No. 648,696. Patented May 1, 1900.

M. T. A. KUBIERSCHKY.

METHOD OF CONTROLLING ELECTRIC MOTORS.

(Application filed Dec. 6, 1899.)

(No Model.) 3 Sheets—Sheet 1.

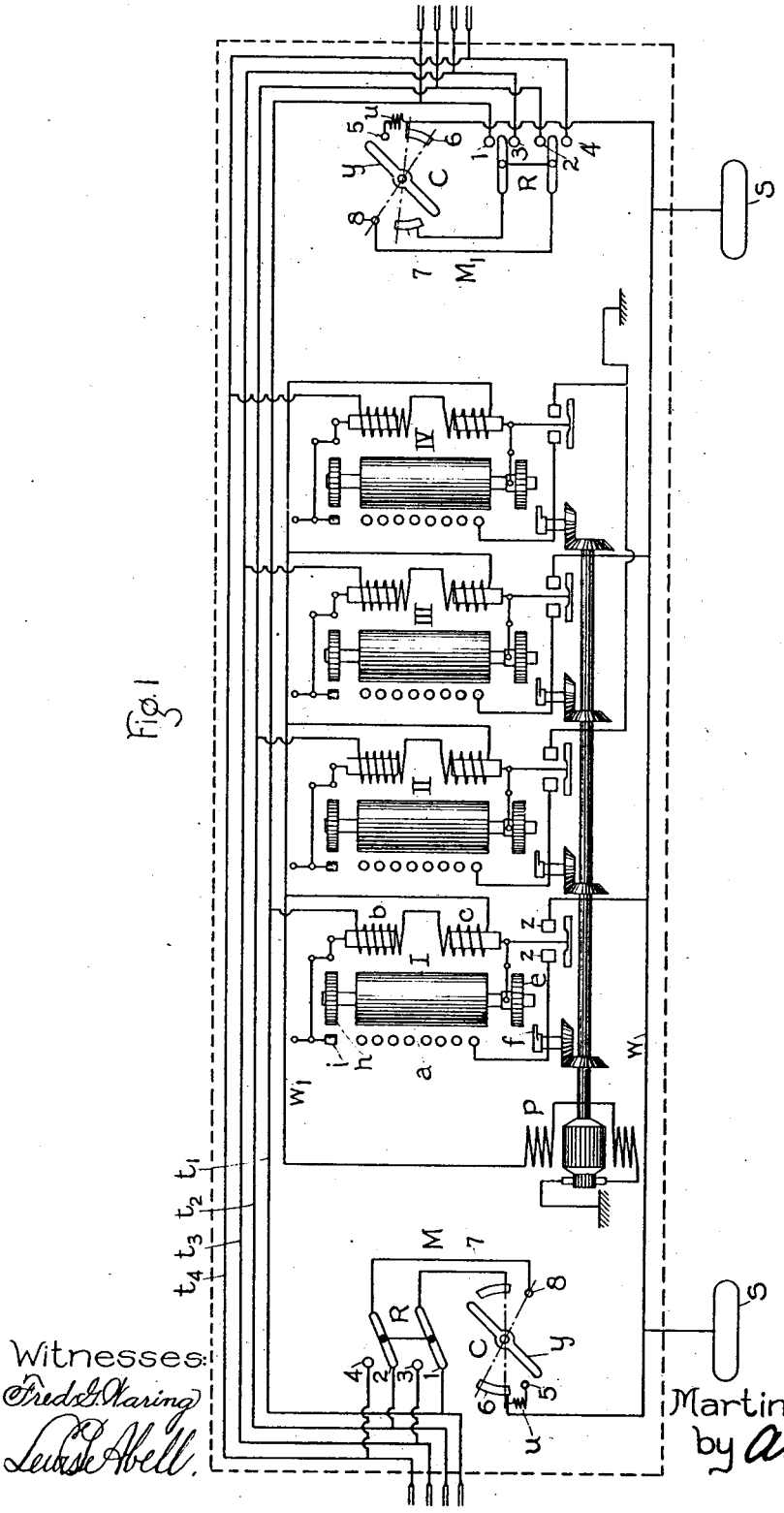

Fig. 1

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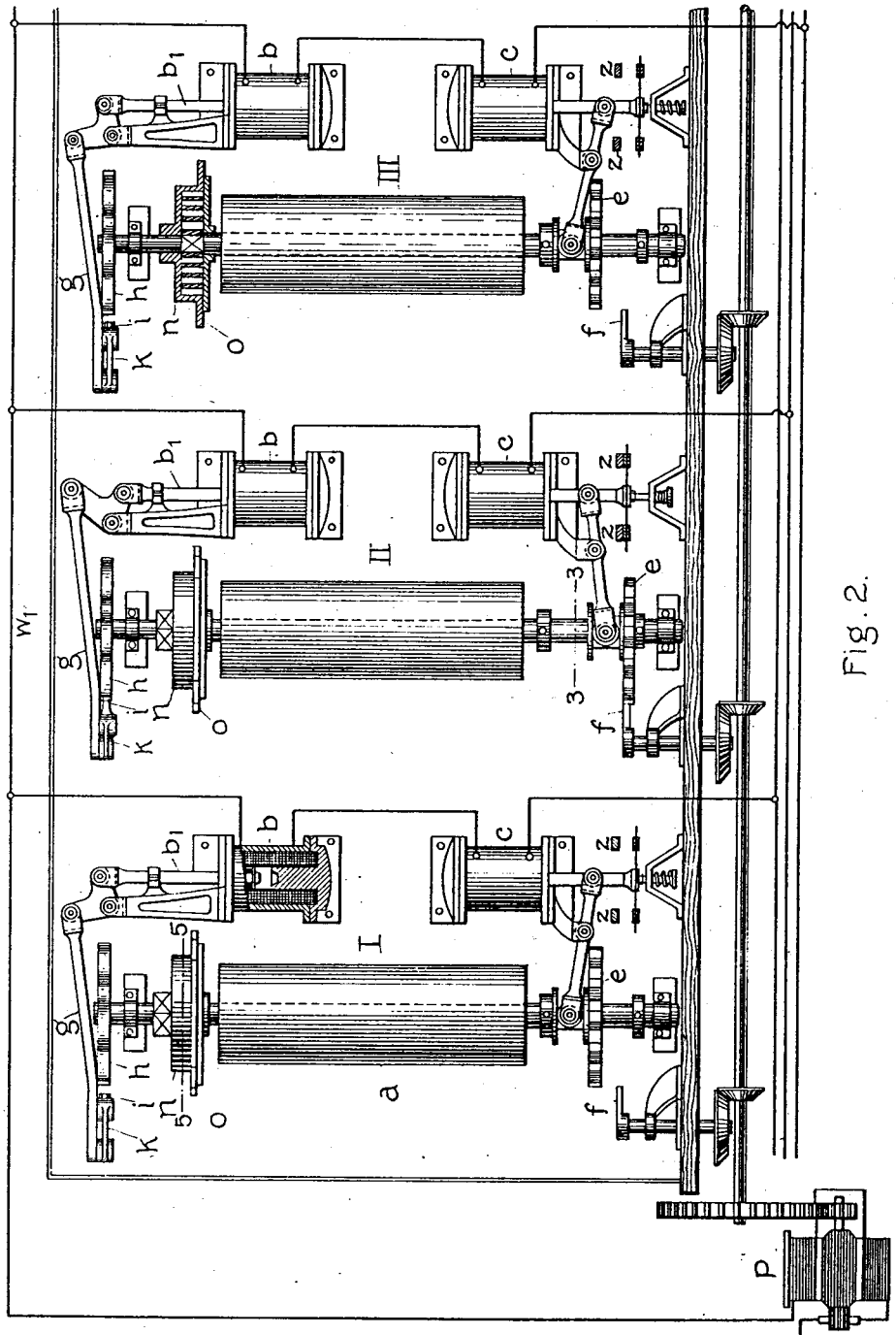

Fig. 2.

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(No Model.) 3 Sheets—Sheet 3.

Fig. 3.

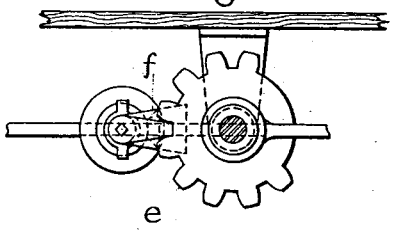


Fig. 4.

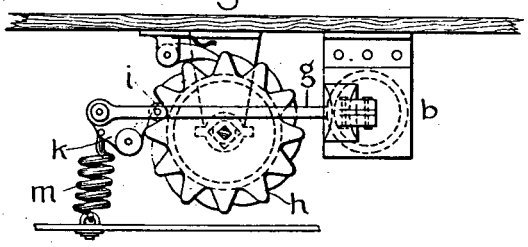


Fig. 5.

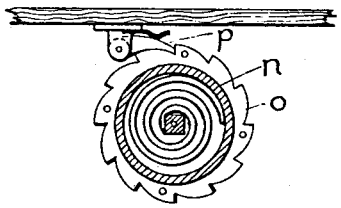


Fig. 6.

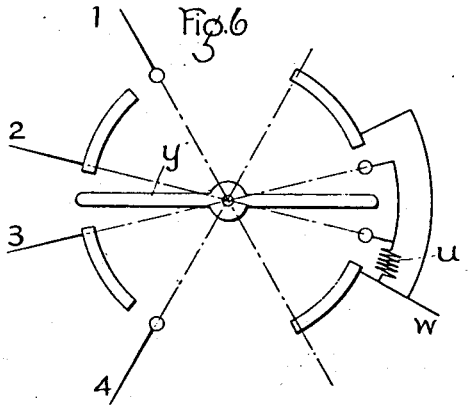
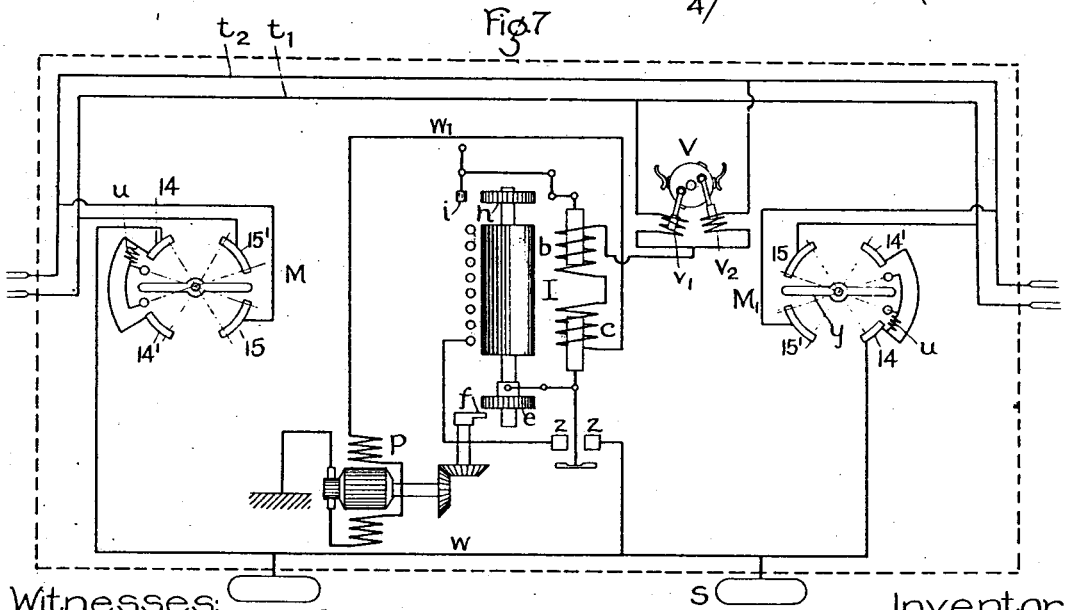


Fig. 7.



Witnesses:
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UNITED STATES PATENT OFFICE.

MARTIN T. A. KUBIERSCHKY, OF BERLIN, GERMANY.

METHOD OF CONTROLLING ELECTRIC MOTORS.

SPECIFICATION forming part of Letters Patent No. 648,696, dated May 1, 1900.

Application filed December 6, 1899. Serial No. 739,428. (No model.)

To all whom it may concern:

Be it known that I, MARTIN T. A. KUBIERSCHKY, a subject of the Emperor of Germany, residing in Berlin, Prussia, Germany, have invented certain new and useful Improvements in Means for Controlling Electric Motors, of which the following is a specification.

My invention relates to a system of control whereby it is possible to control any number of switching devices from a single point, and is particularly adapted to controlling an electric-railway train in which for the purpose of obtaining a rapid acceleration it is desirable to so actuate the operating-switches that the motors on all the cars may be started simultaneously from any one of a number of points on the train. It has heretofore been proposed to operate such a system by means of pilot-motors on each of the cars controlled from a master switch or controller located at any desired point on the train.

It is one of the objects of my invention to simplify such an organization and to reduce the number of train-wires required to operate the various switches to a minimum.

My invention comprises also other features which are fully set forth in the following description and defined in the accompanying claims.

In carrying out my invention I provide each of the motor-cars of the train with a main controller, comprising the ordinary motor-controlling switches, and an auxiliary or pilot motor for operating said switches, and I control the pilot-motors of all the cars from a master-controller located at any desired point on the train. The corresponding switches on each car are operated from the master-controller by means of a single conductor, which traverses the length of the train, and it is one of the distinguishing features of my invention that only two train-conductors are required for operating the train in both directions. In case electric brakes are used a third conductor is used for braking in one direction and a fourth for braking in the other direction. As soon as the master-controller is closed in any one of its several positions the pilot-motors on all the motor-cars are started and the controlling-switch cylinders corresponding to the particular position of the master-switch are thrown into gear and are operated synchronously at a certain predetermined speed from the off to full-power position without any further operation of the master-controller. The rate at which the controlling-switches are operated is so proportioned that the maximum torque is used throughout the whole period of acceleration. The speed of the train at starting is therefore automatically controlled and is not dependent on the skilfulness of the motorman. If it should be necessary to stop the train before the full-power position has been reached by the controlling-switches, the motorman merely brings the master-controller to its off position, thereby opening the pilot-motor circuit and releasing locking devices which normally retain the controlling-switches in their operative positions. As soon as the locking devices are released the power-circuit is immediately opened and the controlling-switches are brought to their off position by means of actuating-springs.

Referring to the drawings accompanying the specification, Figure 1 shows a diagram of connections for a single car. Fig. 2 shows the details of construction of the controlling-switches and their operating-mechanisms. Fig. 3 is a cross-section on the line 3 3 of Fig. 2. Fig. 4 is a view in plan of the locking device of the controlling-switch. Fig. 5 is a view in cross-section along the line 5 5 of Fig. 2. Fig. 6 shows a modified form of master-switch, and Fig. 7 shows a modified diagram of connections for a single car.

Referring to Figs. 1 and 2, I, II, III, and IV indicate the controlling-switches of a single car, the switch IV being omitted in Fig. 2 for lack of space. P indicates the pilot-motor for operating said switches, and M M' the master-switches. Each of the controlling-switches is provided with an electromagnet *b* for actuating a switch-locking device and an electromagnet *c* for actuating a main or cut-out switch and for operatively connecting the controlling-cylinder to the pilot-motor. The windings of the electromagnets *b* and *c* are connected in series with each other. The electromagnets of the several controlling-switches on each car are at one end connected to a common conductor *w'*, leading through the pilot-motor P to ground. At the other

end the electromagnets of controlling-switch I are connected to the train-wire t', those of the switch II to the wire t^2, and so on. The controlling-switches on the other cars of the train are similarly connected to the same train-wires, and from these wires connections are made at various points, as shown, at each end of each car to terminals 1 2 3 4. The master-controllers M and M', located one at each end of the car, comprise a controlling-switch C and a reversing-switch R and are at one point connected to the main source through the contact-shoes S S and the conductor w. By throwing the reversing-switch R to the left or to the right the master-controller may be connected through the terminals 1 to 4, inclusive, with the train-wires $t' t^2$ or $t^3 t^4$.

With the reversing-switch R of the master-controller M connected to the conductors t' t^2, as shown, if the lever of the controlling-switch is moved until it makes contact between the segments 6 7 current will flow from the contact-shoe S through the conductor w to the segment 6, and in the first position of the switch through a small resistance u to the segment 5, through the lever of the master controlling-switch to the segment 7 and through the train-wire t' to the electromagnets b and c of controlling-switch I, and thence to the conductor w' and through the pilot-motor P to ground. The resistance u is provided to prevent too great a current at starting in the pilot-motor circuit; but it is not an essential part of the system and may be omitted, if desired.

As soon as the master-controller has been closed the pilot-motor begins to revolve, and at the same time the electromagnets b and c are brought into operation. The electromagnet c operates to move a gear e along the shaft of the switch-cylinder and into engagement with an intermittent gear or thumb f, driven by the pilot-motor, and the said cylinder is operated step by step at each revolution of the intermittent gear until it has been brought to its final position. The electromagnet c also serves to close a main or cut-out switch z z between the conductor w and the controlling-switch, the circuit to each of the several controlling-switches of the main controller being open until its cylinder is thrown into operation.

In Fig. 2 of the drawings I have shown the switch-cylinders I and III in off position and the cylinder II in operative relation with the pilot-motor and partially turned from its off position, and from this figure, in connection with Fig. 3, which shows a view in cross-section along the line 3 3 of the switch II in Fig. 2, it will be seen that the gear e is provided with teeth throughout a portion only of its circumference, so that after a certain point in the revolution of the controlling-switch cylinder has been reached the intermittent gear f will not operate to move it further. In order that the controlling-switch cylinder may be locked against backward rotation as long as its magnet b is energized, and, further, in order that the switch-cylinder may be compelled to snap from one position to another, I have provided each switch-cylinder with a star-wheel h and a pawl or roller i for engaging the same. As soon as the pilot-motor circuit is closed through any one of the controlling-switches, the magnet b, through its plunger b' and the levers g and k, brings the roller i, carried by k, into engagement with the star-wheel h and holds it thus against the tension of the spring m. Above the cylinder of the controlling-switch and between it and the star-wheel is arranged a spring inclosed in a box n, provided with a flanged portion o, having teeth at its circumference. (See Fig. 5.) The spring is fastened at one end to a squared portion of the shaft of the switch-cylinder and at its other end to the side of the box, and a pawl p engaging the teeth of the flange o, provides a means for regulating the tension of the spring. The spring could of course be replaced by any sort of a counterweight or by any suitable apparatus for giving a backward motion to the switch-cylinder.

In Fig. 1 of the drawings I have shown a motor-controller comprising four controlling-switches, one for each direction of running and one for braking in each direction. With the switch R in the position shown the closing of the controlling-switch C, so that the segments 6 and 7 are connected by the lever y, will, as already stated, close the main circuit to each of the controlling-switches I on the several cars of the train by means of the main switches z z, and through the pilot-motors will operate the controlling-switches in a step-by-step manner to their final positions. The motors on all the cars will be started and the synchronously-operating controlling-switches will bring the power on gradually by the series-parallel or any other method of motor control in such a manner that a maximum torque will be exerted throughout the whole period of acceleration. When it is desired to throw off the power, the master-controller will be opened and the magnets b and c of each of the controlling-switches I will be deënergized. The main circuit will be immediately opened at z z, the gear e will be withdrawn from engagement with the gear f and the pawl i from the star-wheel h, and under the influence of the actuating-spring the controlling-cylinders will be brought to their off position.

If instead of merely throwing off the power it is desired to bring the train to a standstill, the lever y of the master-controller will be moved until it connects the contacts 6 and 8. As soon as the lever y leaves the segment 7 of the master-switch the controlling-switches I will be thrown out of action in the manner above explained; but immediately the lever y reaches the contact 8 a circuit will be closed through the train-wire t^2 and through the

several switches II to the pilot-motors and to ground. These switches will be operated in the same manner as the switches I; but in this case the circuit will be closed at z z—not to the contact-shoes S, but to the brake return—while the cylinder-switches will make the connections necessary for electric braking, as understood in the art.

If it is desired to operate the train in the reverse direction, the switch R is thrown to make contact with the terminals 3 4, and then the switches III IV may be operated to propel the train in the reverse direction or to brake the train when so moving by manipulating the controlling part C of the master-switch in the manner already described.

In Fig. 1 I have shown the master-controller as comprising two distinct switches, one a controlling-switch for operating the motors or applying the brakes and the other a reversing-switch which is used when it is desired to reverse the direction of motion of the train. It is evident that these two parts of the master-controller might be combined in one, and in Fig. 6 I have so illustrated it. Referring to this figure, w indicates the conductor leading from the contact-shoe and the numerals 1 2 3 4 the connections leading to the respective train-conductors. If the switch-lever y is moved to the right, the conductor w may be connected to the train-wires l' or l^2, according to the position of the said lever, while if it is moved to the left connection may be made from the conductor w to the train-wires l^3 or l^4.

While I have shown in Fig. 1 a main controller comprising a separate controlling-switch for each direction of motion and for braking in each direction, it is evidently not necessary that four switches be used. In some cases it might be more advantageous to make use of a distinct braking apparatus, which would reduce the number of controlling-switches and the number of train-wires to two, and in this latter case a single controlling-switch properly connected to a reversing-switch might be used for both directions of running.

In Fig. 7 of the drawings I have illustrated the circuit connections for a car having a single controlling-cylinder and a reversing-switch for connecting the motors for forward or backward rotation, and I have shown a master-switch of the type illustrated in Fig. 6.

Referring to Fig. 7, if the lever y of the master-controller at the left of the figure is turned so as to connect the segment 14 with the segment 15 current from the contact-shoe will pass through the conductor w to the segment 14, through the switch-lever y to the segment 15, and by way of the train-conductor l^2 to the actuating-solenoid v^2 of the reversing-switch V, and thence through the pilot-motor P' to ground. The core pivoted at the right of the shaft of the reversing-switch cylinder will be drawn into the solenoid v^2 and the reversing-switch thrown into the position illustrated in the drawings, while the controlling-switch cylinder will be operated by the pilot-motor in the manner already described. The driving-motors will be supplied with current through the switches z z on each of the cars of the train and the train will be propelled in a certain direction. If now it is desired to reverse the direction of motion, the lever y of the master-controller is thrown so that it makes contact between the segments 14' and 15', current from the contact-shoe will flow through the master-controller to the train-wire l' and through the solenoid v' of the reversing-switch B to the electromagnets b and c_4 as before, and thence through the conductor w' and pilot-motor P to ground. The core pivoted at the left of the shaft of the reversing-switch will now be drawn into its solenoid v', the reversing-switch will be thrown into its other position connecting the motors for rotation in the opposite direction, the controlling-switch cylinder will be operated as before, and the train will be propelled in the reverse direction. It will thus be seen that whether I use a separate controlling-switch for each direction of motion or a single controlling-switch in connection with a reversing-switch, but a single train-conductor is required for each direction of motion.

While I have illustrated my invention in connection with certain specific apparatus, it is evident that it is not limited thereto, but that other arrangements may be employed without departing from the spirit of my invention.

I claim as my invention—

1. In combination, a train comprising one or more motor-cars, main controllers on said motor-cars, a single pilot-motor on each motor-car for operating the controller on said car, a master-controller, and electrical connections consisting of a single train-conductor for each direction of running.

2. In combination, a plurality of cars, main controllers comprising power and braking switches carried by said cars, a master-controller, and electrical connections comprising a single train-conductor for each direction of running and for braking in each direction.

3. In combination, a main controller comprising a plurality of switches, electrically-controlled means for operating said switches at a predetermined rate, a master-controller, and electrical connections comprising conductors equal in number to the switches of the main controller.

4. In combination, a main controller, a pilot-motor therefor, a master-controller, a cut-out switch, and connections such that bringing the master-controller to its off position operates the cut-out switch.

5. In combination, a main controller, an electromagnetic pilot-motor therefor, a master-controller, an electromagnetic cut-out switch, and circuit connections such that bringing the master-controller to its "off" position operates the cut-out switch.

In combination, a controlling-switch, a pilot-motor therefor, an electromagnetic coupling device operatively connecting said motor to said controlling-switch, means for simultaneously actuating said motor and said coupling device, and means for returning said controlling-switch to "off" position as soon as the electromagnetic coupling device is released.

7. In combination, a main controller, means for operating said controller, a master-controller, an electromagnetic cut-out switch, and circuit connections such that bringing the master-controller to its "off" position operates the cut-out switch.

8. In combination, a plurality of controlling-switches, a common actuating means, means for causing engagement between said controlling-switches and said actuating means, and a master-controller for controlling said engaging means.

9. In combination a plurality of groups of controlling-switches, a pilot-motor for each of said groups, means for operatively connecting said controlling-switches to said motors, and a master-controller for actuating said motors and controlling said connecting means.

10. In a system of train control, a plurality of cars, each provided with a controlling-switch and a reversing-switch, means for actuating said controlling-switches, means for actuating said reversing-switches, and two train-conductors connecting said reversing-switch and said controlling-switch actuating means with a master-controller, said master-controller being so constructed and arranged that a single manipulation operates both the controlling and reversing switches.

11. In combination, a controlling-switch, a motor for actuating said switch, means for operatively connecting said controlling-switch to said motor, and a single circuit for controlling said motor and said connecting means.

12. In combination, a controlling-switch, a motor for actuating said switch, means for operatively connecting said controlling-switch to said motor, and means for simultaneously actuating said motor and said connecting means.

13. In combination, a controlling-switch, a motor for actuating said switch, means for operatively connecting said controlling-switch to said motor, a locking means for said controlling-switch, and means for simultaneously actuating said motor, said connecting means, and said locking means.

14. In combination, a controlling-switch, a main switch, means for actuating said controlling-switch, means for actuating said main switch, and a master-controller simultaneously controlling the said actuating means.

15. In combination, a controlling-switch, a main switch, a motor for actuating said controlling-switch, electromagnetic means for operatively connecting said controlling-switch to said motor, and for closing said main switch, and a single circuit for controlling said motor and said electromagnetic means.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

MARTIN T. A. KUBIERSCHKY.

Witnesses:

HENRY HASPER,

WOLDEMAR HAUPT.