No. 801,239. PATENTED OCT. 10, 1905.

G. H. HILL.

CONTROL APPARATUS.

APPLICATION FILED MAR. 1, 1905.

Fig. 1.

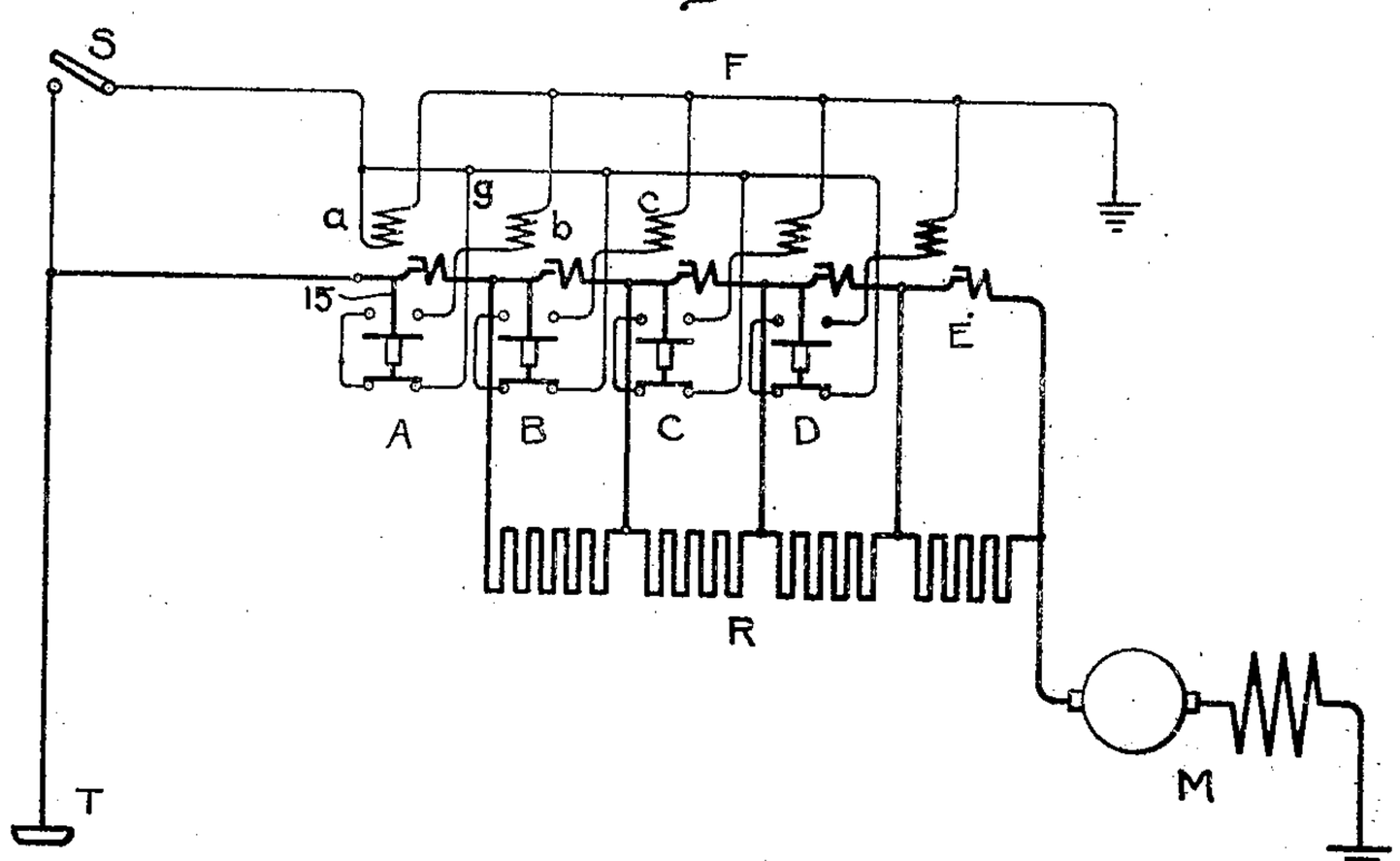
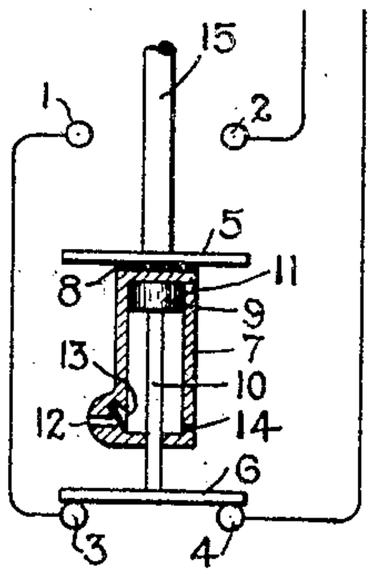


Fig. 2.



Witnesses.
Ebnathan E Briggs.
Helen Alford

Inventor:
George H. Hill.
by Albert G. Davis.
Atty

UNITED STATES PATENT OFFICE.

GEORGE H. HILL, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

CONTROL APPARATUS.

No. 801,239. Specification of Letters Patent. Patented Oct. 10, 1905.

Application filed March 1, 1905. Serial No. 247,886.

To all whom it may concern:

Be it known that I, GEORGE H. HILL, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Control Apparatus, of which the following is a specification.

The present invention relates to control systems, and particularly to control apparatus for electric motors comprising a plurality of individual switches or contacts some of which are arranged to be actuated in automatic progression.

In Patent No. 778,242, granted December 27, 1904, I have disclosed several forms of motor-control systems in which a series of individual switches in closing establish actuating-circuits for succeeding switches by means of auxiliary switches associated therewith. A definite time interval is caused to elapse between the closing of successive switches by means of relays or by means of dash-pots connected with the main switches themselves and which retard the closing movement of these switches as well as of the auxiliary switches. Where the dash-pots are associated directly with the main switches, the main switches are caused to close slowly in order that the auxiliary switches associated therewith may remain open a predetermined length of time. It is, however, very desirable that the main switches should be free to close and open quickly in order to prevent disastrous burning of the contacts, and for this reason any dash-pot mechanism which impedes the movement of the main switch itself is objectionable.

The object of the present invention is to so construct and arrange the parts of the controller of the separately-actuated-contact type that an automatic progression of certain of the contacts is obtained without the use of a time-interval relay and without employing mechanism which impedes the movement of the main switches.

To the above ends the present invention consists of the devices and combinations of devices to be hereinafter described, and particularly pointed out in the claims.

Reference being had to the accompanying drawings, which illustrate one form of the present invention, Figure 1 is a diagram showing a motor and my improved control apparatus, and Fig. 2 shows a detail.

Similar reference characters will be used throughout the specification and drawings to indicate like parts.

M represents the motor; T, a current-collecting device; S, a master-switch; R, a series of resistance-sections adapted to be included in the motor-circuit; A, an electromagnetically-actuated switch for connecting the motor to the current-collecting device with the resistance R in circuit, and B, C, D, and E switches for cutting out successively the sections of resistance. These parts may all be of any suitable or desired construction, since they in themselves form no part of the present invention. Instead of being connected to the current-collecting device T and to ground, as is customary in electric railways, the motor M may be arranged across the metallic conductors leading from any source of current-supply.

The present invention resides in the means provided for causing the main switches A to E, or some of them, to close in automatic progression when a suitable circuit is closed—as, for instance, by closing the switch S. When the switch S is closed, current flows from the current-collecting device, through the actuating-coil *a* of switch A, through wire F, to ground, causing the switch A to close. Current now flows from the current-collecting device through switch A, through resistance R, through the motor, and to ground. Associated with the switch A and all of the remaining switches except the last, which are adapted to close in automatic progression, are auxiliary contacts for controlling the actuating-circuits of succeeding switches. These auxiliary contacts are most clearly shown in Fig. 2, each set consisting of stationary members 1, 2, 3, and 4 and bridging members 5 and 6, adapted to connect together, respectively, contact members 1 and 2 and 3 and 4. The members 5 and 6 are secured together by means of a dash-pot, so that when the member 5 is lifted rapidly the member 6 rises with it in substantially the same manner as if the two members were rigidly connected together. As soon, however, as the member 5 comes to rest the member 6 begins to drop and returns to its normal position at a rate determined by the adjustment of the dash-pot. The dash-pot connection between the two movable members 5 and 6 may be variously constructed, a suitable arrangement consisting of a cylinder 7, secured to the member

5, but insulated therefrom by means of insulation 8, and a piston 9, closely fitting the cylinder and carrying upon the free end of its stem 10 the member 6. A rather large opening 11 is formed in the wall of the cylinder 7, near the top thereof, and another smaller opening 12, controlled by check-valve 13, is located near the bottom of the cylinder. The openings 11 and 12 are so proportioned and the check-valve 13 is so positioned that when the piston is near the lower end of the cylinder and the cylinder is released air flows freely out through the opening 11 and through the opening 12 and past the check-valve, the dash-pot therefore checking the dropping of the cylinder but slightly. When the parts are in their normal positions—namely, the piston at the upper end of the cylinder, as illustrated in Fig. 2—the rate at which the piston may travel downwardly is determined by a third opening 14, arranged near the bottom of the cylinder. This latter opening is made quite small, so that the air beneath the piston may be exhausted slowly, and by providing this opening with a suitable valve the rate at which the piston may drop may be controlled within wide limits. The movable member 5 of each of these sets of auxiliary contacts is operatively connected to one of the main switches, so that upon the closing of each main switch one of the auxiliary switch members 5 is moved into engagement with its coöperating contacts 1 and 2. This operative connection between the main and the auxiliary contacts may be made in various ways—as, for instance, by connecting the main and auxiliary switch members together by means of stems 15. It is seen that when both of the auxiliary switch members 5 and 6 associated with main switch A are in engagement with their coöperating contacts a circuit is completed from the collecting device T, through wire *g*, contacts 4, 6, 3, 1, 5, and 2, through the actuating-coil *b* of switch B, through wire F, to ground. The closing of these auxiliary contacts is effected upon the closing of the switch A, which immediately brings the movable contact member 5 into engagement with the stationary contacts 1 and 2, at the same time lifting the member 6 from the fixed contacts 3 and 4. Thus before the circuit of the actuating-coil *b* is completed at contacts 1 and 2 it is broken at 3 and 4 and is not finally completed until contact member 6 drops, subject to the influence of the dash-pot, and comes again into engagement with the fixed contacts 3 and 4. A definite time interval must therefore elapse between the closing of switches A and B. In the same manner a circuit is completed for the actuating-coil *c* of switch C upon the closing of the switch B. Switches B and E likewise close one after the other and after a switch C has closed.

By the present arrangement several switches are enabled to close automatically and progressively and at a rate which may be definitely determined and readily varied, the use of a time-interval relay is avoided, and the free opening and closing of the main switches is not affected in any way by the auxiliary mechanism.

Although I have shown but one form of the present invention and one as applied to controlling electric motors, I do not desire to limit the present invention to the particular form or operation illustrated, since in its broader aspects the present invention may be embodied in various other forms and applied to different uses.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a system of control, a series of electrically-controlled main switches, and a normally closed auxiliary switch connected to one of the main switches by means of a dash-pot and arranged in the controlling-circuit of another main switch.

2. In a system of control, a series of electrically-controlled main switches, an auxiliary switch arranged in the controlling-circuit of one of the main switches, and a connection between the auxiliary switch and another of said main switches constructed and arranged to cause said auxiliary switch to be opened and again closed upon the closing of the latter main switch.

3. In a system of control, a series of electrically-controlled main switches, a normally open and a normally closed auxiliary switch in the controlling-circuit of one main switch, and operative connections between said auxiliary switches and another main switch constructed and arranged to cause one auxiliary switch to close and the other to open and again close after a predetermined time interval upon the closing of the main switch.

4. In a system of control, a series of electromagnetically-actuated main switches, a pair of auxiliary switches in the actuating-circuit of one of said main switches, an operative connection between one of said auxiliary switches and another main switch, and a connection including a dash-pot between the latter main switch and the other auxiliary switch.

5. In a switch mechanism, a normally open switch, a normally closed switch, and a dash-pot connecting the movable members of said switches.

6. In a switch mechanism, a normally open switch, a normally closed switch arranged beneath said normally open switch, and a dash-pot connecting the movable members of said switches.

7. In a switch mechanism, a pair of switches arranged one above the other and one of said switches being normally closed and the other normally open, and a dash-pot connecting the movable members of said switches together.

8. In a switch mechanism, a movable main

switch member, an auxiliary switch member operatively connected to said main switch member, and a second auxiliary switch member suspended from the main switch member by means of a dash-pot.

9. In a system of control, a series of electromagnetically-actuated main switches adapted to operate in automatic progression, and auxiliary switches including members suspended through dash-pots from certain of said main switches arranged in the actuating-circuit of certain of said main switches.

10. In a system of control, a series of electromagnetically-actuated main switches adapted to close in automatic progression, and auxiliary switches in the actuating-circuit of certain of said main switches including members suspended from preceding main switches through dash-pot connections.

11. In a system of control, a plurality of electromagnetically-actuated main switches, a normally open and a normally closed auxiliary switch arranged in the actuating-circuit of one switch, a connection between another main switch and the normally open auxiliary switch whereby the latter is closed when the main switch closes, and a connection including a dash-pot between the latter main switch and the normally closed auxiliary switch whereby the latter switch opens and again closes when the main switch closes.

In witness whereof I have hereunto set my hand this 27th day of February, 1905.

GEORGE H. HILL.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.