to the supply circuit, an electromagnetic device having windings independent of the armature circuit, adapted to first move said latter contact into engagement with the contact on said member and then move said member into the running position, and a switch for controlling said device.

3. The combination with a motor starter comprising a member spring-pressed toward the stop position and movable from said position to the running position, of a main switch adapted to establish and interrupt the flow of current to the armature circuit, said switch comprising a contact secured to said member and a cooperating contact connected to the supply circuit, an electromagnetic device adapted to first move said latter contact into engagement with the contact on said member and then move said member against the action of its spring into the running position.

4. The combination with a motor starter comprising a member spring-pressed toward the stop position and movable from said position to the running position, and a main switch contact secured to the member, of a cooperating contact connected to the supply circuit and an electromagnetic device having windings independent of the armature circuit adapted to move said latter contact into engagement with the contact on

said member and then move said member against the action of its spring into the running position and a switch for controlling said electromagnetic device.

5 5. The combination with a starter for electric motors comprising a switch member, adapted to cut out starting resistance, means for normally holding the same in open position, regulating means, having coils in the
10 armature circuit, for regulating the closing movement of said member, an electromagnetic device adapted, when energized, to first close the circuit through the coils of said regulating means and the armature and
15 then move said holding means to release the switch member, and a switch for opening and closing the circuit through said electromagnetic device.

6. The combination with a starter for electric motors comprising a switch member, adapted to cut out starting resistance, a
20 spring-pressed device for normally holding the same in open position, regulating means, having coils in the armature circuit, for regulating the closing movement of said member, an electromagnetic device, having windings
25 independent of the armature circuit, adapted, when energized, to first close the circuit through the coils of said regulating means and the armature and then move said holding
30 means to release the switch member, and a switch for opening and closing the circuit through said electromagnetic device.

7. The combination with a starter for electric motors comprising a normally open
35 resistance-controlling switch, and an electromagnetic regulating device therefor connected in the armature circuit, of a main switch adapted to first close the armature
40 circuit and to then cooperate mechanically with the starter in releasing the resistance controlling switch so that the latter may close when the current in the regulating device falls below a predetermined quantity.

45 8. The combination with a starter for electric motors comprising a normally open

resistance-controlling switch, and an electromagnetic regulating device therefor connected in the armature circuit, of a main
50 switch adapted to first close the armature circuit and to then cooperate mechanically with the starter in releasing the resistance controlling switch so that the latter may close when the current in the regulating device falls below a predetermined quantity,
55 an electromagnet for closing the main switch, and a circuit for said electromagnet independent of the armature circuit.

9. The combination with a starter comprising a normally open resistance-controlling switch, and electromagnetic regulating
60 means therefor connected in the armature circuit, of a main switch for the armature circuit comprising two members, one having a contact adapted to yield when engaged
65 by the other, and means whereby one of said members cooperates mechanically with the starter to release the resistance-controlling switch after said members have closed the
70 armature circuit.

10. The combination with a starter comprising a normally open resistance-controlling switch, and electromagnetic regulating
75 means therefor connected in the armature circuit, of a main switch for the armature circuit comprising two members, one having a contact spring-pressed toward the
80 other, a magnet for moving the later member to closed position, a circuit for said magnet independent of the armature circuit, and means whereby one of said members
85 cooperates mechanically with the starter to release the resistance-controlling switch after said members have closed the armature circuit.

In testimony whereof I affix my signature, in presence of two witnesses.

GEORGE H. WHITTINGHAM.

Witnesses:

FRIEDA ERNST,
M. E. NICORE.