G. H. WHITTINGHAM.

CONTROLLER FOR ELECTRIC MOTORS.

APPLICATION FILED JUNE 21, 1909.

965,673. **Patented July 26, 1910.**

Fig. 1.

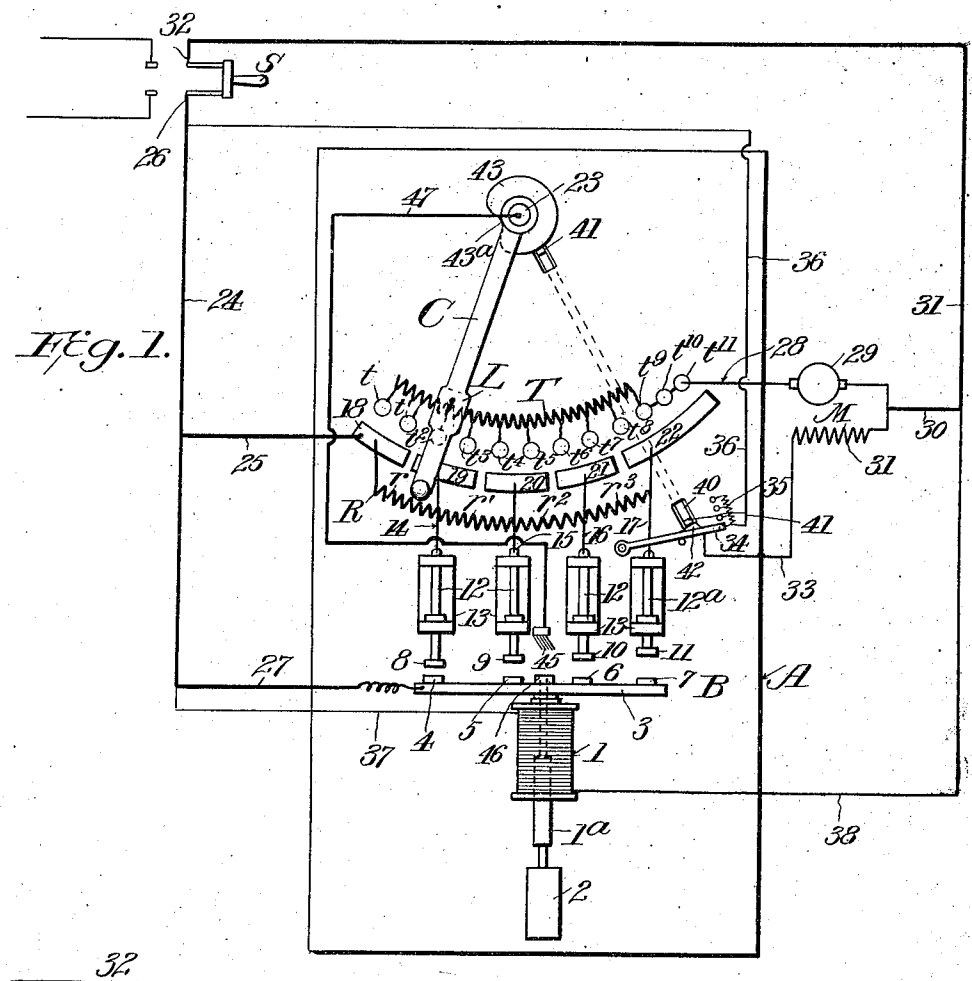
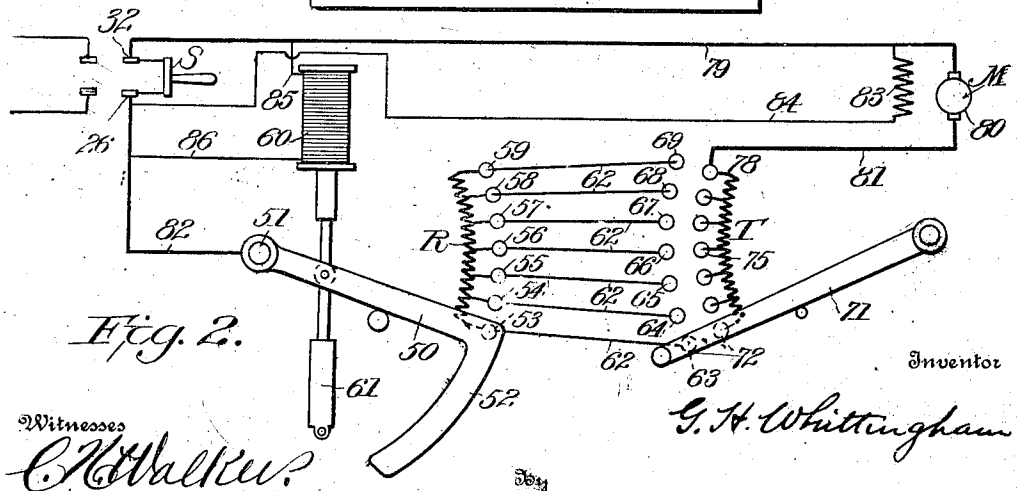


Fig. 2.



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CONTROLLER FOR ELECTRIC MOTORS.

965,673. Specification of Letters Patent. Patented July 26, 1910.

Application filed June 21, 1909. Serial No. 503,435.

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 Controllers for Electric Motors, of which the following is a specification.

This invention relates to improvements in motor controlling devices, its purpose being to provide means for adapting the ordinary time controlled starter to conditions for which said starters have not heretofore been entirely satisfactory.

In the operation of some kinds of machines, such as printing presses, with individual motors, it is necessary to provide means for operating the motor at different speeds for different classes of work, and it is also necessary, under some circumstances, as when threading a web of paper into a large printing press, to start and stop at short intervals, with the regulator set for a low speed. Under such conditions the ordinary time controlled starter has not heretofore been satisfactorily used for several reasons, but principally because of the time consumed in cutting out the starting resistance at each starting operation and because of the necessity for retaining a sufficient amount of regulating resistance in circuit for operation at low speeds for longer or shorter periods of time.

In carrying out my invention I provide an automatic time controlled device for bridging the successive contacts of the starting resistance and a manually controlled device for connecting the contacts of the starting resistance with the contacts of the regulating resistance, these resistances and contacts being so arranged that the manually controlled device in one of its extreme positions will cut out the starting resistance and include the regulating resistance in the armature circuit and in its other extreme position will include the starting resistance and cut out the regulating resistance, and in intermediate positions portions of the starting and regulating resistances will be cut out and the remaining portions will be included in series with one another and with the armature. By these means, as will be made clear in the following description, in operating at any speed below the normal, the proper amount of current will be admitted to the armature before the time controlled element has completed its movement, and during the latter part of its movement said element will not operate to eliminate resistance from the armature circuit. For operating at speeds above the normal an auxiliary device may be used for inserting resistance in the field circuit automatically after the time controlled device has operated, but this field resistance can only be inserted when the manually controlled switch is set in position to permit all of the resistance to be cut out of the armature circuit.

In the accompanying drawing which illustrates my invention, Figure 1 is a front view of a controlling mechanism in which the time-controlled starter comprises a short-circuiting bar which makes butt contacts, in succession, with a series of coöperating contact members connected to the successive sections of the starting resistance, the circuits being shown diagrammatically; and, Fig. 2 is a diagrammatic view of a controlling mechanism in which the short circuiting bar of the time controlled device is arranged to move in sliding engagement with a series of contacts connected to the starting resistance.

Referring to Fig. 1 of the drawing A indicates a suitable panel upon which the operating devices are mounted, B indicates a time controlled starter and C indicates a manually controlled switch-arm. The starter B comprises a solenoid 1, a dash pot or other suitable retarder 2, connected to the core 1^a of the solenoid, a short circuiting bar 3, suitably supported upon the upper end of the solenoid core and provided with contact pieces 4—4 adapted to engage coöperating contacts 8—11 respectively. The contacts 8—11 are secured to the lower ends of rods 12 adapted to slide vertically in suitable brackets 13 and these rods are connected by flexible leads 14—17 to the ends of successive sections r, r', r^2 and r^3 of a starting resistance R. The ends of the starting resistance sections are connected to a series of segmental contact pieces 18—22 arranged concentric with the pivot 23 of the switch-arm C, which is adapted to engage said contact pieces. Conductors 24 and 25 connect the first contact piece 18 in the series with one terminal 26 of the supply circuit switch S, and the short circuiting bar 3 is connected to the same terminal of said switch by conduc-

tors 24 and 27. The contact members 8, 9, 10 and 11 are arranged at successively greater distances from the contacts 4, 5, 6 and 7 so that when the short circuiting bar moves upward it will engage the contacts 8—11, successively, and in the uppermost position of the bar it will be seen that the bar connects with all of the contact members 8—11 and forms a low resistance circuit not only around the entire starting resistance but between the contacts of successive sections. A regulating resistance T is provided with a series of contacts pieces t to t^9, inclusive, arranged concentrically with respect to the pivot 23 and the lever C is adapted to engage any one of these contact pieces and connect it with one of the segmental contact pieces 18—22 of the starting resistance. One end of the regulating resistance is connected through conductor 28 to the armature 29 of a motor M and thence through conductors 30 and 31 to the terminal 32 of the supply circuit switch S. The shunt field winding 31 of the motor is connected at one end to the conductor 30 and at the other end to a conductor 33 which is connected to a switch lever 34, which is adapted to insert or remove a field resistance 35, and this field resistance and lever are connected by a conductor 36 to the supply switch terminal 26. The solenoid 1 may be connected in any suitable way so that the current will pass through its windings when the supply switch S is closed and the solenoid will be deënergized when the supply switch is opened. As shown in the drawing, the solenoid is connected across the line by conductors 37 and 38 which connect with the conductors 24 and 31 leading to the supply switch terminals. As shown in the drawing, the resistances and their adjacent contacts are so arranged that if the manually controlled switch member C is moved on to the contacts t and 18 and the supply switch S is then closed, the current to the armature will flow through the regulating resistance, which is then in series with the armature, but no current can flow through the starting resistance as the latter is not, in this position of the lever C, in series with the armature. This assumed position of the lever C is the position for the lowest speed of the motor and the regulating resistance T affords full protection to the motor armature when the current is admitted so that there is no need of having the starting resistance in circuit. Therefore, although the solenoid 1 gradually lifts the short circuiting bar 3 into engagement with the contacts 8—11, after the closure of the supply switch S, no change in the resistance of the armature circuit results by reason of this automatic operation, and the motor, at the instant of closing the supply switch S, receives all of the current that it is desired to admit to the armature for operation at this slow speed, without waiting for the automatic starter to operate, through the conductors 24 and 25, contact 18, switch lever C, contact t, the entire regulating resistance T and conductor 28, and thence by way of conductors 30 and 31 to the opposite side of the supply switch. If it is desired to have the motor operate at normal speed, the switch-arm C is moved over until it connects the last contact 22 of the starting resistance with the contact t^9 at the end of the regulating resistance. This will connect the starting resistance in series with the motor armature and cut out all of the regulating resistance. Then, when the supply switch is closed, no current will pass through the regulating resistance, but the usual starting current will flow through the starting resistance, and the solenoid 1 will move the short circuiting bar 3 upward and gradually cut out the starting resistance so that the motor will run at normal speed. If it is desired to operate the motor at a speed intermediate its highest and lowest speeds, the switch lever C is moved to an intermediate point.

In the drawing the lever C is shown in engagement with the contact t^2 of the regulating resistance and the contact 19 of the starting resistance. In this position of the lever it will be seen that the first section r of the starting resistance is connected through the switch lever in series with that part of the regulating resistance which is between the contacts t^2 and t^9, while the sections r', r^2 and r^3 of the starting resistance and the sections of the regulating resistance between the contacts t and t^2 are cut out of the armature circuit. In the position of the lever C shown in Fig. 1 of the drawing, when the switch S is closed, current will flow to the armature, through the section r of the starting resistance, and thence through the main part of the regulating resistance. As the solenoid 1 lifts the short circuiting bar, the contacts 4 and 8 will engage, thus cutting out the section r of the starting resistance, and leaving only the main part of the regulating resistance in series with the motor armature. The short-circuiting bar then engages the contacts 9, 10 and 11, successively, but performs no function in so doing. If the switch-arm C is set so as to engage the contacts 20 and t^4 or t^5, the sections r and r' of the starting resistance will be included in series with that portion of the regulating resistance between the contacts t^5 or t^6 and the contact t^9. Upon the closure of the line switch the sections r, r' of the starting resistance will be automatically cut out, in succession, leaving about one-half of the regulating resistance in series with the armature for controlling the speed, while the engagement of the short-circuiting bar 3 with the contacts 10 and 11 will not vary the resistance in the

armature circuit. Similarly if the arm C is set so as to engage the contact 21 and the contacts t^6 or t^7, a greater portion of the starting resistance will be included in the armature circuit, and the sections r, r' and r^2 of the starting resistance will be gradually cut out while the engagement of the contacts 7 and 11 will not effect a change in the resistance of the armature circuit.

By the means above described, it will be seen that when the arm C is set to operate the motor at the lowest speed, the automatic starter performs no function and no time is lost in waiting for the starter to operate, while when the arm is set to operate at intermediate speeds, the motor is protected at first by parts of the starting and regulating resistances, and all of the starting resistance in circuit with the armature is cut out before the starter ceases its movement. When it is desired to operate the motor at normal speed, of course the full starting resistance is required to be in circuit and this is not cut out until the starter has engaged all of its contact points.

If it is desired to operate the motor above normal speed, auxiliary devices may be provided for inserting resistance in the shunt field circuit of the motor after the last section of starting resistance has been cut out. This may be done by arranging a pivoted switch arm 34 above the rod 12^a so that when the short circuiting bar 3 moves the rod 12^a upward, the latter will move the switch arm 34 to include more or less of the resistance in the shunt field circuit. Normally this switch lever 34 is locked against upward movement by a rod 40 arranged on the back of the panel A and having over-turned ends 41 one of which is adapted to bear against a shoulder 42 on the lever 34 while the other bears against a cam 43, rotatable about the pivot pin 23 with the switch arm C. This cam is concentric with the pivot 23 except for the depression 43^a which comes opposite the upper end of the rod 40 when the arm C is moved into engagement with the contact studs or buttons t^{10} or t^{11}. When the arm C engages these buttons the regulating resistance T is cut out of the armature circuit and the starting resistance is entirely included in the armature circuit and the rod 40 is free to move upward into the depression in the cam and thereby allow the switch-arm 34 to be moved upward by the rod 12^a when the latter is moved by the short circuiting bar 3. Therefore, in this assumed position of the switch-arm C, after the last section of the starting resistance is cut out by the engagement of the contact 7 with the contact 11, the rod 12^a is moved upward and lifts the arm 34 to insert more or less of the field resistance 35, according to the distance which the cam surface 43^a permits the rod 40 to move. When the supply circuit switch is opened the short circuiting bar and rod 12^a and the switch arm 34 drop back by gravity to their normal positions. The field resistance is thus cut out when the motor is stopped, and inserted at the completion of the starting operation provided the switch-arm C is in its right hand position and engaging the contacts t^{10} or t^{11}. If the switch arm is out of engagement with these contacts then the cam 43 holds the rod 40 against the shoulder on the lever 34, so that the latter can not be moved upward when the rod 12^a is engaged by the short circuiting bar 3.

In order to insure a good electrical connection between the short circuiting bar and the stationary contacts of the regulating resistance a yielding brush 45 may be arranged above a central contact point 46 on the short circuiting bar and this yielding brush contact may be connected by a conductor 47 to the lever at its pivotal point.

In Fig. 2 of the drawing is shown a modification of the above described arrangement, omitting the field regulating resistance. In this latter figure, a lever 50, mounted upon a pivot 51, is provided with an arcuate short-circuiting bar or arm 52 adapted to slide upon and electrically connect a series of contact pieces 53—59 inclusive, which are arranged concentrically with respect to the pivot 51 and connected to successive points in a starting resistance R. This arm is movable, when the supply switch S is closed, by a solenoid 60 and the upward movement of the arm is retarded by a dash pot 61. The contacts 53—59 are connected by leads 62 to a corresponding number of contacts, 63—69, which are arranged concentrically with respect to the pivot point of a switch lever 71. Another series of contacts 72—78 connected with a regulating resistance T, are arranged parallel with the contacts 63—69 so that the lever 71, in any of its positions, will engage one contact of each series and thus connect the starting resistance with the regulating resistance. The arm 71, in Fig. 2, performs the same function as the arm C in Fig. 1. In its lowest position, shown in the drawing, the arm 71 cuts out the starting resistance and includes the regulating resistance in series with the armature of the motor M and in its uppermost position the arm 71 cuts out the regulating resistance and includes the starting resistance in series with the armature of the motor. In the normal position of the lever 50 the armature circuit extends from the terminal 32 of the supply switch, through conductor 79 to the armature 80 of the motor, thence through conductor 81, to the last contact 78 of the regulating resistance, thence through said resistance to the contact 72, thence through lever 71, contact 63, lead 62 and contact 53 of the starting resistance,

thence through switch arm 50 to conductor 82 and thence to the terminal 26 of the supply switch. The shunt field winding 83 of the motor is connected at one end to the supply switch, through the conductor 79, and at its opposite end through conductor 84 to the opposite side of the supply switch. The windings of the solenoid 60 are connected by conductors 85 and 86 to the terminals of the supply switch through conductors 79 and 82, respectively.

In operation, if the motor is to run at its lowest speed the manually controlled arm 71 is set in its lowest position, as shown in the drawing, so as to include all of the regulating resistance and short-circuit the starting resistance. Upon closing the supply switch S, the solenoid lifts the arm 50 and the short-circuiting bar or arm 52 moves slowly upward connecting the contacts 53—59, successively, but this does not either cut out or insert starting resistance as the arm 52 remains in engagement with the contact 53 and thus a path of low resistance is afforded to the contact 63 and through the lever 71 to the regulating resistance, which is in series with the armature. Therefore, in the lowermost position of the switch arm 71 the automatic starter will perform no function. If the switch arm 71 is moved to engage the contacts 78 and 69 the regulating resistance will be excluded and the starting resistance included in the armature circuit. Then, when the switch S is closed the starter will automatically and slowly cut out the starting resistance, in the usual way, to bring the motor up to full speed. In an intermediate position of the lever 71, for an intermediate speed, the arm 71 will connect part of the regulating resistance in series with part of the starting resistance. Thus, for instance, if the lever 71 is moved to engage the contacts 75 and 66, the upper half of the regulating resistance and the lower half of the starting resistance will be in series. Then, when the supply switch S is closed, the upward movement of the arm 50 and bar 52 will cause the gradual elimination of the lower half of the starting resistance, and during the remainder of the movement of the arm 52 no resistance will be cut out. Since the bar 52 will have a direct connection with the contact 56, even in the uppermost position of said bar, the current may flow directly from the supply circuit switch through the arm 50, bar 52, contact 56, and lead 62 to the contact 66, thence through the lever 71 and contact 75 to the upper half of the regulating resistance and thence to the motor armature. It will be understood, of course, that when the supply switch S is opened, the solenoid 60, being thereby deenergized, releases its core and the arm 50 drops to its lowermost position.

In this invention it will be noted that the manually adjustable arm connects the starting and regulating resistances in such a way that when moved to include or increase the regulating resistance in circuit with the armature, more or less of the starting resistance becomes inoperative, as a current controlling means, according to the position in which the manually controlled switch arm is set, and this inoperative portion of the starting resistance becomes short-circuited or bridged. The same result might be attained, so far as bridging the inoperative portion of the starting resistance is concerned by connecting the bridging arm for the starting resistance contacts to the manually controlled switch instead of to the automatic starter. Thus, for instance, in Fig. 2, the bridging arm 52, instead of being connected to the lower side of the arm 50 might be connected to the upper side of the arm 71 so as to engage the contacts 63—69, with the same result, as will be obvious.

What I claim is:

1. A motor controlling mechanism comprising a switch member, adjustable at will, a regulating resistance governed thereby, an automatically movable member, a starting resistance governed jointly by said two members, one of said members being adapted to bridge successive portions of the starting resistance.

2. A motor controlling mechanism comprising starting and regulating resistances for the armature circuit, a switch member adjustable at will for varying the relative amounts of said resistances in said circuit, a second member for cutting out said starting resistance and means for moving said latter member automatically, one of said members being adapted to bridge successive portions of the starting resistance.

3. In a motor controlling mechanism, starting and regulating resistances for the armature circuit, a switch member connecting said resistance, said member being adapted, when moved, to increase the amount of one resistance in circuit and decrease the amount of the other resistance in circuit, and means for bridging successive portions of the starting resistance.

4. In a motor-controlling mechanism, starting and regulating resistances, means for cutting out the starting resistance comprising means for bridging successive sections thereof, and means connecting said resistances and adapted to render more or less of one resistance operative and more or less of the other resistance inoperative at will.

5. A controlling mechanism for electric motors comprising starting and regulating resistances for the armature circuit, means for cutting out the starting resistance and independent means, adjustable at will, for rendering more or less of the starting resistance inoperative and for rendering more

or less of the regulating resistance operative or vice versa.

6. A controlling mechanism for electric motors comprising starting and regulating resistances for the armature circuit, automatic means for cutting out the starting resistance and means, adjustable at will, for rendering more or less of the starting resistance inoperative and for rendering more or less of the regulating resistance operative and vice versa.

7. A controlling mechanism for electric motors comprising starting and regulating resistances for the armature circuit, automatic time controlled means for cutting out the starting resistance and means, adjustable at will, for rendering more or less of the starting resistance inoperative and for rendering more or less of the regulating resistance operative and vice versa.

8. A controlling mechanism for electric motors comprising starting and regulating resistances for the armature circuit, means for cutting out the starting resistance and independent means, adjustable at will, for rendering more or less of the starting resistance inoperative and for simultaneously rendering more or less of the regulating resistance operative and vice versa.

9. A controlling mechanism for electric motors comprising starting and regulating resistance for the armature circuit, automatic means for cutting out the starting resistance and means, adjustable at will, for rendering more or less of the starting resistance inoperative and for simultaneously rendering more or less of the regulating resistance operative and vice versa.

10. A controlling mechanism for electric motors comprising starting and regulating resistances for the armature circuit, automatic time controlled means for cutting out the starting resistance and means, adjustable at will, for rendering more or less of the starting resistance inoperative and for simultaneously rendering more or less of the regulating resistance operative and vice versa.

11. A controlling mechanism for electric motors comprising starting and regulating resistance for the armature circuit, a switch member, adjustable at will, adapted, when moved, to cut out starting resistance and insert regulating resistance, or vice versa, independent means for cutting out that part of the starting resistance which it not cut out by said member, and means for bridging or short-circuiting the portions of the starting resistance which are cut out by said member.

12. A controlling mechanism for electric motors comprising starting and regulating resistances for the armature circuit, a switch member, adjustable at will, adapted, when moved, to cut out starting resistance and insert regulating resistance, or vice versa, automatic means for cutting out that part of the starting resistance which is not cut out by said member, and means whereby that portion of the starting resistance which is cut out becomes bridged or short-circuited.

13. A controlling mechanism for electric motors comprising a starter, a regulating resistance, a switch member, adjustable at will, connecting the regulating resistance with the starting resistance, and adapted, when moved, to cut out starting resistance and insert regulating resistance, or vice versa, said mechanism comprising means whereby the starting resistance cut out by said member is bridged or short-circuited.

14. A controlling mechanism for electric motors comprising an automatic time controlled starter, a regulating resistance, a switch member, adjustable at will, connecting the regulating resistance with the starting resistance, and adapted, when moved, to cut out the starting resistance and insert regulating resistance, or vice versa, said mechanism comprising means whereby the starting resistance cut out by said member is bridged or short-circuited.

15. A controlling mechanism for electric motors comprising a regulating resistance and a starting resistance for the armature circuit, a switch member connecting said resistances and adapted, when moved, to simultaneously decrease the amount of one of said resistances in circuit and increase the amount of the other of said resistances in circuit and means whereby that portion of the starting resistance cut out by said member may be short-circuited and the balance of the starting resistance may be cut out or short-circuited.

16. The combination with an automatic starter comprising a starting resistance, and means for bridging successive contact surfaces of said resistance, of a regulating resistance, a switch member connecting said resistances, said member being adapted, when moved, to increase the amount of one resistance in circuit and decrease the amount of the other in circuit.

17. The combination with an automatic starter comprising a starting resistance and means for bridging successive contact surfaces of said resistance, of a regulating resistance, a switch member connecting said resistances, said member being adapted, when moved to one of its extreme positions, to cut out all of the starting resistance and include all of the regulating resistance, and when moved to its other extreme position, to cut out all of the regulating resistance and include all of the starting resistance.

18. In a motor controlling mechanism a starter comprising a bar or arm adapted to connect the various contact points of the starting resistance electrically together, a

regulating resistance and a switch member connecting said resistances, adjustable at will, to simultaneously include starting resistance and cut out regulating resistance, and vice versa.

19. An automatic controlling means for electric motors comprising an automatic starter, a regulating resistance for the armature circuit, a manually controlled switch member adapted to cut out said regulating resistance and insert the starting resistance, a field regulating resistance, means movable by the starter, for inserting said field regulating resistance when the armature regulating resistance is cut out and means adjustable by said manually controlled switch member for preventing the insertion of field resistance except when the armature regulating resistance is cut out.

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

GEORGE H. WHITTINGHAM.

Witnesses:
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