No. 795,670. PATENTED JULY 25, 1905.

W. R. WHITEHORNE.

ELECTRIC CONTROLLER.

APPLICATION FILED MAR. 28, 1905.

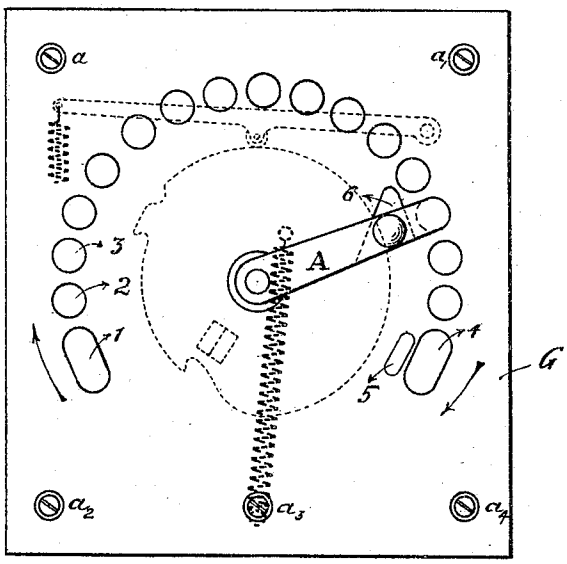



Fig. 1.

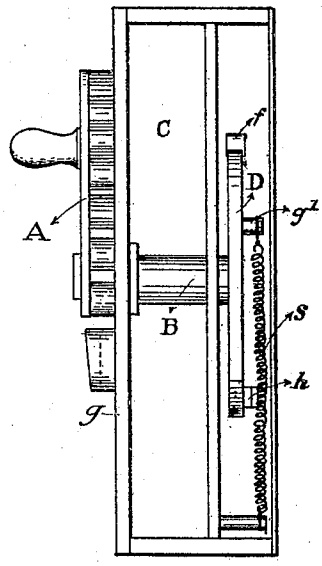



Fig. 2.

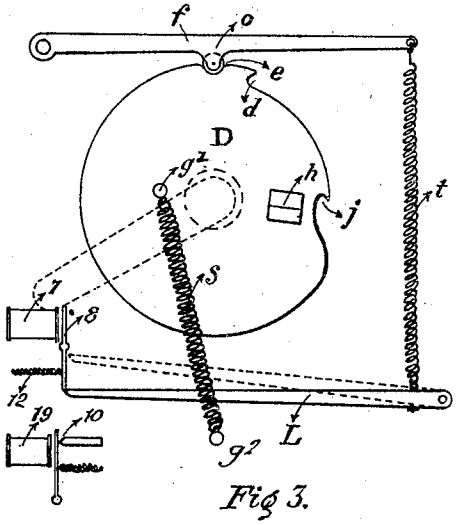



Fig 3.

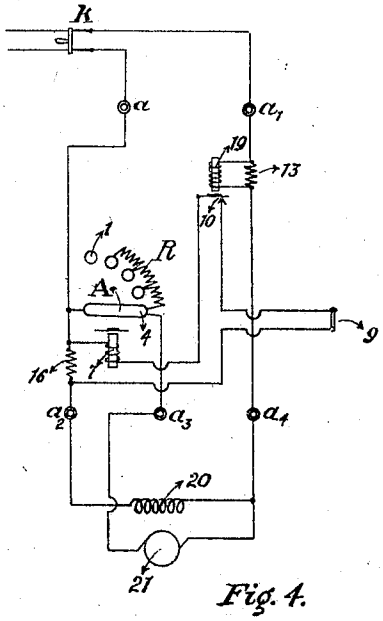



Fig. 4.

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# UNITED STATES PATENT OFFICE.

WILLIAM R. WHITEHORNE, OF BETHLEHEM, PENNSYLVANIA.

## ELECTRIC CONTROLLER.

No. 795,670. Specification of Letters Patent. Patented July 25, 1905.

Application filed March 28, 1905. Serial No. 252,533.

*To all whom it may concern:*

Be it known that I, WILLIAM R. WHITEHORNE, a subject of the King of Great Britain, residing in Bethlehem, Pennsylvania, have invented certain Improvements in Electric Controllers, of which the following is a specification.

One object of my invention is to provide an apparatus for controlling the current flowing to a motor which shall include a novel arrangement of electric connections and devices whereby the motor-circuit is automatically opened whenever the current-flow therein varies beyond predetermined maximum or minimum limits.

It is further desired to provide a motor-starting box or controller including a body of resistance provided with contacts and an arm movable over said contacts for varying the amount of resistance in circuit and which in addition shall be provided with means for automatically returning said arm to its "off" or zero position under predetermined conditions of current-flow and that by a path other than that through which it was moved in starting the motor.

I also desire to provide a controller having its resistance-contacts arranged in an arc of a circle and provided with means whereby the contact-arm when released from its full "on" position shall be compelled to return to its off position by movement through that portion of the arc not occupied by said contacts.

I further desire to provide a motor-controller with an improved device for compelling its operating-handle to be moved to its zero position after being once released from its full on position and before it will again be automatically held in said full on position.

These objects and other advantageous results hereinafter noted I secure as described in the following specification, reference being had to the annexed drawings, in which—

Figure 1 is an elevation of the face of my improved controlling device, showing also in dotted lines the relative positions of certain parts of the operating mechanism. Fig. 2 is a side elevation illustrating certain of the details of construction of the device. Fig. 3 is a rear elevation, to some extent diagrammatic, of the controlling mechanism for the contact-arm; and Fig. 4 is a diagrammatic view showing the electrical connections within my improved controller and illustrating their arrangement relatively to a shunt-wound motor.

In the above drawings, 20 and 21 indicate, respectively, the field and the armature of a shunt-motor, which are connected in the well-known manner to three terminals on the controller G, one armature and one field terminal being connected to a common terminal $a^4$, while the remaining terminals of these two parts are respectively connected to the terminals $a^3$ and $a^2$. In addition the controller has also two terminals $a$ and $a'$ for the connection of the supply-mains, in which is interposed a main switch K of the well-known form. The controller itself is provided with a face-piece $g$, preferably of slate or marble, on which are mounted a series of contacts 1 2 3 4, preferably arranged in the arc of a circle. A contact-arm A is pivoted at the center of the arc of contacts in such manner as to engage them in the well-known manner, and this arm is provided with an auxiliary contact 6 adjacent to its outer end. This latter contact is placed to coöperate with an auxiliary contact 5 adjacent to the contact 4 at one end of the series of contacts on the plate G.

The arm A is rigidly fixed to a spindle B, carried in bearings in the frame of the controller, and there is also fixed to said spindle a plate D. The periphery of this plate is provided with a number of notches $e$, $d$, and $j$, designed to coöperate with a roller $o$, carried by a lever $f$, suitably pivoted to the frame of the controller.

It will be noted that in the present instance the roller $o$ is carried upon the lever about midway between its ends and that the end farthest from the pivot of the lever has attached to it one end of a spring $t$, whose second end is connected to a second lever L. The free end of this latter lever may be retained in a set position by means of the armature 8 of a magnet 7, this armature being so mounted that as long as its magnet is energized the lever L is retained in a position such that the spring $t$ is under tension, and thereby made to cause the lever $f$ to press the roller $o$ against the edge of the notched plate D. The adjustment of these parts, however, is such that as soon as the magnet 7 is deënergized a spring 12 moves the armature 8 into a position to release the free end of the lever L, thereby permitting it to move into such position that no tension is exerted upon the spring $t$, and no pressure is exerted by the lever $f$ and its roller $o$ upon the plate D.

In addition to the above a spring $s$ extends from some fixed point on the frame of the con-

troller to a pin $g'$ on the plate D, so that there is a tendency to return this plate to a definite position at all times whenever it is turned therefrom from this position. A lug $h$ is, however, provided upon said plate at a point one hundred and eighty degrees from the pin $g'$, so as to prevent the possibility of said plate being held in unstable equilibrium when the pin $g'$, the center of the spindle B, and the pin $g^2$ are in the same straight line.

Referring to Figs. 1 to 3, it will be seen that the pin $g'$ is definitely placed upon the plate D relatively to the contact-arm A, so that the tendency of the spring $s$ is to return this contact-arm to its off position whenever it has been moved into engagement with any of the contacts 1 2 3 4, it being, however, noted that for certain of these contacts said spring acts to move the arm in one direction to its off position and for the remainder of the contacts tends to move the arm to said position in the opposite direction.

Referring now to the diagrams of connections, it will be seen that there is a body of resistance R connected between the various contacts 1 2 3 4 and that the magnet 7 is included in a circuit in shunt to a relatively low resistance 16, placed in series with the field-winding 20. In series with the winding of the magnet 7 there is also placed a normally closed switch 9, which may be of the push-button type, and a switch 10 under the control of a magnet-winding 19 in shunt to a low resistance 13 in series with one of the supply-mains.

In order to start up the motor, the handle A is turned in the direction of the arrow from its off position upon or adjacent to contact 1, so that it is moved over the various contacts, thus cutting out successive portions of the resistance R from the armature-circuit. This movement of the arm A and the consequent revolution of the plate D is resisted by the spring $s$ up to a point where the pins $g'$ and $g^2$ are in line with the center of the spindle B. As before noted, at this dead-point the handle A might have a tendency to stick if the operator should not apply additional force; but owing to the peculiar construction and arrangement of the lug $h$ upon the plate D it will be seen that this is not possible. By reason of the lug having beveled surfaces whose line of intersection coincides with the line passing through pins $g'$ and $g^2$ and the center of the spindle B the spring $s$ is deflected from this straight line until after the arm A has been moved past the dead-point. When such movement has occurred, said spring $s$ suddenly passes over the lug $h$ and thereafter has a tendency to move the arm A over the remaining contacts 1 2 3 4 until finally the roller $o$ is pulled into the recess $e$ of the plate D under the action of the spring $t$.

It will be assumed that the free end of the lever L has been engaged by the end of the armature 8 of the magnet 7, since this magnet is energized by the current flowing through the field-winding 20, and said lever is maintained in a position such that the spring $t$ will pull the lever $f$ against the plate D with sufficient force to prevent its further motion when the roller $o$ enters the recess $e$ and the arm A rests upon the contact 4. If now for any reason an abnormal current flows in the motor-circuit, the magnet-winding 19 attracts its armature 10, and thereby opens the circuit containing the magnet-winding 7. The de-energization of this magnet permits the armature 8 to turn on its pivot under the action of spring 12, thereby also permitting the free end of the lever L to move into the position indicated in dotted lines in Fig. 3, and so release the tension on the spring $t$. Such release permits the roller $o$ on the lever $f$ to be moved out of the recess in the plate D under the action of the spring $s$, and said plate is therefore rapidly turned to such a position that said spring exerts its minimum tension. This movement of the plate has, however, caused the arm A to move off of the contact 4 in the direction of the arrow adjacent thereto, and the arc otherwise forming between said contact 4 and said arm is accordingly formed between the projecting lug 6 and the secondary contact 5, usually of carbon, which is electrically connected to the contact 4. Inasmuch as the condition of minimum tension of spring $s$ corresponds to a position of the arm A upon or adjacent to the contact 1, which is preferably dead, it will be seen that the above-noted action of said spring effectually breaks the motor-circuit and prevents any injury following the overload. When the plate and arm are in this off position, the recess $j$ in said plate is immediately under the roller $o$, and the lever $f$ is consequently in such position that the lever L falls by gravity to an extent sufficient to bring its free end below the lower end of the armature 8 of the magnet 7 and that without causing tension upon the spring $t$. As soon now as current again flows through the armature-circuit the magnet 7 is energized, and consequently moves its armature 8 into a position to hold the lever L in its lower position regardless of the position of the lever $f$, so that it will be seen that the device is automatically set for action.

In the event of the voltage of the supply-circuit dropping below a predetermined point or of the supply-current ceasing altogether the deënergization of the magnet 7 permits the armature 8 to move under the action of the spring 12, so that, as was the case when the circuit of this magnet was opened by switch 10, the pull on the lever $f$ is so diminished that the plate D, and with it the contact-arm A, are moved under the action of

the spring *s*, so that said contact-arm is returned to its zero position, as before described.

In order to prevent the possibility of the arm A being moved in the wrong direction from its zero position into engagement with the contact 4 instead of over the contacts 1 2, &c., I provide a depression forming a tooth *d*, which in case of such movement engages the roller *o* and effectually prevents such operation. The depression *j* also serves as an additional protection against this improper movement of the arm A.

It will be seen that after the magnet 7 has once been deënergized either by the opening of switches 9 or 10 or by the failure of the supply-current it is absolutely essential that the arm A be moved to its starting position before it can be made to remain in its full on position. In other words, if the arm A should be held in engagement with any but the first of the contacts after a failure of current and the main switch closed the device would not act to retain said arm in its full on position in engagement with contact 4, the reason for this being that the lever L cannot be held by the armature 8 unless the recessed portion *j* of the plate D be brought under the roller *o*. To do this, it is necessary that the arm A be moved to its zero position, as unless the lever L be held in its lowermost position the spring *t* cannot be made to exert sufficient tension upon the lever *f* to hold the roller *o* in engagement with the recess *e* with sufficient force to prevent rotation of the plate D under the action of the spring *s*.

It will of course be understood that, if desired, recesses similar to *e* may be formed in the periphery of the plate D in order that it shall be possible for the arm A to remain in engagement with any desired contact.

By returning the arm A to its zero position from its full on position over that portion of the arc of the circle not occupied by the contacts 1 2 3 4 I obviate the possibility of said arm sticking upon any of the contacts, as has so often happened with controllers or motor-starters of the well-known construction. Whatever arc is caused by moving the arm A off the contact 4 while current is flowing is prevented from doing damage by the contacts 5 and 6, as above noted.

As shown in Fig. 2, I preferably bevel or incline the top surface of contact 1 in order that it may assist in bringing the arm A to rest after it has been released.

I claim as my invention—

1. An electric controller including a series of contacts, a body of resistance connected thereto, a member movable in a single plane for engaging said contacts, and an automatically-acting device for moving said member from a position in engagement with a contact or contacts at one end of the series to a position at the other end of said series by a path other than that through which it it was moved to bring it to such position, substantially as described.

2. The combination in an electric controller of a series of contacts arranged in the arc of a circle, a contact-arm for said contacts, and means for automatically moving said arm over that portion of its arc of movement which is unoccupied by contacts, substantially as described.

3. An electric controller including a series of contacts, an arm movable in a single plane for engagement with said contacts, means for holding said arm in engagement with a definite contact or contacts, means for automatically releasing said arm, and means for bringing the arm to its zero position when so released, said latter means tending to move said arm over a space unoccupied by contacts, substantially as described.

4. An electric controller including a series of contacts, an arm movable into engagement with said contacts, means for holding said arm in engagement with a definite contact or contacts, means for automatically releasing said arm, and means for bringing the arm to its zero position when so released, said latter means tending to move said arm over a space unoccupied by contacts, with means for permitting movement of the arm in but a single direction over said unoccupied space, substantially as described.

5. The combination in an electric controller of a series of contacts, a contact-arm therefor, a piece attached to said arm, a spring active upon said piece to resist movement of the arm, mechanism for retaining the arm in a definite position against the action of the spring, and means actuated by abnormal current-flow for releasing said retaining means, said spring tending to move said arm in one direction through certain parts of its path of motion and in an opposite direction through other parts of said path of motion, substantially as described.

6. The combination in an electric controller of a series of contacts having resistance connected to them, a contact-arm movable in engagement with said contacts, a plate rigidly connected to said arm, a spring placed to act on said plate, with electrically-controlled means active on said plate for retaining it in opposition to said spring in a position such that the contact-arm is in engagement with certain of the contacts, substantially as described.

7. The combination in an electric controller of a series of contacts, an arm for engagement with said contacts, a spring connected to said arm in such manner as to oppose to a certain point its motion over the contacts and to assist such motion beyond said point, means for maintaining the arm in a desired position against the action of the spring, and electric-

ally-actuated means for releasing said arm-holding means to permit the spring to act, substantially as described.

8. An electric controller including a series of contacts, a contact-arm, a body of resistance connected to said contacts, a spring tending to move said arm off of the contact corresponding to the full "on" position of the controller, and that in a direction away from the other contacts, electrically-controlled means for holding the arm in such full "on" position, and means for releasing the arm under conditions of abnormal current-flow, substantially as described.

9. An electric controller including a series of contacts having a body of resistance connected to them, a contact-arm, a piece connected to said arm, means including two levers for retaining said piece in a definite position, a spring connecting said levers, and an electromagnetic device for controlling said levers, substantially as described.

10. An electric controller including a series of contacts having a body of resistance connected to them, a contact-arm, a piece connected to said arm, means tending to move said piece, means including spring-connected bars for retaining said piece in a definite position against the action of the spring, and an electromagnetic device for normally holding said bars in position to prevent movement of the contact-arm, substantially as described.

11. The combination with an electric motor of a controller including a body of resistance, a series of contacts connected thereto, a contact-arm, a normally energized winding, a switch or switches in circuit with said winding, means tending to move the contact-arm to its zero position by a path other than that over the contacts, and a device for holding the arm in a given position against such tendency as long as said winding is energized, substantially as described.

12. The combination with an electric motor of a controller including a body of resistance, a series of contacts connected thereto, a contact-arm, a normally energized winding, an automatic overload-switch in circuit with said winding, means tending to move the contact-arm to its zero position by a path other than that over the contacts, and a device for holding the arm in a given position against such tendency as long as said winding is energized, substantially as described.

13. An electric controller including a series of contacts, a contact-arm therefor, means for retaining said arm in engagement with a particular contact or contacts, and means for automatically moving said arm to its "off" position through an arc in substantially the same plane as, but different from, the arc through which it was moved into engagement with the contact, said retaining means including a lever, a normally-energized magnet having an armature controlling the position of said lever, and a switch in circuit with the magnet, substantially as described.

14. The combination with an electric motor of a controller including contacts, a body of resistance therefor, a contact-arm, means tending to retain the arm in its "off" position, and means for holding said arm in engagement with a contact or contacts, said means including windings respectively in series with the main motor-circuit and with the field-circuit, and a switch in series with the second magnet and actuated by the first magnet under conditions of abnormal current-flow, substantially as described.

15. The combination with an electric motor of a controller including contacts, a body of resistance therefor, a contact-arm, means tending to retain the arm in its "off" position, and means for holding said arm in engagement with a contact or contacts, said means including a piece connected to the contact-arm, a lever acting to hold said piece in a definite position, a second lever, a spring connecting said levers and an electromagnetic device for holding the second lever in a position to tense said spring, substantially as described.

16. An electric controller including resistance-contacts and a relatively movable contact for engagement therewith, a notched plate connected to said movable contact, a spring acting to resist movement of the plate upon its axis in either direction, means for retaining the plate in a definite position relatively to the resistance-contacts, means for releasing said plate from said position, and means for preventing the spring remaining in the line of the dead-point of said plate, substantially as described.

17. An electric controller including resistance-contacts and a relatively movable contact for engagement therewith, a notched plate connected to said movable contact, a spring extending substantially parallel to the plane of the plate for resisting its movement in either direction on its axis, means for holding the plate in a definite position, means for releasing said plate from said position, and a beveled lug on the plate substantially in line with its axis and the point of attachment of the spring, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM R. WHITEHORNE.

Witnesses:
HELEN E. WHITEHORNE,
R. W. LEIBERT.