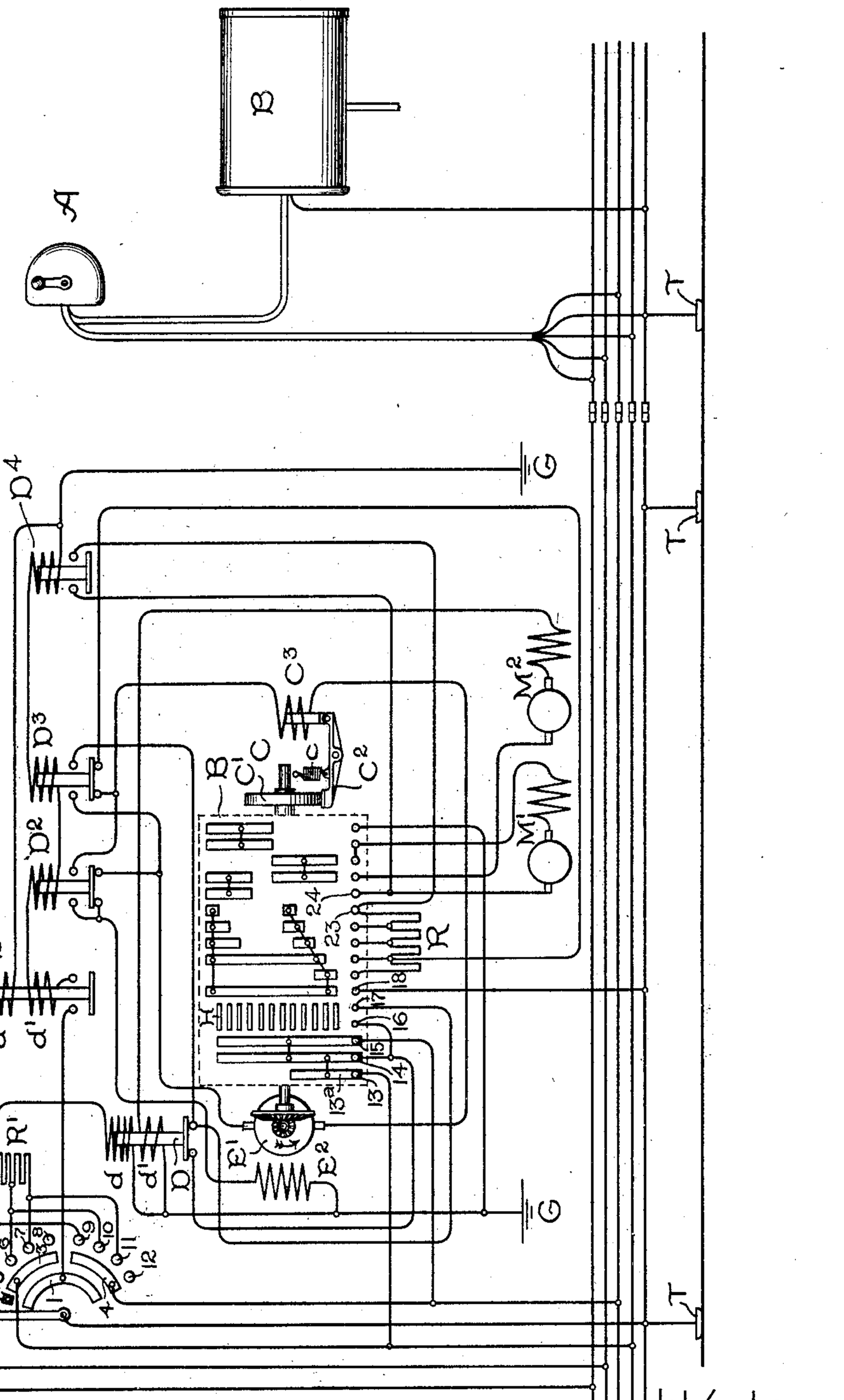
No. 705,016. Patented July 22, 1902.

C. E. BARRY.

TRAIN CONTROL SYSTEM.

(Application filed Dec. 16, 1898.)

(No Model.)



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UNITED STATES PATENT OFFICE.

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TRAIN-CONTROL SYSTEM.

SPECIFICATION forming part of Letters Patent No. 705,016, dated July 22, 1902.

Application filed December 16, 1898. Serial No. 699,409. (No model.)

To all whom it may concern:

Be it known that I, CHARLES E. BARRY, a citizen of the United States, residing at Schenectady, in the county of Schenectady and State of New York, have invented certain new and useful Improvements in Train-Control Systems, (Case No. 825,) of which the following is a specification.

My present invention relates to the electric control of trains on railways, and has for its object to obviate certain difficulties which arise with that form of controlling device which consists of motor-controllers upon each car operated in synchronism by one or more so-called "master-controllers." The general features of this system of control are now well understood, and ordinarily each motor-controller regulates the motors of the car upon which it is placed. These controllers are of well-established form, usually of the series-parallel type, though nothing in my invention or, in fact, in the ordinary systems of train control limits the selection to this type of controller. In all motor-controllers there are certain defined positions in which the rotating switch may remain for a greater or less length of time, some of which are known as "transition-points," in which the switch should rest only for a short time. Other positions are known as "running-points," in which the controller may remain for an indefinite time. In order to render certain the proper manipulation of the controller, so that it will always rest at one or another of the selected positions, certain devices called "step-by-step actuators" are generally employed. A well-known form of this device consists of the so-called "star-wheel" or ratchet-wheel, with which a pawl engages, the spaces in the star-wheel being so arranged as to register with the proper positions of the cylindrical switch usually employed in the controller.

In train control these motor-controllers are operated by "pilot-motors," so called, the operation of all the pilot-motors being governed by the master-controllers, so that from any one of the latter all of the pilot-motors are simultaneously operated in either direction and to the extent desired. With this form of control, using a step-by-step device, it may happen that the desired certainty of operation will not be obtained. In these controlling schemes there is usually provided a so-called "throttle" or open-circuiting contact for the pilot-motor, which constitutes a means for limiting the current supplied to the motors, and hence for limiting the rate of acceleration of the train driven thereby. This throttle is operated when the current rises to a predetermined value, so that the throttle may open just before the controller reaches the desired position, the momentum of the controller and motor serving to bring the former to just the point intended; but it may happen that the star-wheel will be forced backward by its pawl overcoming the momentum of the revolving parts, so that the controller does not complete the intended steps, and a bad arc may result. The throttle is of course independent of the rotation of the controller, except in so far as the latter affects the current-flow in the main motor-circuit. In order to render the action just spoken of certain and to postpone the open-circuiting of the pilot-motor until the controller has certainly reached the desired position, I have arranged upon the controller-switch itself certain contacts by which the throttle is short-circuited until the controller-switch comes to just the point desired, at which time the short-circuiting contacts are opened. By this means the actuation of the controller to the extent desired is made to depend upon the rotation of the controlling-switch itself.

Another feature of my invention consists of means for varying the rate of acceleration in a train-control system of the character described. In its broadest aspect this branch of the invention is of the scope just indicated. As above stated, it has been heretofore proposed to provide a so-called "throttle" or open-circuiting contact in the circuit of the pilot-motor operating the motor-controller. This throttle opens the pilot-motor circuit whenever the current in the main motor-circuit exceeds a certain predetermined limit. It therefore constitutes a means for limiting the current in the motor-circuit to a predetermined value, and because it so limits

the current it also constitutes a means for limiting or determining the rate of acceleration of the motors and the cars or train driven thereby. In order that I may be enabled to change this rate of acceleration at will, I provide at the master-controller a means for modifying the operation of the current-limiting device. The current-limiting device is therefore controlled in part by the current in the motor-circuit and in part from the master-controller. The modifying means enables the motorman to change the limit at which the current-limiting device will operate, and therefore to change the limiting rate of acceleration of the car or train. The modifying means at the master-controller comprises a resistance which is connected in series with an actuating-coil of the current-limiting device. When the master-controller is so moved as to diminish this resistance and increase the current flowing through the coil, then the operation of the current-limiting device or throttle will be modified, so that it will open the pilot-motor circuit at a less current than before in the motor-circuit, or, in other words, the current limit in the motor-circuit will have been reduced. The particular arrangement which I show in this case consists of an auxiliary coil upon the throttle, which of itself is not sufficient to actuate the latter to open the pilot-motor circuit, but which assists another coil in circuit with the motors, so that when the current in the motor-circuit reaches a certain determinate limit the throttle will be opened until the counter electromotive force of the motors cuts down the current sufficiently to permit the throttle to close again, when the controller will again take a step. By including a regulable resistance in circuit with the first-named coil I can control its effect, and thereby the amount of current which may flow in the motor-circuit before the throttle will open. It is manifest that by increasing the resistance, assuming it to be in series with the coil, the amount of current flowing in the motor-circuit and necessary to pull open the throttle would be larger than where the effect of the first coil was not thus restricted. Of course the resistance might be arranged in shunt or in series, the necessary modifications being apparent to engineers.

In the operation of the invention I find it desirable to entirely eliminate the usual step-by-step devices, and for these I substitute a brake which acts to check the rotation of the controller as soon as the pilot-motor circuit is opened. This is accomplished in the usual way by including a coil in the latter circuit, which will act to release the brake whenever current is flowing, a spring applying a brake-shoe of suitable form to a disk or drum affixed to the controller-shaft whenever the current ceases. I furthermore arrange the circuits so that when the master-controller is brought to the off position the pilot-motor will be reversed and will run the motor-controller backward until the off position is reached, when certain contacts, to be described hereinafter, open-circuit all the pilot-motors.

The accompanying drawing is a diagram which shows a convenient way of applying the invention. The circuits of the apparatus are illustrated in full on the left side of the drawing, while a conventional illustration of a motor-controller and a master-controller are shown on the right, it being intended by this to show a train of two cars. It is to be understood that the connections of the apparatus on the right are the same as those on the left of the drawing, the master-controllers and motor-controllers being in multiple, and by a consideration of the circuits it will be manifest that the operation of the master-controller will be sufficient to insure the operation of any number of motor-controllers in the desired manner.

In the drawing, A represents a master-controller which may be of any convenient type, but which I have here shown as a switch provided with a rotating arm *a* and contacts 1 to 12. The throttle referred to in the statement of invention is shown in diagram at D, and consists of the usual core provided with two coils *d d'*. The former of these is in series with the resistance R', controlled by the contacts 5 to 12 of the master-controller A. The latter is in circuit with one of the motors and would usually be connected between the final field-terminal and ground, though it is immaterial in what part of the circuit it is placed. The resistance R' is, as already described, regulable, and the effect of the coil *d* may be changed in accordance with the amount of resistance in circuit. As already indicated, the resistance might be placed in shunt to the coil, and the corresponding difference in circuits and effect will be understood by engineers, so that I have not considered it necessary to illustrate it. Switches similar in construction to the throttle D are illustrated at D' D^2 D^3. D^2 and D^3 form in conjunction a reversing-switch for the pilot-motor, the armature of which is shown at E' geared to the controller B, its field being illustrated at E^2. It is a series motor of ordinary construction. The switch D' is provided with two coils *d d'*, the upper one, *d*, of which is in circuit between the trolley and ground, the lead from the trolley T passing to the switch-blade *a* of the master-controller. As the blade passes over the contact 2 the coil *d* is energized and draws up its core, so that the contacts illustrated are bridged. The switch-blade *a* at this time also touches the contact 1, so that the coil *d'* is energized, as are the coils of the switches D^2 D^3, thus completing the upper set of contacts of the reversing-switch. The controller B has contacts 13, &c., the upper three of which control the action of the pilot-motor, as presently to be described. The lower contacts, beginning with number 18, regulate the motors M' M^3 by the well-known system of series-parallel control, the motors being first

connected in series, and as the controller rotates, the resistance R being cut out step by step until finally one motor is shunted around the other, the circuit is opened and the two are reconnected in multiple, this being a well-known system of control, the particular steps of which it is unnecessary to trace. A series of contacts H are also provided, registering with the brushes or fixed contacts 16 17. A brake C is also used, consisting of the drum C′ upon the shaft of the controller, a brake-shoe C^2, having a spring *c*, which applies it to the drum, and a coil C^3 in the circuit of the pilot-motor.

With the parts in the position illustrated the operation is as follows: Assuming that the switches D′ D^2 D^3 are drawn up to close the upper sets of contacts and that the throttle D is in its illustrated position, current passes from the trolley to the switch-arm *a*, contact 3, and thus to the contact 13 of the motor-controller, to contact 14, across the contacts of the throttle D, by the upper contacts of switch D^3 to the armature E′ of the pilot-motor, thence through the coil C^3, across the upper contacts of switch D^2, through the field E^2 to ground. The pilot-motor then starts in the direction of the arrow, rotating the controller B until the contact 13 passes off the corresponding contact 13^a. This, as will be seen by inspection, is the "full series" position of the motors, at this point the resistance R being all cut out and the motors M′ M^2 connected in series. Depending upon the position of the switch-arm *a*, the acceleration will be greater or less, as may be desired, and as already pointed out in connection with the operation of the throttle D. If the arm *a*, for instance, be on the contact 7 and full resistance R′ is in circuit, the acceleration will be very considerable, it requiring a large current in the motors to open the throttle D, and this effect will be still further increased if the arm *a* touches the open-circuiting contact 8, which entirely cuts out the coil *d*, thus throwing upon the coil *d*′ all of the work of opening the switch. The arm *a* being between the contacts 3 and 4, the circuit of the pilot-motor will be opened, and the motor-controller will be, as already explained, in the full series position. When the arm *a* touches contact 4, however, the circuit will be again closed, passing from that contact to contact 15 on the motor-controller and then through the pilot-motor, as before. In this case the controller B will be operated until it comes to the full multiple position, and here also the acceleration may be regulated, as may be desired, by the regulation of the resistance R′. In both cases the contacts 16 and 17 when touching any one of the contacts H on the motor-controller short-circuit the throttle D until the motor-controller has opened the contacts 16 and 17, so that the latter controller will only stop in one of the defined positions at which it is designed to operate. Should the current fail for any reason, the motorman would bring the master-controller A to its off position. The motor-controller would remain where it happened to be until the currrent came on again; but as soon as this occurred a circuit would be completed from the intermediate point in the resistance R, passing across the lower contacts of the switch D^3, through the coil C^3, releasing the brake through the armature E′ in the reverse direction and then through the lower contacts of the switch D^2, through the field E^2 in the same direction as before to ground, reversing the connection of armature and field and rotating the controller in the opposite direction until it is brought to the off position. It of course may happen that the controller will be in any of these positions, even the full multiple, when the current fails. In order to prevent damage to the motors by the current coming on while they are stationary and without resistance, I have introduced the switch D^4. This, it will be observed, is connected between the end of the resistance and the main motor lead at the contacts 23 24 of the controller B. It is in the same circuit with the other automatic switches, and when the first switch D′ is picked up by turning the master-controller the circuit of D^4 is completed from the contact 1 of the master-controller, so that the motors are again brought in circuit. The action of this switch is independent of the reversing-circuit for the pilot-motor just described, as will be manifest by tracing the connections. It will thus be impossible to throw the main current on the motors until the controller B has been brought to the off position, unless, indeed, it be the intention of the motorman to do so, when it may be accomplished by manipulation of the controller A.

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

1. In a motor system, in combination, a controller, automatic means for preventing the operation of the controller whenever the current in the motor-circuit rises above a predetermined value, and means for modifying the operation of said automatic means.

2. In a train-control system, in combination, automatic means for limiting the rate of acceleration to a predetermined value, and means for modifying the operation of the said automatic means so as to change the limiting rate of acceleration to a different value.

3. In combination, a motor or motors, a motor-controller, actuating means for said controller, a master-controller, and means controlled in part by the current in the motor-circuit, and in part from the master-controller, for controlling the operation of said actuating means.

4. In combination, a motor or motors, a motor-controller, electromagnetic actuating means for said controller, a switch for opening the circuit of the electromagnetic actuating means, and actuating-winding therefor included in circuit with the motor or motors

and arranged to open the switch whenever the current in the motor-circuit rises above a predetermined limit, a master-controller by means of which an operator may control the operation of the motor-controller, and means also under the control of the operator for changing the limit at which the said switch will be operated.

5. In a train-control system, motors and a motor-switch, a pilot-motor for actuating the said switch, means controlled by the current-flow in the main motors for opening the pilot-motor circuit, and means under the control of the motorman for retarding or accelerating the opening of the circuit so as to increase or decrease, as may be desired, the permitted main current, and thus correspondingly change the acceleration of the train.

6. The combination, with motors and a motor-switch, a pilot-motor actuating the switch, and a master-controller for the pilot-motor, of an open-circuiting device for the pilot-motor, and means controlled by the master-controller for modifying the action of the open-circuiting device.

7. The combination of motors and a motor-switch, a pilot-motor, and a master-controller, with a throttle for the pilot-motor circuit comprising a coil, means for varying the ampere-turns of the coil, and a part movable under the influence of the coil, actuating the switch controlling the pilot-motor circuit.

8. In an open-circuiting device for the pilot-motor of a train-control system, the combination of a coil the effect of which is regulated by the master-controller, with another coil in series in the motor-circuit, a part movable under the influence of the coils, and a switch operated by the moving part.

9. In a throttle or open-circuiting device for the pilot-motor of a train-control system, the combination of a coil, a regulable resistance in circuit with the coil, means on the master-controller for varying the regulating resistance, a second coil in circuit with the motors, and a switch controlled by the coils.

10. The combination with motors and a motor-controller, of a pilot-motor operating the controller, a throttle or open-circuiting device for the pilot-motor, and means upon the controller for bridging the throttle-contacts until the controller reaches certain predetermined positions.

11. The combination of motors and a motor-controller, with a pilot-motor actuating the controller, an open-circuiting device or throttle in the circuit of the pilot-motor and controlled by the current-flow in the motor-circuit, and bridging contacts operated by the controller, maintaining the circuit of the pilot-motor until the controller reaches certain definite positions.

12. The combination with the throttle or open-circuiting device for the pilot-motor of a train-control system, of fixed contacts in the motor-controller connected to those of the throttle, and moving contacts carried by the main motor-switch for bridging the fixed contacts at desired times.

13. The combination with the throttle or open-circuiting device for the pilot-motor of a train-control system, of means for short-circuiting said throttle to prevent its operation.

14. The combination with the throttle or open-circuiting device for the pilot-motor of a train-control system, of means located at the point from which the train is for the time being controlled for modifying the operation of said throttle.

15. The combination in a train system, of one or more motors, a controller therefor, a pilot-motor for operating said controller, a switch in the pilot-motor circuit, an actuating-winding for said switch arranged to open the pilot-motor circuit whenever the current in the motor-circuit rises above a predetermined limit, and means located at the point from which the train is for the time being controlled for increasing the limit at which the said switch will be operated.

In witness whereof I have hereunto set my hand this 14th day of December, 1898.

CHARLES E. BARRY.

Witnesses:
B. B. HULL,
GENEVIEVE HAYNES.