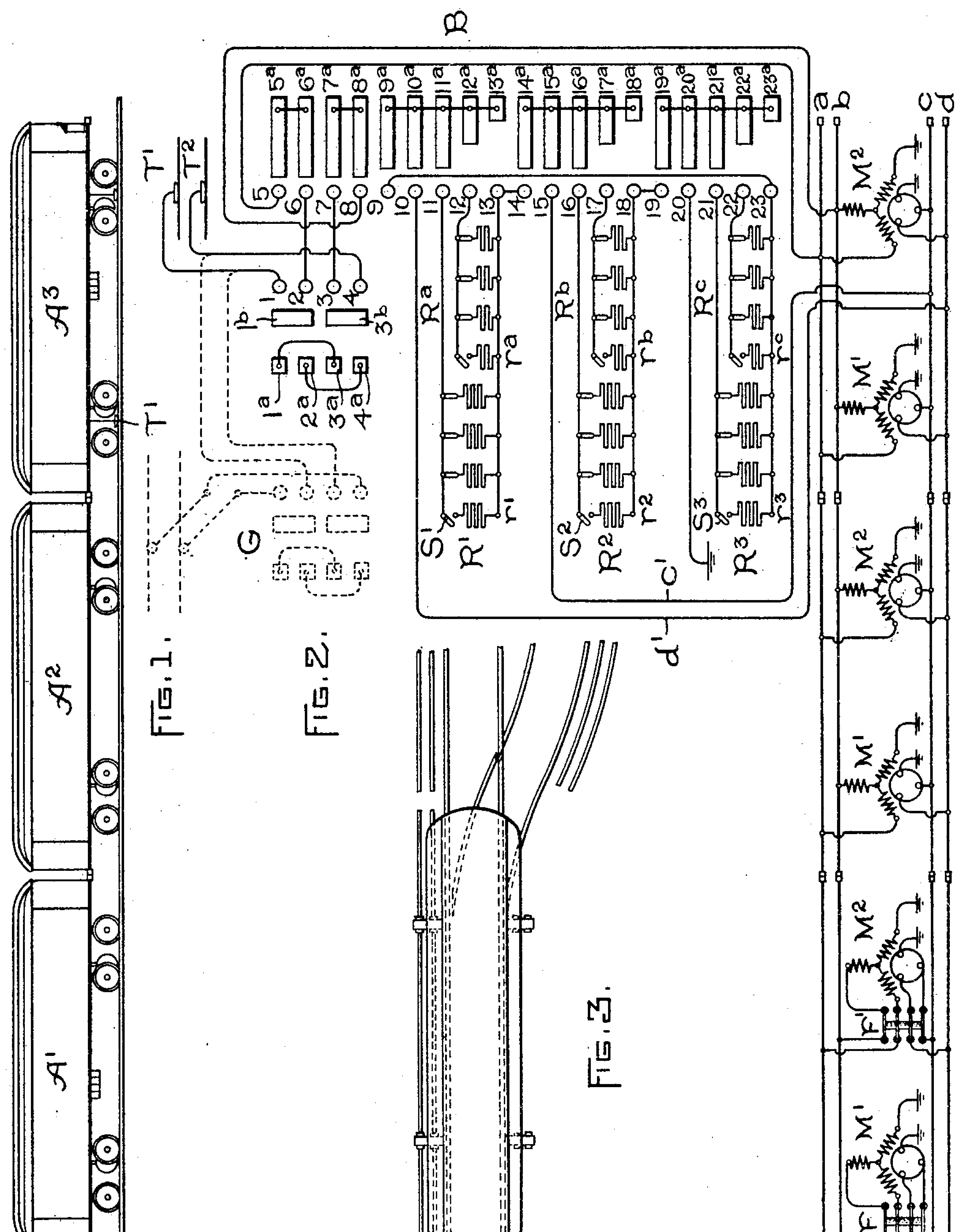
No. 671,491. Patented Apr. 9, 1901.

W. B. POTTER.

SYSTEM OF TRAIN CONTROL.

(Application filed June 12, 1899.)

(No Model.)



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SYSTEM OF TRAIN CONTROL.

SPECIFICATION forming part of Letters Patent No. 671,491, dated April 9, 1901.

Application filed June 12, 1899. Serial No. 720,291. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM B. POTTER, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Systems of Train Control, (Case No. 923,) of which the following is a specification.

This invention relates to systems for controlling the several cars of an electrically-propelled train, the object being to provide the cars with independent electric motors and to regulate the speed, torque, and direction of rotation of the motors from a single point in the train, so that the train may be composed of any number of units controllable and regulable by a single controller.

The invention is particularly applicable to interurban or elevated-railway traffic where a plurality of motor-cars are used in each train, the simplification of the controlling system, the minimizing of the number of parts, and the mounting of the current-toning resistances for all of the cars on a single car greatly cheapening the cost of installation.

My invention is applicable to electrically-propelled cars of any type, whether direct or alternating current and single or polyphase in character. The invention, however, is especially applicable to cars propelled by alternating-current motors of the polyphase-induction type.

As illustrated in the drawings, I provide each car with one or more propelling-motors, suitable feed-wires being carried through the train and terminating at the ends of each car in connecting devices, by which a common supply system may be provided for the entire train. Current is led from the source of supply by a suitable collector or collectors, which lead to the controller in a "pilot-car," by which is meant the car upon which the common controller for the system is located. On this car are mounted also a series of resistances for graduating the strength of current in the several armature-circuits of the motors of the train, and thereby graduating the torque and speed of the motors. A considerable number of independent resistances are mounted on the pilot-car, as many as the requirements of train-service will call for as to the maximum number of cars per train. The controller is organized to render all or any desired number of these resistances operative, according to the number of cars in the train. If a polyphase system of the two or three phase type be employed, I use two supply-wires, from which the current is collected by trolleys or other suitable devices, and provide two independent conductors for the field-magnet and armature circuits of the motors, said conductors extending throughout the train. The several motors connect in multiple with these conductors, ground connections from the several motors being utilized as a third conductor or common return. The amount of resistance necessary to provide for the increased flow of current with an increased number of cars is graduated by switches on the pilot-car.

My invention therefore comprises a system of train control having a plurality of cars the speed and torque of which are governable by a single controller and rheostat mounted at some one point of the train.

It comprises, further, such an organization in which the current-carrying capacity of the rheostat is variable to permit control of trains of different sizes.

More specifically it comprises an alternating-current system of train control in which the several cars are provided with induction-motors connected in parallel to leads extending throughout the train and governable as to speed and torque from a single controlling-point.

Other features of novelty will be hereinafter more fully set forth and definitely claimed.

In the drawings which illustrate the invention, Figure 1 is an elevation of a railway-train, showing three cars, the number being selected simply for the purpose of convenience in the drawings. Fig. 2 is a diagram of the system of current control and distribution in a polyphase alternating-current system supplying a train driven by induction-motors. Fig. 3 shows a modification of the current-collectors on the pilot-car.

I have shown in the drawings a train of three cars.

An important point of my invention is that I permit a variable number of cars to compose a train, the maximum number being limited only by the capacity of the controller on the pilot-car. This controller, as is shown diagrammatically at B in the drawings, is provided with two distinct sets of contacts, one set, comprising the fixed contacts 1 to 4 and the coöperating movable contacts 1^a to 5^a and 1^b to 3^b, constituting a reversing-switch, and the other set, comprising the fixed contacts 5 to 23 and the movable contacts 5^a to 23^a, constituting the main controlling-switch for controlling the flow of current in the motor-circuits. The two sets of contacts are shown developed on a plane surface, as is customary in diagrammatically illustrating such structures, though in practice the movable contacts of each set are mounted on a cylinder and are arranged to be rotated past corresponding rows of fixed contacts. Extending through the train are two pairs of conductors or leads *a b* and *c d*, the former of which connect with two of the field-terminals of each motor, coupling the several motor field-magnets in parallel relation, as shown, and the latter connecting with two ring-contacts on the several armatures or secondary motor members, coupling them in a similar relationship. The third terminal of each field-magnet and armature winding of the motors is grounded, as indicated. The leads *a b*, which are connected to the field-magnet windings of the primary members of the induction-motors, connect with two contacts 5 and 8 on the main controlling-switch, the contacts 6 and 7 being connected to the source of supply through the contacts of the reversing-switch. The armature-leads *c d* connect with two controller-contacts, as 10 and 15, a third contact 20 being connected with the ground. For controlling the flow of current in the armature-circuits of the motors a plurality of sets of resistances are provided, as indicated at R′, R^2, and R^3. In the system shown in the drawings there are three sets of these resistances, one for each phase of the system. For a quarter-phase system but two would be necessary, and if a system of a higher order were employed more would be required. Each of these resistance sets comprise a plurality of separate resistances arranged in as many sections as it is desired that there shall be resistance-steps on the controller. As shown in the drawings, there are two resistance-sections, and each of the separate resistances in each section may be cut in or out by a manipulation of a hand-switch. Thus in the set R′ there are two sections of resistances r' and r^a, and each of the resistances in each of the sections may be cut in or out by a manipulation of a small hand-switch S′. The number of resistances in a section should correspond with the greatest number of cars it is desired to operate in a single train. With the system shown in the drawings this number is four; but when it is desired to operate a train comprising a number of motor-cars less than four the number of resistances in each section should be reduced to correspond. The system shown in the drawings is arranged for the operation of a three-car train, and it will be noted that three of the separate resistances are connected in circuit in each resistance-section. The controller is provided with a group of contacts for each set of resistances, these contacts operating first to close the armature-circuits of the several motors through the resistances r', r^2, and r^3, next to connect the resistance r^a in multiple with r', r^b with r^2, and r^c with r^3, and finally to short-circuit all the resistances. This result is accomplished in the usual manner by making some of the movable contacts of the controller shorter than the others, as exemplified in the diagram.

The method of controlling the train will now be understood. Supposing the reversing-switch to be thrown so as to bring its contacts 1^b and 3^b into engagement with the contacts 1 to 4, the first movement of the main controlling-switch will close the primary or field-magnet circuits of the motors on the train, as follows: Starting from the trolley-shoe T′, one circuit leads through contacts 1 and 2 of the reversing-switch to contact 6 of the main controlling-switch and thence through cross-connected contacts 5^a and 6^a and the contact 5 to lead *a*. Another circuit leads from the trolley-shoe T^2 through contacts 3 and 4 of the reversing-switch to contact 7 of the main controlling-switch and thence through cross-connected contacts 7^a and 8^a and contact 8 to lead *b*, while the third circuit is through ground, the third terminals of all the motors being always connected through ground to the third terminal of the source of supply. As soon as the field-magnet circuits have been closed the armature-circuits will be closed through the maximum resistance at the contacts 9 to 11, 14 to 16, and 19 to 21 as follows: Starting from the lead *d*, to which one of the secondary terminals of all the motors is connected, one circuit leads through conductor *d′* to contact 10 of the main controlling-switch, through cross-connected contacts 10^a and 11^a to contact 11, and thence through the resistances of the section r' to contact 14, through cross-connected contacts 14^a and 15^a to contact 15, and thence through conductor *c′* to the lead *c*, to which another secondary terminal of each motor is connected. Other similar circuits, including the resistances r^2 and r^3, respectively, are connected between each of the leads *c d* and ground through controller-contacts 9, 16, 19, 20, and 21. The resistances are thus connected in delta to the motor-armature circuits. A second step in the manipulation of the controlling-switch brings each of the contacts 12^a, 17^a, and 22^a into engagement with a corresponding fixed contact, thus cutting in an additional section of resistances for each current phase in multiple with the section already included in circuit and permitting an increased flow of current and greater torque in the motors. A third step in the manipulation of the controller brings the contacts 13^a, 18^a, and 23^a into engagement with their corresponding fixed contacts and places the several windings of the motor-armatures on short circuit, thus giving the maximum speed to the several motors.

While I have illustrated a controller having but two resistance-sections, and therefore only three steps in the graduation of the speed of the motors, it will of course be understood that more than these steps may be provided, if desired.

It will be noted that the contacts 5^a to 8^a are somewhat longer than the contacts controlling the connections of the armature-circuits. They are thus elongated, so that the field-magnet circuits will not be opened until after the armature-circuits have been broken, thus subduing sparking at the controller-contacts at the time of breaking the circuit.

By the system above described it will be seen that I am enabled to control all the motors of a train comprising a variable number of motor-cars in multiple from a single controller with (in the case of a three-phase system) but four train-leads.

In order to permit the motors of any particular car to be disconnected from the supply-circuit, I may provide a four-point switch for each motor, as indicated at F F′, by which the field-magnet and armature circuits may be simultaneously opened. Thus in case of accident to a motor or other emergency the motor or motors on the car where the trouble exists may be cut out of circuit.

In systems employing a single set of contact devices or trolley-shoes engaging corresponding supply-conductors arranged along the railway it will be found desirable to provide the pilot-car with an auxiliary reversing-switch in series with the reversing-switch of the controller, as shown in dotted lines at G in Fig. 2. When the pilot-car is turned end for end, it will be necessary to throw this auxiliary reversing-switch in order to preserve the same relationship between the direction of motion of the handle of the controller-reversing switch and the directions of motion of the car or train. This will be evident when it is considered that as the pilot-car is turned end for end the trolley-shoes, through which current is supplied to the car or train system, are shifted, so that each bears upon a conductor formerly engaged by the other. If when the car is so wired that when the reversing-switch is thrown, say, to the right the car will be propelled in the direction toward which the motorman faces, it will be found that when the car is turned end for end a throwing of the reversing-switch to the right will cause the car to be propelled in the wrong direction. Whether a train or only a single car is to be operated such an auxiliary reversing-switch will be found desirable to preserve uniformity in direction of motion of the operating-handle of the controller-reversing switch, and thus to prevent mistakes in cases of emergency, which might prove disastrous. The same result might be accomplished in a system where the supply-conductors are located at one side of the track by providing the car carrying the contact or collecting devices with collecting devices on each side, as indicated in Fig. 3, the outside collectors on one side being connected to the outside collector on the other and the inner collectors on each side being also correspondingly connected. Obviously in such an organization the same collector will be connected to the same supply-wire irrespective of the position of the car and the auxiliary reversing-switch will not be required. It will of course be understood that in order to reverse the direction of motion of a three-phase motor it is necessary to change the connections at only two of its terminals. Therefore but two of the main supply-conductors are carried through the reversing-switch and the other is connected permanently to ground.

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

1. In an electric train system, a plurality of motor-cars, a controlling system for said train, and a controller provided with means for adjusting its capacity to correspond with the number of motor-cars in the train.

2. In an electrically-operated train, a plurality of cars provided with electrically-operated devices, a controlling system for said devices, and a controller therefor provided with means for adjusting its capacity to correspond to the number of said cars in the train.

3. In an electrically-operated train, a plurality of cars provided with electrically-operated devices, a controlling-circuit for said devices, a resistance in said circuit, a controller for successively increasing or diminishing said resistance, and means for adjusting the amount of said resistance to correspond to the number of devices in circuit.

4. In combination, in a controlling system for electric-railway trains, a plurality of motor-cars, a controller, for controlling all the motors on a train, located on one of the cars of said train, and means for adjusting the capacity of the controller to correspond to the number of motor-cars in the train.

5. A controlling system for electric-railway trains, comprising a plurality of motors mounted on the several cars, and connected in parallel with a common source of supply, and a controller, mounted at a single point in the train, provided with means for adjusting its capacity proportionately to the number of cars in the train.

6. A controlling system for electric-railway trains, comprising a plurality of motors mounted on independent cars and connected in parallel relation with supply-conductors extending through the train, and a controller, mounted at a single point in the train, provided with means for adjusting its capacity proportionately to the number of cars in the train.

7. A controlling system for electric-railway trains, comprising a plurality of motors mounted on independent cars and connected in parallel relation with supply-conductors extending through the train, a controller mounted at a single point in the train, a variable resistance for said controller, and means for varying the capacity of said resistance so as to permit trains of varying numbers of cars to be supplied through the same controller.

8. In combination in an electric-railway system, a car system supplied with current through a set of contact devices engaging corresponding supply-conductors, a controller for said system provided with a reversing-switch, and an auxiliary reversing-switch connected in series with the controller-reversing switch so that, by proper adjustment of the auxiliary reversing-switch, the controller-reversing switch may always be thrown in the same direction to propel the car in a given direction irrespective of the relation of the supply-conductors to the contact devices.

9. In combination in a polyphase electric-railway system, a car system supplied with current through a plurality of contact devices carried by the car and engaging corresponding supply-conductors arranged along the railway, a controller for said system provided with a reversing-switch, and an auxiliary reversing-switch connected in series with the controller-reversing switch so that, by proper adjustment of the auxiliary reversing-switch, the controller-reversing switch may always be thrown in the same direction to propel the car in a given direction irrespective of the relation of the supply-conductors to the contact devices.

10. In a polyphase electric railway, the combination of a number of cars each equipped with one or more polyphase motors, and a switch at a desired point on the train for regulating the resistance of the secondary circuits of all of the motors.

11. In an electric-railway train, the combination of a number of cars, each having one or more induction-motors upon it, with a controlling device at a desired point upon the train, arranged to first connect the primaries of all of the motors in multiple with a source of supply, and afterward vary the resistance of the secondary circuits to regulate the speed and torque of the motors.

12. In a three-phase electric railway, a pair of metallic conductors, a ground return, and a number of cars carrying suitable traveling contacts and polyphase motors; in combination with a controller located at a desired point upon the train, designed to first connect in the primary members of all of the motors and then to change in a desired manner the resistance of the secondary circuits, so as to progressively vary the speed and torque of the motors.

13. A controlling system for electric-railway trains, comprising a plurality of induction-motors for driving the train, distributed among the several cars thereof, a single controller for the train mounted at one point therein, and resistance devices for the several motors operated by the controller.

14. A controlling system for electric-railway trains, comprising a plurality of induction-motors distributed throughout the train connected in parallel with current-leads extending throughout the train, a controller common to all the motors mounted at a single point in the train, and independent devices operated by said controller for closing the field-magnet and armature circuits in the order stated.

15. A controlling system for electric-railway trains, comprising a plurality of induction-motors distributed throughout the train, independent field-magnet and armature leads with which said motors connect in parallel relation, a plurality of resistances governed by the controller in an armature-circuit common to the several motors, and means for adjusting the resistances according to the number of cars in the train.

16. A system of control for electric-railway trains, comprising a plurality of polyphase induction-motors distributed throughout the train, the field-magnet and armature windings of the respective motors connecting in parallel with two pairs of train-leads and ground, and a controller located at a single point in the train, governing the motors.

17. In combination, a control-circuit for a variable number of electrically-operated devices, a resistance in said circuit, a controller for successively increasing or diminishing said resistance, and means for adjusting the amount of said resistance to correspond with a number of devices in circuit.

18. In combination, a control-circuit for a variable number of electrically-operated devices, a rheostat therefor, a controller for successively cutting the resistance-sections into and out of circuit, and means for changing the value of the resistance-sections acted upon by the said controller, in accordance with the variable number of devices in circuit.

In witness whereof I have hereunto set my hand this 9th day of June, 1899.

WILLIAM B. POTTER.

Witnesses:
BENJAMIN B. HULL,
MABEL E. JACOBSON.