G. H. WHITTINGHAM.

MOTOR STARTER.

APPLICATION FILED AUG. 4, 1908. RENEWED DEC. 31, 1909.

965,675.

Patented July 26, 1910.

2 SHEETS—SHEET 1.

Fig. 1.

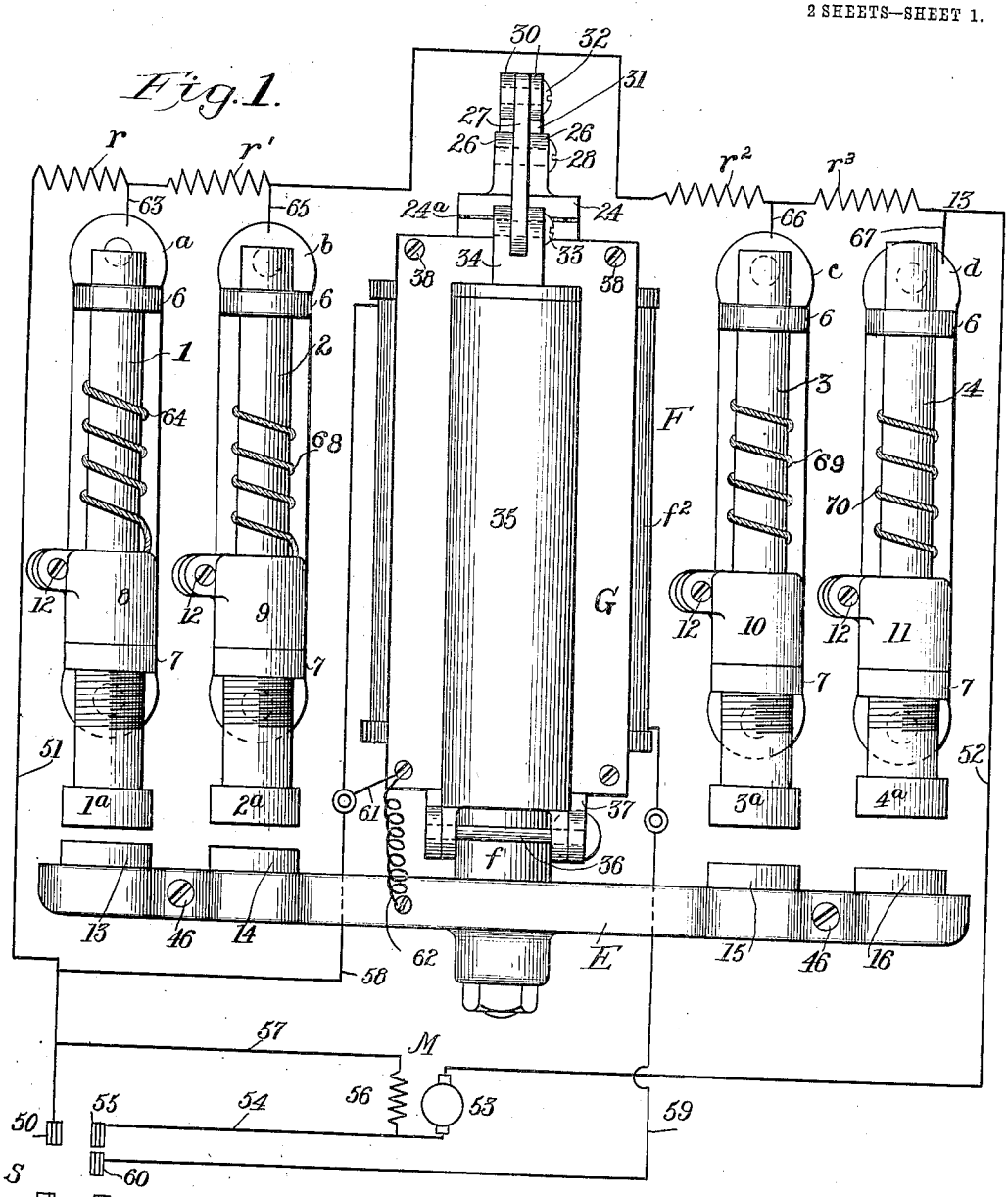
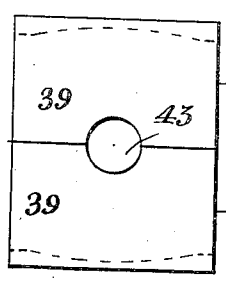


Fig. 2.



Witnesses

Trevor P. Wells

Thomas Howe

Inventor

G. H. Whittingham

By Robert H. Watson

Attorney

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2 SHEETS—SHEET 2.

Fig. 3.

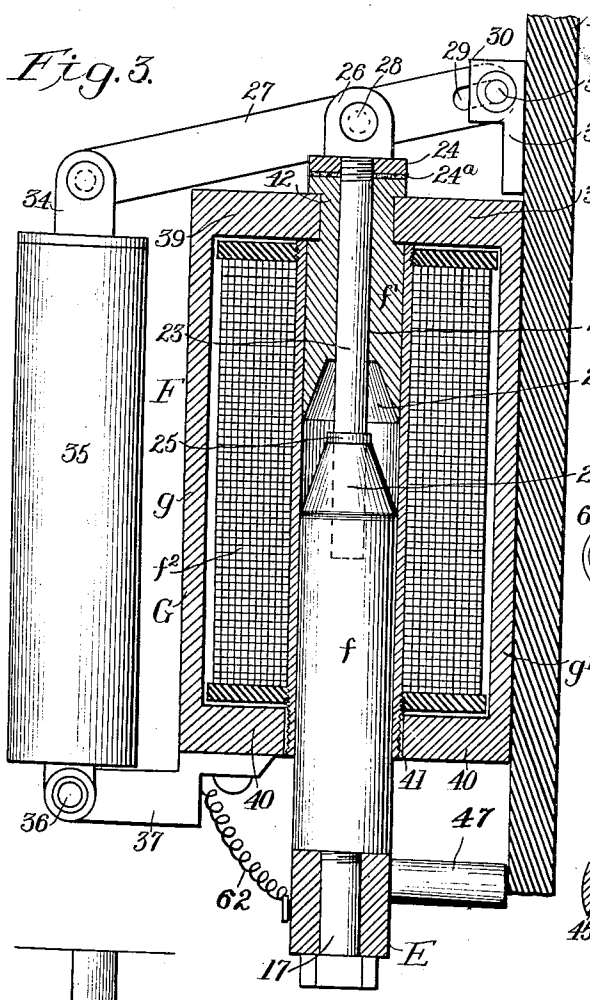


Fig. 4.

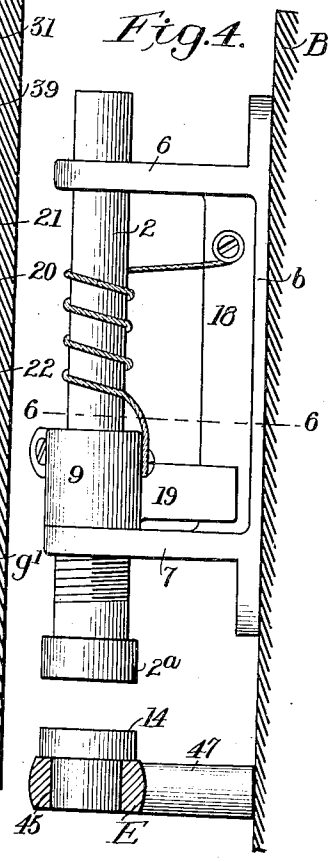


Fig. 5.

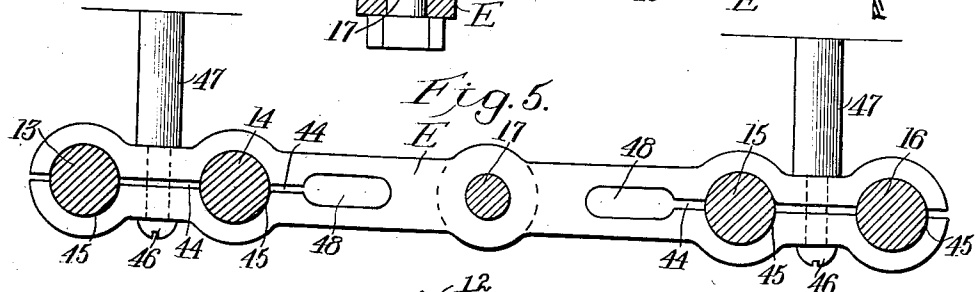
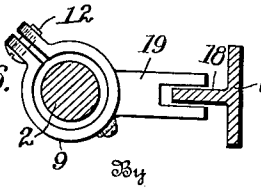


Fig. 6.



Witnesses

Newton P. Willis

Thomas Howe

Inventor

G. H. Whittingham

By

Robert Walson,

Attorney

UNITED STATES PATENT OFFICE.

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

MOTOR-STARTER.

965,675. Specification of Letters Patent. Patented July 26, 1910.

Application filed August 4, 1908, Serial No. 446,900. Renewed December 31, 1909. Serial No. 535,903.

To all whom it may concern:

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

This invention comprises certain improvements in starters, for electric motors, the details and advantages of which will be clear from the following specification taken in connection with the accompanying drawing, in which,

Figure 1 is a front view of the starter, the circuits being shown diagrammatically; Fig. 2 is a top plan view of the solenoid casing, Fig. 3 is a central section through the solenoid of the starter, taken from front to rear; Fig. 4 is a side elevation of one of the movable contact members, and its supporting bracket, the short circuiting bar being shown in section; Fig. 5 is a top plan view of the short circuiting bar, the contact blocks being shown in section; and Fig. 6 is a section on the line 6—6 of Fig. 4.

Referring to the drawing, 1, 2, 3 and 4 indicate rods which extend through guide openings in the arms 6 and 7 of brackets *a*, *b*, *c* and *d* which are suitably secured upon a switch board and insulated from one another, except for the connection between them through the starting resistance indicated at r, r' r^2 and r^3, as hereinafter referred to. The rods 1 to 4, inclusive, are made of metal and collars 8, 9, 10 and 11 are threaded on to the rods above the bracket arm 7. Preferably each collar is split and provided with a clamping screw 12 by means of which the collar may be gripped as tightly as desired upon the threaded rod to prevent accidental turning of the rod in the collar. Copper contact blocks 1^a, 2^a, 3^a and 4^a are provided upon the lower ends of the rods opposite carbon contact blocks 13, 14, 15 and 16 upon the short circuiting bar E which is secured to the movable core *f* of a solenoid F. As shown, a bolt 17 extends through the center of the short circuiting bar and into the lower end of said core. Each of the brackets *a*, *b*, *c*, and *d* has a vertical web 18 on its forward side between the arms 6 and 7, and each of the collars, 8 to 11, inclusive, has a slotted or forked projection 19 which straddles the web on the bracket so that the web serves as a guide to prevent the collar from turning. By turning the rods or plungers 1, 2, 3 and 4, as the collars are prevented from turning, the rods may be adjusted to any desired distance from the contact blocks on the short circuiting bar, and, in practice, the rods are adjusted so that the contact blocks 1^a, 2^a, 3^a and 4^a, at their lower ends will be at successively greater distances from the opposing blocks on the short circuiting bar, as shown in Fig. 1 of the drawing. The clamping screws 12 are preferably set so as to hold the rods against accidental turning but to permit the rods to be turned by hand, when desired, without loosening the screws.

The solenoid has in its upper portion a stationary core *f'* which core has a conical recess 20 in its lower end and a central bore 21. The upper end portion 22 of the movable core *f* is conical so as to fit into the recess 20 and a brass rod 23, threaded into the upper end of the core *f* extends through the bore 21 in the stationary core *f'* and into a block or fitting 24, which serves as a stop to limit the downward movement of the core *f*, and the short circuiting bar attached to said core. A collar 25 of brass or other non-magnetic metal upon the rod 23 prevents the conical faces of the two cores from coming into actual contact and adhering when the movable core is drawn upward. Ears 26 project upwardly from the stop block or fitting 24 and a lever 27 is pivotally mounted upon a stud 28 which passes through said ears. One end of this lever has a slot 29 entering between the arms or forks 30 of a bracket 31 which is secured to the switch board B above the solenoid. A pivot pin 32 fixed in the forks 30 extends through the slot 29 in the lever. The free end of the lever is connected by a pivot pin 33 to the plunger 34 of a dash pot 35 which is arranged in front of the solenoid casing G. The lower end of the dash pot is connected by a pivot pin 36 to a bracket 37 which is secured to the under side of the solenoid casing. The arrangement is such that when the solenoid core *f* is lifted it will swing the lever 27 about the fixed pivot 32, and a short movement of the solenoid core will give an extended movement to the dash pot plunger for the reason that the pivotal connection 28 is between the ends of the lever and closer to the fulcrum pin 32 than to the outer or free end of the lever.

The solenoid is of the iron-clad type and the iron casing G is made of two similar halves g and g' connected by screws 38. Each half of the casing, as shown, consists of an upright side with laterally projecting end portions 39 and 40 through which the fastening screws extend. A circular opening 41 extends through the center of the bottom of the casing and is of sufficient diameter to permit the movable core f to slide freely therethrough. The stationary core f' has an annular recess 42 and the upper end of the casing has an opening 43 of smaller diameter than the body of the core f' so that when the two parts of the casing are placed together the two halves of the upper end of the casing will fit into the annular recess and hold the core f' against longitudinal movement.

The short circuiting bar E has slots 44 extending inward from its ends for a considerable distance and intersecting the openings 45 for the carbon blocks. Clamping screws 46 extend through the bar and into distance pieces 47 which abut against the switch board and hold the bar parallel with the board in its upward and downward movement. These clamping screws 46 also compress the split ends of the bar around the carbon blocks, to hold them in position and make good electrical contact therewith. The distance pieces 47 are preferably made of some light material, such as hard wood or insulating composition, and to make the bar E light, and also to give the required resiliency to the split ends of the bar, the bar is cast with openings 48, and the kerfs or slots 44 extend from the ends of the bar to these openings.

For the purpose of illustration I have shown the circuit connections for an electric motor diagrammatically in Fig. 1. In said figure, s indicates the line switch for connecting the motor circuits with the supply circuit. From the terminal 50 the armature circuit extends by conductor 51 through the resistance r, r', r^2, r^3, to conductor 52, thence through the armature 53 of the motor M, thence by conductor 54 to the switch terminal 55. The field winding 56 is connected by the conductors 54 and 57 to the switch terminals 55 and 50, respectively. The terminals of the coil f^2 of the solenoid are connected by conductors 58 and 59 to the terminals 50 and 60, respectively, of the switch s. The terminal 60 is an auxiliary terminal, having no connections with the adjacent motor circuit terminal 55. It will be noted that when the line switch is closed the terminals of the solenoid coil will be connected directly to the supply circuit. The solenoid is wound with fine copper wire of sufficient length to require no artificial resistance and to prevent over heating when connected across the line for an indefinite period. The conductor 58 is grounded by the connection 61 on the solenoid casing G, and a flexible conductor 62 connects the solenoid casing with the short circuiting bar E. The bracket a is connected by a conductor 63 to one end of the resistance section r, and a flexible conductor 64 secured to the bracket a and wound loosely around the rod or plunger 1 connects the collar 8 with said bracket. Similarly the brackets b, c and d are connected to successive resistance sections by conductors 65, 66 and 67 and said brackets are connected by flexible conductors 68, 69 and 70 to the collars 9, 10 and 11, respectively. The flexible connections between the brackets and the collars are best illustrated in Fig. 4.

In operation when the line switch s is closed the solenoid F is energized and its core f is drawn upward, being retarded in the upward movement by the dash pot. As the core moves upward, the short circuiting bar E, secured to the core, engages and lifts, in succession, the rods or plungers 1, 2, 3, 4. When the short circuiting bar engages the contact block 1^a on the plunger 1 the section r of the starting resistance is cut out, the current then flowing from the terminal 50, through conductors 58, 61 and 62 to the short circuiting bar, thence through the plunger 1, collar 8, flexible conductor 64, bracket a and conductor 63 to the resistance sections r', r^2, r^3 and thence by conductor 52 to the armature and by conductor 54 to the switch terminal 55. When the short circuiting bar engages the contact block 2^a on the next plunger 2, the section r' will be cut out, the armature circuit being completed from the short circuiting bar through said plunger, collar 9, flexible conductor 68, bracket b and connections 65 to the resistance sections r^2, r^3, and thence by conductor 52 to the armature. Similarly when the short circuiting bar engages the contact block on the plunger 3, the section r^2 of resistance will be short circuited, the current flowing from the short circuiting bar through the plunger 3, bracket c and connection 66 and thence through the resistance section r^3 to the conductor 52, and when the short circuiting bar engages the contact on the last plunger 4, of the series, the resistance section r^3 will be short circuited, the current flowing from the short circuiting bar through the plunger 4, flexible conductor 70, bracket d and conductor 52 to the armature.

It is common practice, in the construction of starters, to arrange the operating solenoid so that its core will have a long movement in order to move the short circuiting bar or armature the required distance to cut out the starting resistance, and as the work to be performed by the solenoid is practically uniform, in the ordinary starter during the entire movement of the core and short circuit-

ing bar, it is usual to wind the solenoid so that it will receive for a short time more current than its coils could stand without injury for a longer period of time, and after the solenoid has performed its work of lifting the short circuiting bar, the solenoid coils are usually cut out of circuit or an artificial resistance is introduced to cut down the quantity of current flowing in the coils to a safe limit. These devices are resorted to because, at the start, the solenoid core is in its least effective position with relation to the coils, and a large current is required to move the core, which, as stated, must do as much work in one position as in another. In the present invention it will be seen that only a short movement of the solenoid core is required and that in moving from its lowermost and least effective position, it has, first, only the weight of the short circuiting bar to lift, and then as the core approaches its more effective positions the weight to be lifted by the core gradually increases as the resistance bar raises the plungers in succession. Therefore, as it is unnecessary to give a long stroke to the solenoid core and as the work required of the solenoid is light in the lowermost position of the core, and gradually increases as the core moves upward, it is unnecessary to wind the solenoid for a heavy flow of current at the start, and, therefore, the solenoid may be provided with a winding which will carry continuously the total amount of current required, and its coils may be left connected to the line terminals, while the motor is in operation, without resort to any means for diminishing or cutting off the current from the solenoid windings. Where the short circuiting bar slides over a series of resistance contacts, it is necessary to give the solenoid additional strength in order to pull the resistance bar over any contact which may be roughened or blistered; but with the arrangement shown in the drawing whereby the short circuiting bar makes butt joints or contacts with the contact blocks on the plunger no resistance is offered to the movement of the bar by reason of any irregularity in the contacts, and hence no additional strength is required in the solenoid to overcome obstructions. In order to permit the dash pot plunger to have an extended movement notwithstanding the limited movement of the solenoid core, the multiplying lever 27 is provided. When the motor is in operation all of the contact plungers 1 to 4, inclusive, are held up by the short circuiting bar. When the line switch is opened to stop the motor, and the current is thereby cut off from the solenoid coils, the accumulated weight of the solenoid core, the short-circuiting bar and all of the contact plungers or rods, is made effective to at once start the plunger of the dash pot downward. As the movement of the bar is short and the dash pot plunger is started with the entire weight of the moving parts, this insures a quick insertion of the resistance into the armature circuit after the opening of the line switch. After the dash-pot plunger has started, as the resistance bar moves downward the weight thereon becomes gradually less, as the bar leaves the contact plungers, and when the bar reaches its lowest position, the fitting 24 strikes against the washer 24^a upon the top of the stationary core f' and the shock is thereby cushioned.

In order to vary the time for cutting out the resistance, instead of changing the oil in the dash-pot, or adjusting the usual valve in the dash-pot plunger, the rods 1 to 4, inclusive, are turned within the collars 8 to 11, inclusive, respectively, and the distance between said rods and the short-circuiting bar is thereby varied. As the bar travels upward at a practically uniform rate of speed, its load increasing as the pull on the core becomes stronger, it will be seen that the time that any one or all of the resistance sections remain in circuit, after the closing of the line switch, may be varied by adjusting the plungers within the collars.

What I claim is:—

1. In an automatic starter, a starting resistance, a series of independently movable rods electrically connected to said resistance, guiding means for said rods permitting the rods to slide longitudinally therein a short-circuiting bar for engaging and moving said rods, an electromagnetic device for moving said bar, and means for retarding the movement of said bar.

2. In an automatic starter, a starting resistance, a series of independently movable rods, electrically connected to said resistance, guiding means for said rods permitting the rods to slide longitudinally therein stops for adjusting the positions of said rods, a short-circuiting bar for engaging and moving said rods, an electromagnetic device for moving said bar, and means for retarding the movement of said bar.

3. In an automatic starter, a starting resistance, a series of brackets, rods movable in said brackets and electrically connected to various points of the resistance, a short-circuiting bar, electromagnetic means for moving said bar into engagement with said rods, and a retarding means for the bar.

4. In an automatic starter, a starting resistance, a series of brackets, rods movable in said brackets and electrically connected to various points of the resistance, stops threaded onto said rods for adjusting the positions of the rods, a short-circuiting bar, electromagnetic means for moving said bar into engagement with said rods, and a retarding means for the bar.

5. In an automatic starter, a starting re-

sistance, a series of brackets electrically connected to said resistance, rods movable in said brackets and electrically connected thereto, a short-circuiting bar for engaging and moving said rods, an electromagnetic device for moving said bar and means for retarding the movement of said bar.

6. In an automatic starter, a starting resistance, a series of brackets electrically connected to said resistance, rods movable in said brackets and electrically connected thereto, collars threaded onto said rods for adjusting the positions of the rods, a short-circuiting bar for engaging and moving said rods, an electromagnetic device for moving said bar and means for retarding the movement of said bar.

7. In an automatic starter, a starting resistance, a series of brackets electrically connected to the resistance, said brackets having guides thereon, rods movable in said brackets and electrically connected thereto, collars threaded onto said rods and having means for engaging said guides, a short-circuiting bar for engaging and moving said rods, electromagnetic means for moving said bar, and means for retarding the movement of said bar.

8. In an automatic starter, a starting resistance, a series of vertically movable contact members electrically connected to said resistance, a short-circuiting bar adapted to engage and lift said members, a solenoid for lifting said bar, said solenoid comprising a shunt or high resistance coil, a stationary tubular core in the upper part of said coil and a movable core connected to said bar, a rod of non-magnetic material secured to said movable core and extending through said stationary core, a lever pivoted at one end to a fixed support and connected between its ends to said rod, and a dash-pot having a plunger pivoted to the free end of said lever.

9. In an automatic starter, a starting resistance, a series of vertically movable contact members electrically connected to said resistance, a short-circuiting bar adapted to engage and lift said members, a solenoid for lifting said bar, said solenoid comprising a shunt or high resistance coil, a two-part iron casing extending around the ends of said coil and having openings in its ends, a stationary tubular core having an annular recess engaged by the upper end portions of the casing and a movable core connected to said bar, a rod of non-magnetic material secured to said movable core and extending through said stationary core, a lever pivoted at one end to a fixed support and connected between its ends to said rod, and a dash-pot having a plunger pivoted to the free end of said lever.

10. In an automatic starter, a starting resistance, a series of brackets, rods movable in said brackets and electrically connected to various points of the resistance, stops for adjusting the positions of the rods, a short-circuiting bar, electromagnetic means for moving said bar into engagement with said rods, and a retarding means for the bar.

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

GEORGE H. WHITTINGHAM.

Witnesses:

ROBERT WATSON,

NEWTON P. WILLIS.