G. H. WHITTINGHAM & W. C. O'BRIEN.

AUTOMATIC MOTOR STARTER.

APPLICATION FILED OCT. 2, 1908.

965,840. Patented July 26, 1910.

Fig. 1.

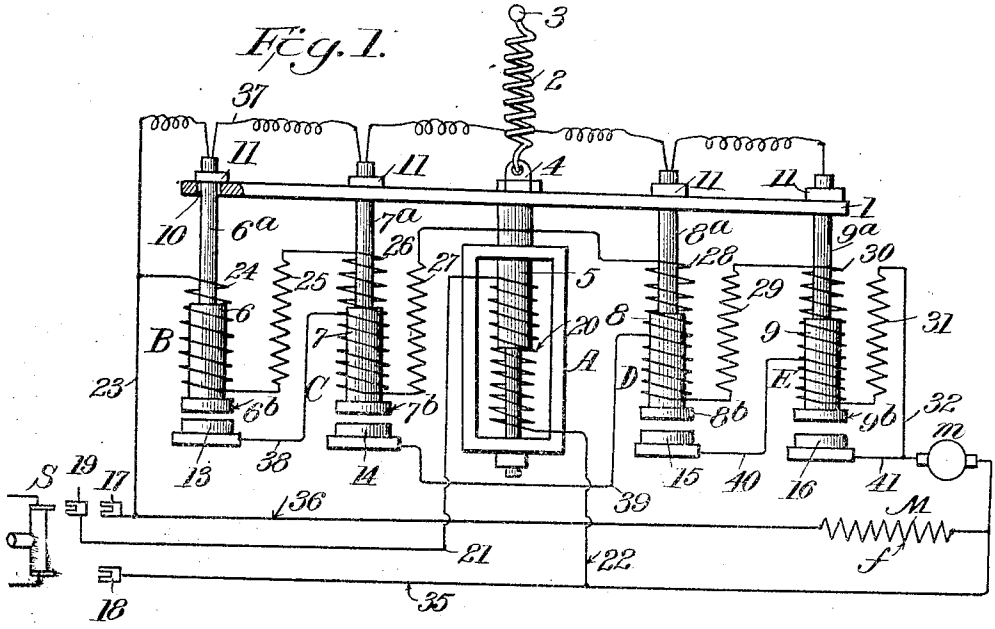
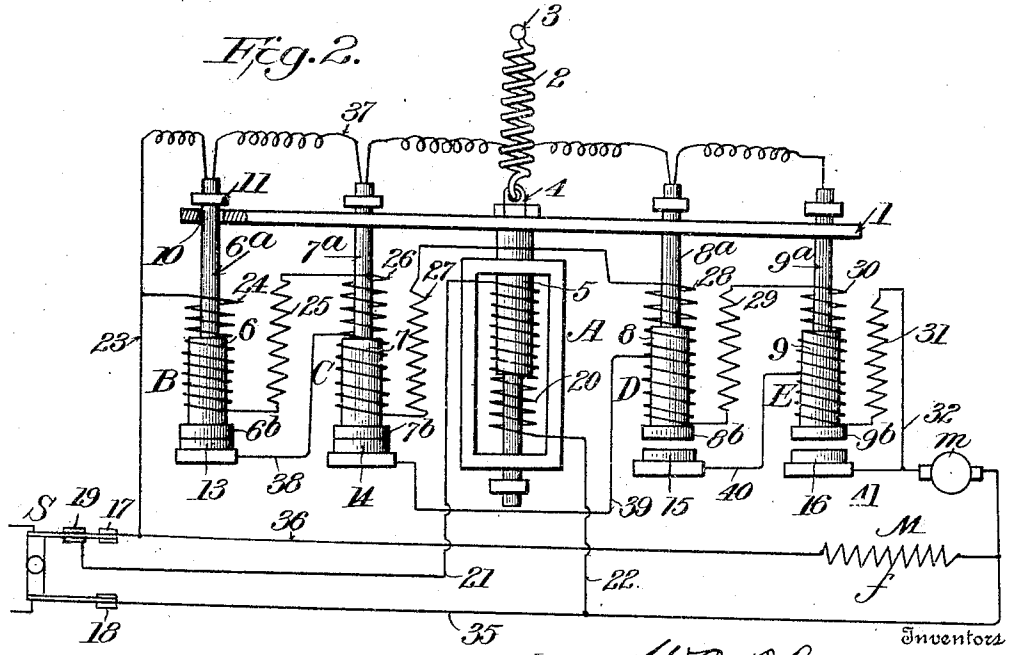


Fig. 2.



Inventors

W. C. O'Brien

G. H. Whittingham

Witnesses

E. M. Walker

Newton P. Willis

By

Robert Watson

Attorney

UNITED STATES PATENT OFFICE.

GEORGE H. WHITTINGHAM AND WILLIAM C. O'BRIEN, OF BALTIMORE, MARYLAND, ASSIGNORS TO MONITOR MANUFACTURING COMPANY OF BALTIMORE CITY, A CORPORATION OF MARYLAND.

AUTOMATIC MOTOR-STARTER.

965,840. Specification of Letters Patent. **Patented July 26, 1910.**

Original application filed April 9, 1907, Serial No. 367,193. Divided and this application filed October 2, 1908. Serial No. 455,861.

To all whom it may concern:

Be it known that we, GEORGE H. WHITTINGHAM and WILLIAM C. O'BRIEN, citizens of the United States, residing at Baltimore, in the State of Maryland, have invented certain new and useful Improvements in Automatic Motor-Starters, of which the following is a specification.

This invention comprises improvements in automatic controllers for electric motors of the kind in which the cutting out of the starting resistance is regulated by the quantity of current flowing in the armature circuit.

This application is a division of our copending application, Ser. No. 367,193, filed April 9, 1907.

In the accompanying drawing Figure 1 is a side elevation of the controller, the circuits being shown diagrammatically and the movable parts being shown in their normal positions, and Fig. 2 is a similar view, illustrating the operation of the mechanism.

Referring to the drawing, 1 represents a metal cross-bar and 2 indicates a spring having one end secured to a stationary support 3 and its opposite end connected to an eye 4, which is rigidly attached to the center of the cross-bar. The core 5 of an iron clad holding solenoid A is rigidly secured to the center of the cross bar and projects downwardly therefrom, the arrangement being such that when the solenoid is energized the cross bar will be moved downwardly against the action of the spring. The cross bar normally supports the core 5 and also the cores 6, 7, 8 and 9, of regulating solenoids B, C, D and E, respectively. The cores 6, 7, 8 and 9 are suspended from the cross bar by rods of copper or other non-magnetic metal, indicated at 6^a, 7^a, 8^a and 9^a, respectively. These rods are driven into suitable openings in the upper ends of the cores, making good mechanical and electrical connections therewith, and extend loosely through openings 10 in the cross bar, and are provided with stops 11 which rest upon the top of the bar. The cores 6, 7, 8 and 9 are provided with contact disks or blocks 6^b, 7^b, 8^b and 9^b, of suitable metal, such as copper, having flat lower surfaces, and these cores are supported so that said contact blocks will be normally held out of contact with stationary contact steps or blocks 13, 14, 15 and 16, respectively, having flat contact surfaces adapted to be engaged by the flat contact disks on the solenoid cores.

The line or supply switch for connecting the controlling apparatus and the motor with the supply circuit is indicated at S, and it is shown with the two usual terminals 17 and 18 and an auxiliary terminal 19. The winding 20 of the holding solenoid A has one of its ends connected by a conductor 21 to the auxiliary terminal 19 and its other end connected by conductors 22 and 35 to the line switch terminal 18, the circuit arrangement being such that the solenoid A will be energized each time the line switch is closed and will be deënergized as soon as the line switch is opened. Thus, the solenoid A will draw the cross head or bar 1 downward as soon as the switch is closed and the cross head will remain down until the switch is opened, when it will be moved upward by the spring 2.

The windings of the solenoids B, C, D and E, are arranged in series with one another and with the starting resistance and with the armature *m* of the motor M. These windings are all of low resistance in order to carry the full starting current, and they are all operative for the purpose of regulating the descent of the solenoid cores. The circuit is traced as follows: From the line switch terminal 17, through conductor 23, winding 24, resistance section 25, winding 26, resistance section 27, winding 28, resistance section 29, winding 30, resistance section 31, conductor 32, armature *m* and conductor 35 to line switch terminal 18. A shunt winding for the motor field is indicated at *f*, its terminals being connected to the line switch terminals by conductors 35 and 36, respectively. The rods 6^a, 7^a, 8^a and 9^a, are electrically connected to the terminal 17 of the supply circuit switch by a flexible conductor 37 which permits the rods to move independently, said conductor having one end connected to the conductor 23 leading to the supply circuit switch. Conductors 38, 39 and 40 connect the stationary contacts 13, 14 and 15 with the coils of the solenoids C, D and E, respectively, at points between the ends of said coils, and a conductor 41 connects the stationary contacts 16 with the

conductor 32 leading to the motor armature. When the line switch S is moved to closed position, the solenoid A is energized, and its core is immediately drawn downward, thereby moving the cross bar 1 away from the collars on the rods 6, 7, 8 and 9, and placing the spring 2 under tension. The cores of the regulating solenoids, B, C, D and E, will remain suspended owing to the abnormal quantity of current flowing in the armature circuit immediately after the closing of the switch, the quantity of current permitted to flow at the start being, of course, regulated by the amount of starting resistance. The solenoids C, D and E may be all similarly wound, with the same length of wire, while the solenoid B has a shorter winding than the others in the series. If the maximum current which can pass through the resistance at starting is, say 50 per-cent. above the normal full load current of the motor, the winding of the solenoid B may be such that it will sustain its core with this amount of current flowing, but with a 10 per-cent. decrease in the current, as the motor accelerates, it will release its core, while the other solenoids D, E, F, having greater lengths of windings in circuit at the start, will not release their cores with this decrease in current. When the core of the solenoid B drops, however, it cuts out its own coils, one section, 25, of the resistance and a part of the windings of the solenoid C, thus weakening the latter solenoid so that after the temporary rise in the current which results from the cutting out of the resistance section, when the current falls to a predetermined amount, which may be the same amount that was flowing when the core of the solenoid B dropped, the core of the solenoid C will drop. This cuts out the remainder of its own coils, the resistance section 27 and a part of the coils of the next solenoid D, weakening the latter so that when the current falls as before, the core of the latter solenoid will drop and cut out the remainder of its own coils, resistance section 29 and part of the coils of the solenoid E. When the current again falls to a predetermined amount, the solenoid E will release its core and the remainder of its coils and the last resistance section 31, will be cut out.

The operation of the device in cutting out the resistance is illustrated in Fig. 2, wherein the line switch is closed, the cross bar moved down and the cores of the first two solenoids, B and C, in the series are down, while the cores of the last two solenoids D and E, are still supported by the action of the current in their coils. When the core of the solenoid B drops, it will be seen that the current, instead of flowing through its coils and the resistance section 25, will flow from the line switch terminal 17 through a low resistance path formed by the flexible conductor 37, conducting rod 6^a, solenoid core 6, contacts 6^b and 13, and conductor 38 to a point intermediate the ends of the coils of the solenoid C, thus short circuiting all of the coils of the solenoid B, the resistance section 35 and a part of the coils of the solenoid C. When the core of the solenoid C drops, a path for the current will be formed from the flexible conductor 37 through the conducting rod 7^a, core 7, contacts 7^b and 14, and conductor 39 to a point intermediate the ends of the winding of the solenoid D, thus short circuiting the remaining coils of the solenoid C, the resistance section 27 and part of the coils of the solenoid D. Similarly, when the core of the solenoid D drops, the current will flow from the flexible conductor 37 through the rod 8^a, core 8, contacts 8^b and 15, and conductor 40, and when the core of the solenoid E drops, the current will have a direct low resistance path to the motor armature from the flexible conductor through the rod 9^a, core 9, contacts 9^b and 16 and conductors 41 and 32. As soon as the line switch is opened to stop the motor, the solenoid A is deënergized and the spring moves the cross head 1 upwardly into the position shown in Fig. 1. The cores of the solenoids B, C, D and E are thereby moved to separate the contacts at their lower ends, and the windings of said solenoids and the resistance sections are thereby again placed in circuit ready for starting.

In a device of this kind, as the contact members for cutting out the resistance are held together only by the weights of the cores it is desirable, in order to prevent heating, to provide even surfaces of ample area and as few contacts as possible. By the construction shown, wherein non-magnetic conducting rods project upward from the cores of the magnets and the cores are connected into the circuit by flexible conductors leading to such rods, it is possible to support the cores from above the solenoids and utilize the cores as switch members thereby requiring but one stationary contact beneath each core.

What we claim is—

1. An automatic starter for electric motors comprising a starting resistance in the armature circuit, a series of regulating solenoids having all of their operative windings of low resistance and arranged in said circuit, shunt circuits for cutting out windings of each solenoid, a section of starting resistance and a part of the coils of a succeeding solenoid, each of said shunt circuits comprising a solenoid core, a stationary contact below said core adapted to be engaged by the core and a flexible conductor connected to the core, in combination with means for normally supporting said cores

above said contacts and an electro-magnetic device for releasing said cores when current is turned on.

2. An automatic starter for electric motors comprising a starting resistance in the armature circuit, a series of regulating solenoids having all of their operative windings of low resistance and arranged in said circuit, shunt circuits for cutting out windings of each solenoid, a section of starting resistance and a part of the coils of a succeeding solenoid, each of said shunt circuits comprising a solenoid core, a stationary contact below said core adapted to be engaged by the core, a conducting rod secured to the core and a flexible conductor connected to said rod, said rods having shoulders or stops thereon, in combination with a spring supported cross bar normally engaging said shoulders to support the cores in an upper position, and electro-magnetic means for moving said cross bar away from said shoulders when current is turned on.

In testimony whereof we affix our signatures, in presence of two witnesses.

GEORGE H. WHITTINGHAM.
WILLIAM C. O'BRIEN.

Witnesses:
FELIX R. SULLIVAN,
F. HERBERT PREM.