No. 891,721. PATENTED JUNE 23, 1908.

W. C. O'BRIEN.

STARTER FOR ELECTRIC MOTORS.

APPLICATION FILED APR. 9, 1907. RENEWED NOV. 22, 1907.

2 SHEETS—SHEET 1

Fig. 1.

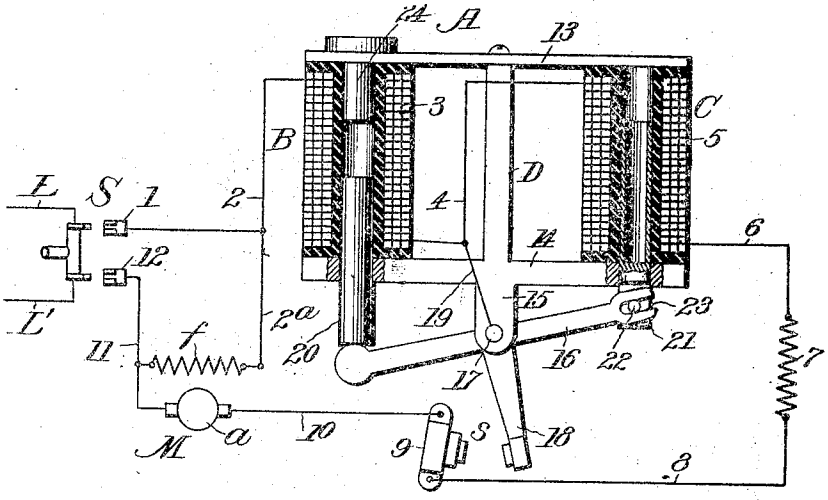
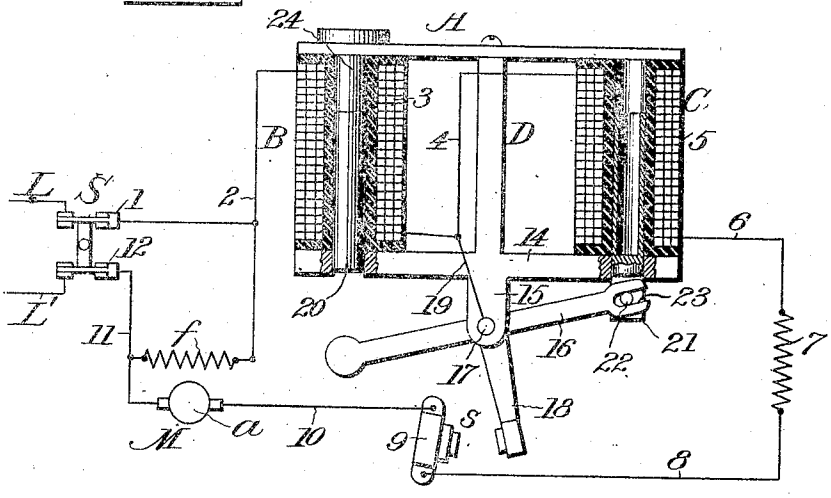


Fig. 2.



Inventor

Wm C. O'Brien

Witnesses

C. H. Walker

Thomas Howe.

By

Robert Watson

Attorney

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2 SHEETS—SHEET 2.

Fig. 3.

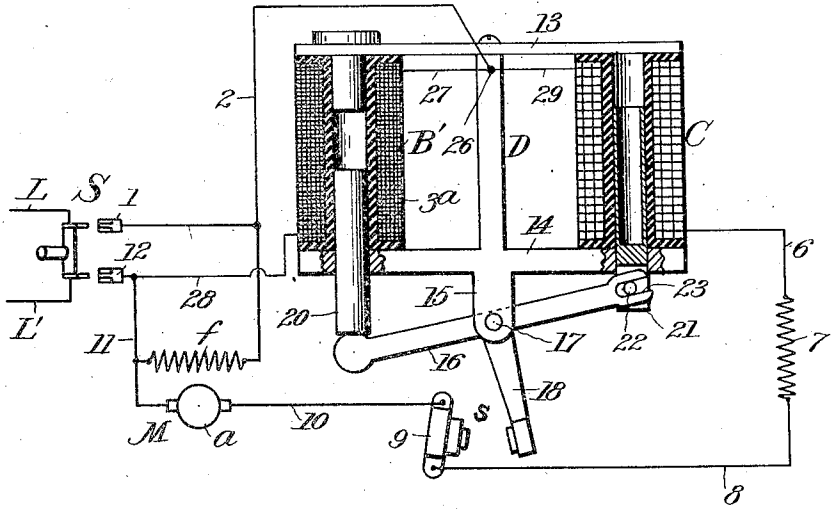
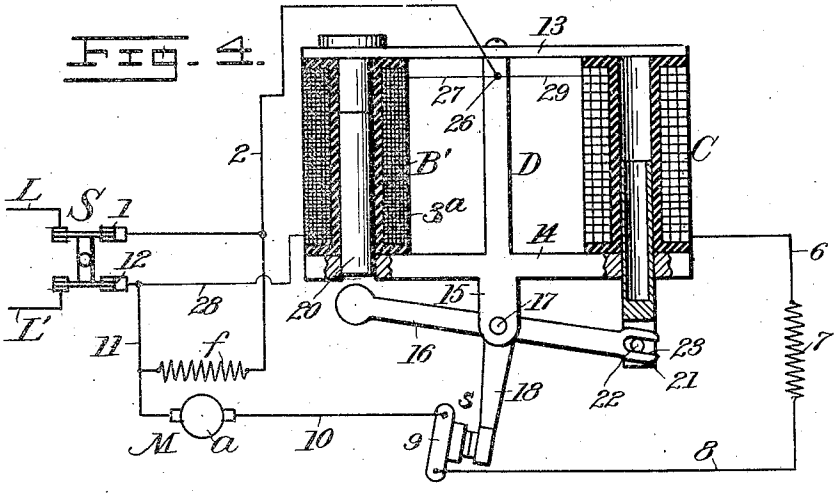


Fig. 4.



Inventor

Wm C. O'Brien

Witnesses

Thomas Howe.

Newton Wells.

By

Robert Watson

Attorney

UNITED STATES PATENT OFFICE.

WILLIAM C. O'BRIEN, OF BALTIMORE, MARYLAND, ASSIGNOR TO MONITOR MANUFACTURING COMPANY OF BALTIMORE CITY, OF BALTIMORE, MARYLAND, A CORPORATION OF MARYLAND.

STARTER FOR ELECTRIC MOTORS.

No. 891,721. Specification of Letters Patent. Patented June 23, 1908.

Application filed April 9, 1907, Serial No. 367,192. Renewed November 22, 1907. Serial No. 403,342.

To all whom it may concern:

Be it known that I, WILLIAM C. O'BRIEN, a citizen of the United States, residing at Baltimore, in the 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 improvements in automatic starters for electric motors, of the kind shown in my copending application, Serial No. 333,987, filed September 10, 1906, in which the cutting out of the starting resistance is regulated by the quantity of current flowing in the armature circuit.

In the accompanying drawing, Figure 1 is a side elevation, partly in section of a starter suitable for cutting out a single step or section of resistance from the armature circuit, the solenoids of the starter being connected in series, and the parts being shown in their normal positions; Fig. 2 is a similar view, showing the positions of the parts at the time the line switch is first closed and before the current in the armature circuit has fallen to a predetermined quantity; Fig. 3 is a view of a similar starter, with the parts in normal positions, the coils of the holding solenoids being connected in shunt to the terminals of the line switch, and the coils of the regulating solenoid being connected in series with the starting resistance and armature, and Fig. 4 is a similar view, of the starter shown in Fig. 3, with the line switch closed and the regulating solenoid and starting resistance cut out.

Referring to Figs. 1 and 2 of the drawing, L and L′ indicate the terminals of the line or supply circuit and S indicates the line switch for connecting the motor M to the line through the motor starter A. The armature circuit of the motor extends from the line switch terminal 1 through conductor 2, solenoid coils 3, conductor 4, solenoid coils 5, conductor 6, starting resistance 7, conductor 8, stationary contact 9, thence by conductor 10 to the brush of the armature *a* and thence by conductor 11 to the line switch terminal 12. The motor shown in the drawing is a shunt wound motor and its field *f* is connected to the switch terminals 1 and 12 through conductors 2, 2^a and 11. The coils 3 and 5 of solenoids B and C, respectively, are of low resistance and adapted to carry the entire armature current and the solenoids are vertically arranged, parallel with one another, between cross bars 13 and 14 of a suitable supporting frame D. An arm 15 depends from the lower cross bar of the frame, midway between the solenoids, and the lever 16 is centrally supported on this arm by a pivot pin 17. A switch arm 18, rigidly connected with the lever 16, is adapted to be moved into and out of engagement with the fixed contact piece 9, according to the direction in which the lever 16 is rocked. The switch arm is connected to the conductor 4, between the coils of the solenoids by a branch conductor 19. When the switch *s*, formed by the switch arm 18 and the stationary contact piece 9 is closed, it will be noted that the conductor 19, switch arm and contact piece form a shunt circuit around the solenoid C and the resistance 7.

The lever 16 supports at its ends the cores of the solenoids B and C and the switch *s* is held normally open by the core 20 of the solenoid B which is heavier than the core 21 of the solenoid C. The core 20, made of solid iron or steel, is not attached to the lever 16 but merely rests upon one end of it, so that the core can move without moving the lever. The core 21 as shown in the drawing, is of the same external dimensions as the core 20, but it is made of tubular iron or steel so as to be lighter than the core 20, and at its lower end the core 21 is connected to the lever 16 by a pin 22 extending through the core and through a slot 23 in the lever, so that the core and the lever will necessarily move together.

The operation of the starter shown in Fig. 1 is as follows: As long as the line switch S remains in the open position, as shown in said figure, the parts of the starter remain in the positions shown. As soon as the line switch is closed, current passes through both solenoids, the starting resistance and the motor. The solenoid core 20 is instantly drawn up, as shown in Fig. 2, against a magnet core 24, arranged in the upper end of the coil 3 and energized thereby. When the core 20 is lifted from the lever 16 the core 21 of the solenoid C is left without mechanical support, as shown in Fig. 2, and is free to move downward, but the windings of the latter solenoid are so proportioned that its core will be held up as long as the current in the armature circuit is above the normal full load current of the armature, or any prede-

termined quantity. The switch *s*, will thus be held open, and the resistance 7 maintained in the armature circuit after the line switch is closed, until the current flowing in the armature circuit is reduced to a predetermined safe quantity, by the rotation of the armature, when the core 21 will drop and move the lever 16 and the switch arm 18 to close the switch *s*. The armature current will then flow from the terminal 1, around the coils of solenoid B and thence through conductor 19 and switch *s* to the armature, thus short circuiting the coils of solenoid C and the starting resistance 7. The core 20 will remain up and the core 21 will remain down as long as the motor runs under normal conditions; but when the line switch is opened, or the voltage on the line is abnormally lowered, the solenoid B will be de-energized or weakened and the core 20 will drop onto the lever and thus force the lever, switch arm and core 21 back into their normal positions, so that the switch *s* will be in open position and the resistance 7 and coils of solenoid C will be in circuit with the armature.

When the motor starts with a load the current in the armature circuit will always be sufficient to raise the core of the holding solenoid when the line switch is first closed, and after said core has moved into engagement with the magnet core 24, it will be supported by the core 24 if only a small quantity of current flows through the armature circuit thereafter.

When the motor starts without load, it may be desirable, in order to insure the upward movement of the core of the holding solenoid, to connect the coils of the latter in shunt to the line switch terminals, instead of in series with the motor armature. This is shown in Figs. 3 and 4. In these figures of the drawing, the wire 2, leading from the switch terminal 1 is grounded at 26 on the frame D. From the frame a wire 27 leads to one end of the coils 3^a of the holding solenoid B′, and a conductor 28 extends from the other end of the solenoid coils to the opposite switch terminal 12. The regulating solenoid coil is connected in series with the starting resistance and armature, the coil being connected at one end to the conductor 6, and at the other end, by a conductor 29 to the frame of the starter, which is electrically connected to the line terminal 1 by the conductor 2.

In Fig. 3, the parts are shown in normal positions. When the switch S is closed, the core 20 jumps up, regardless of the quantity of current flowing in the armature circuit; but the core of the regulating solenoid remains in its upper position until the quantity of current in the armature circuit falls to a predetermined quantity, when it drops, thereby rocking the switch arm 18 to closed position, as shown in Fig. 4. The armature current then flows from conductor 2 to frame D, thence through switch arm 18, stationary switch member 9, and conductor 10 to the armature, the solenoid C and starting resistance being shunted. When the line switch is opened, the core of the holding solenoid drops onto the lever and re-sets the starter as shown in Fig. 3.

I claim,—

1. In an automatic starter for electric motors, a starting resistance in the armature circuit, a regulating solenoid having windings in said circuit, a switch for cutting out said resistance and windings, said switch comprising a lever having one arm connected to the core of the regulating solenoid, and a holding solenoid having its core adapted to rest upon the opposite arm of the lever and to support the core of the regulating solenoid within its coils and the switch in open position, said holding solenoid being arranged to lift its core and release the lever when the current is turned on.

2. In an automatic starter for electric motors, a starting resistance in the armature circuit, a regulating solenoid having its windings in said circuit, a switch for short-circuiting said windings and resistance, said switch comprising a lever having one arm pivotally connected to the core of said solenoid and movable by the weight of said core to close the switch when the core is released from its coils, a holding solenoid having a heavier core than the core of said regulating solenoid said heavy core being adapted to rest loosely upon the opposite arm of said lever and thereby hold the switch in open position and the core of the regulating solenoid in an upper position when the current is turned off, and said holding solenoid being adapted to move its core upwardly from the lever when the current is turned on.

3. In an automatic starter for electric motors, a starting resistance in the armature circuit, a regulating solenoid having its windings in said circuit, a switch for cutting out said resistance and windings, said switch comprising a lever having one arm connected to the core of the regulating solenoid, and a holding solenoid having its windings in the armature circuit and having its core adapted to bear upon the opposite arm of the lever and to support the core of the regulating solenoid in an upper position and the switch in open position, said solenoid being adapted to lift its core and release the lever when the current is turned on.

4. In an automatic starter for electric motors, a starting resistance in the armature circuit, a regulating solenoid having its windings in said circuit, a switch for short-circuiting said windings and resistance, said switch comprising a lever having one arm pivotally connected to the core of said solenoid and movable by the weight of said core to close

the switch when the core is released from its coils, a holding solenoid having its windings in the armature circuit and having a core heavier than the core of said regulating solenoid, said heavier core being adapted to rest loosely upon the opposite arm of said lever and thereby hold the switch in open position and the core of the regulating solenoid in an upper position when the current is turned off, and said holding solenoid being adapted to move its core upwardly from the lever when the current is turned on.

5. In an automatic starter for electric motors, a starting resistance in the armature circuit, a regulating device having windings in said circuit and having a core or armature, a switch for cutting out said resistance and windings, said switch being connected to said core so as to move therewith, an electromagnetic holding device having a core or armature, and connections between said cores whereby the core of the holding device normally overbalances the core of the regulating device and holds the switch in open position, said holding device being arranged to lift its core from said connections when current is turned on.

6. In an automatic starter for electric motors, a starting resistance in the armature circuit, a regulating device having windings in said circuit and having a core or armature, a switch for cutting out said resistance and windings, said switch being connected to said core so as to move therewith, a lever pivotally connected to said core, an electromagnetic holding device having a core or armature adapted to bear upon said lever and to thereby hold the core or armature of the regulating device inoperative relative to its coils and the switch in open position, said holding device being arranged to lift its core and release the lever when current is turned on.

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

WILLIAM C. O'BRIEN.

Witnesses:
ROBERT WATSON,
CLAY JEWELL.