No. 822,275. PATENTED JUNE 5, 1906.

G. H. HILL.

SYSTEM OF MOTOR CONTROL.

APPLICATION FILED NOV. 17, 1904.

3 SHEETS—SHEET 1.

Fig. 1.

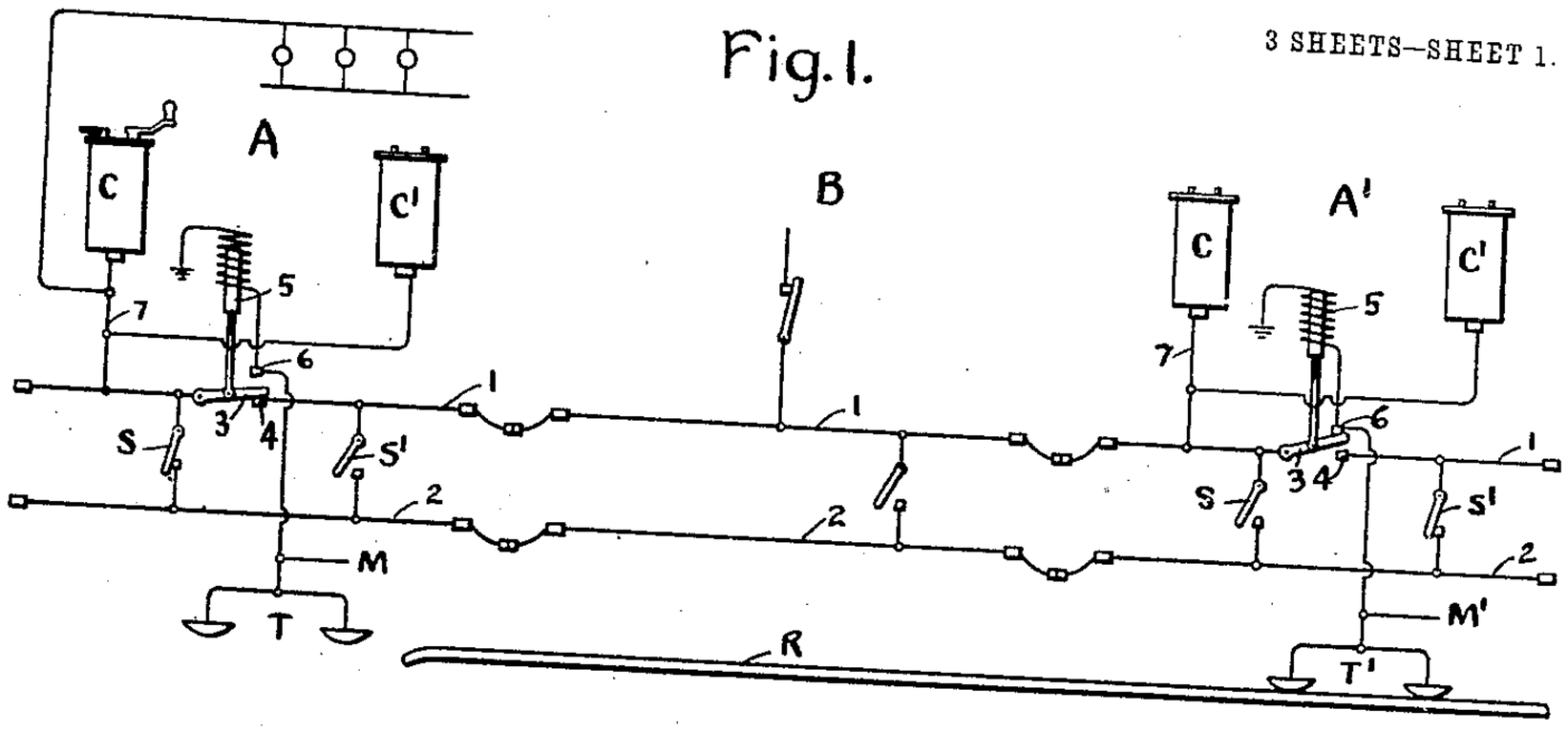


Fig. 2.

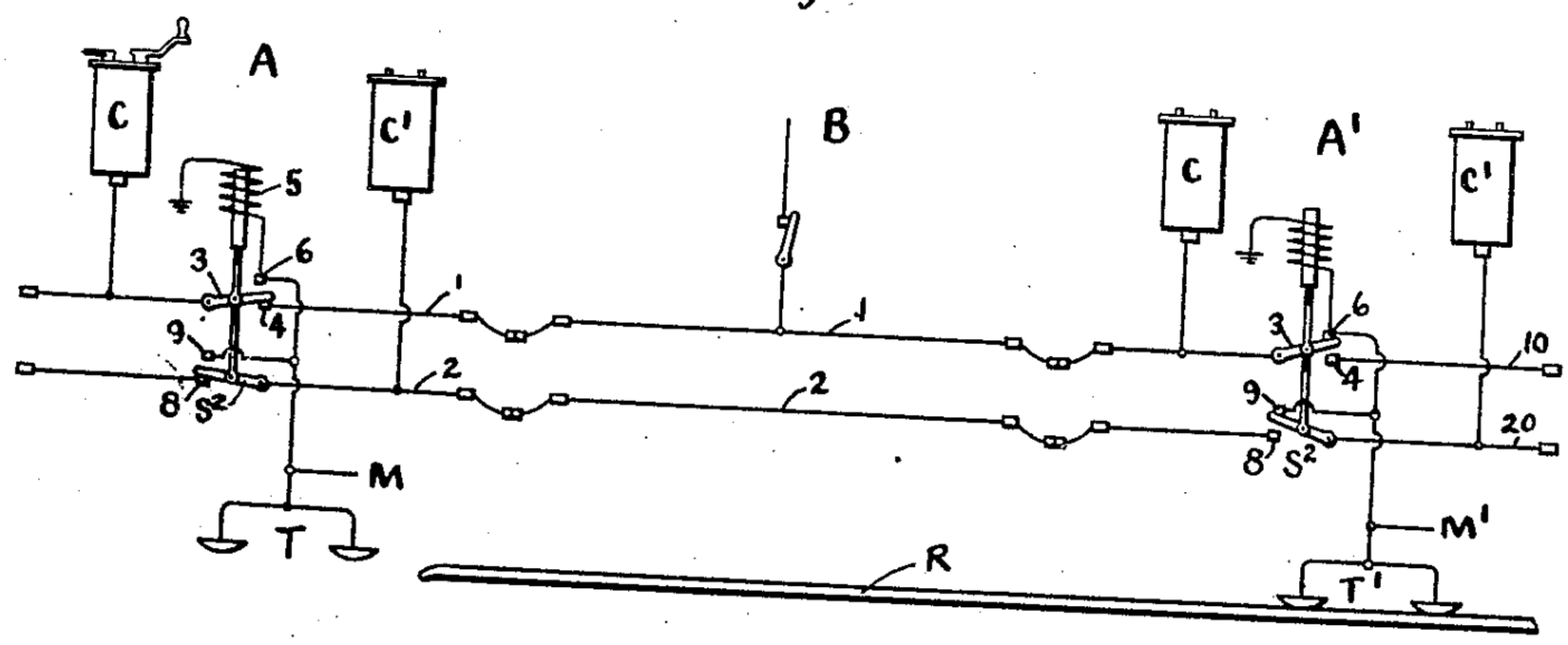
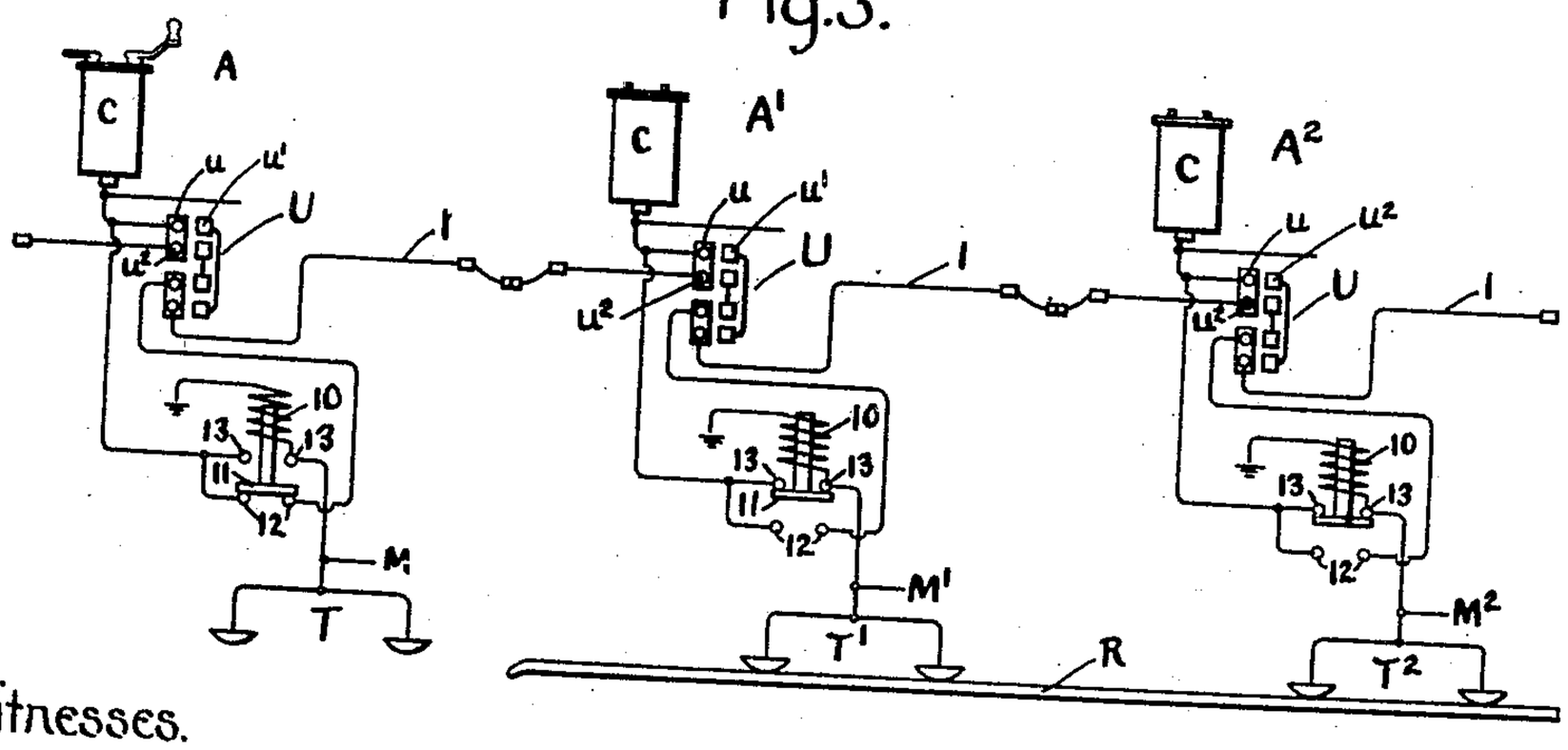


Fig. 3.



Witnesses.
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Helen Orford

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3 SHEETS—SHEET 2.

Fig.4.

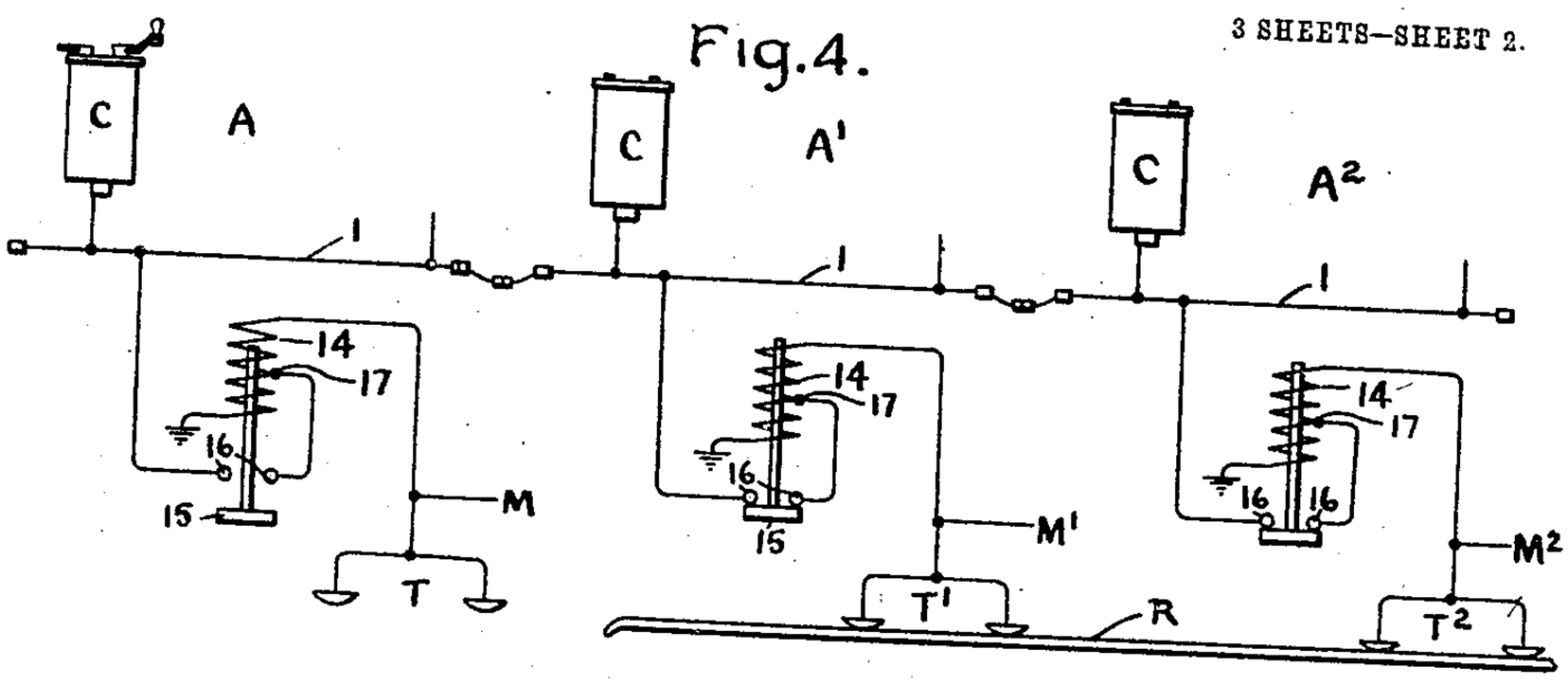


Fig.5.

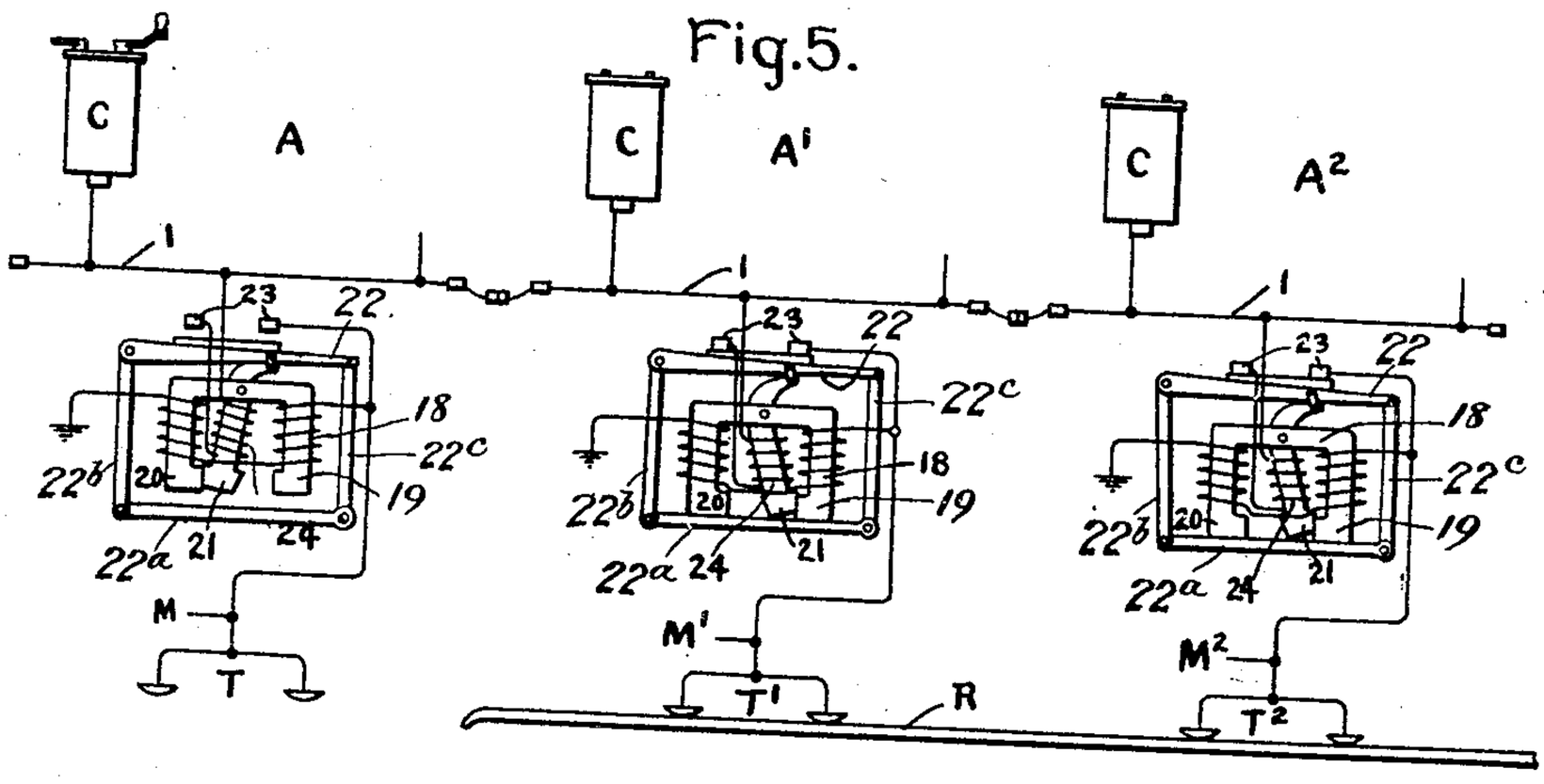
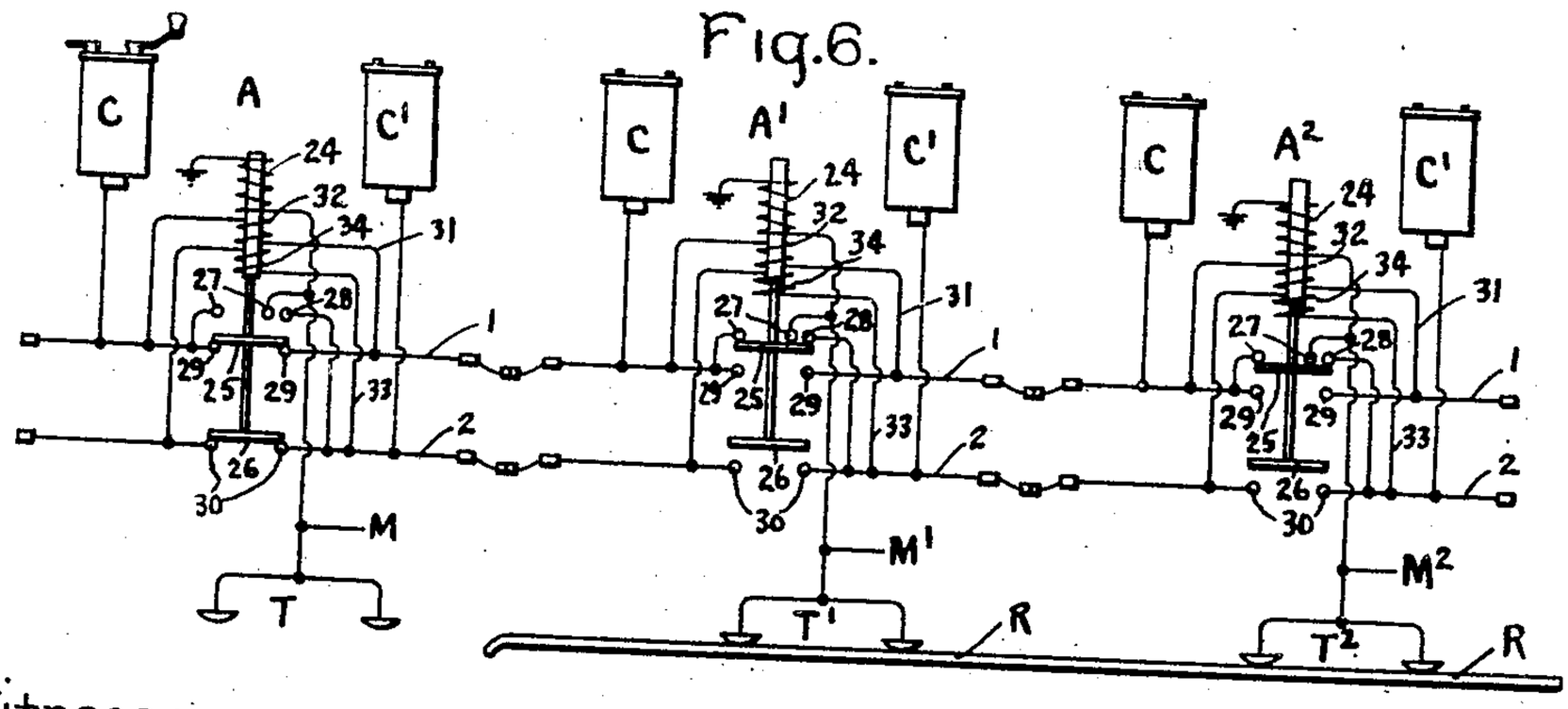


Fig.6.



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3 SHEETS—SHEET 3.

Fig. 7.

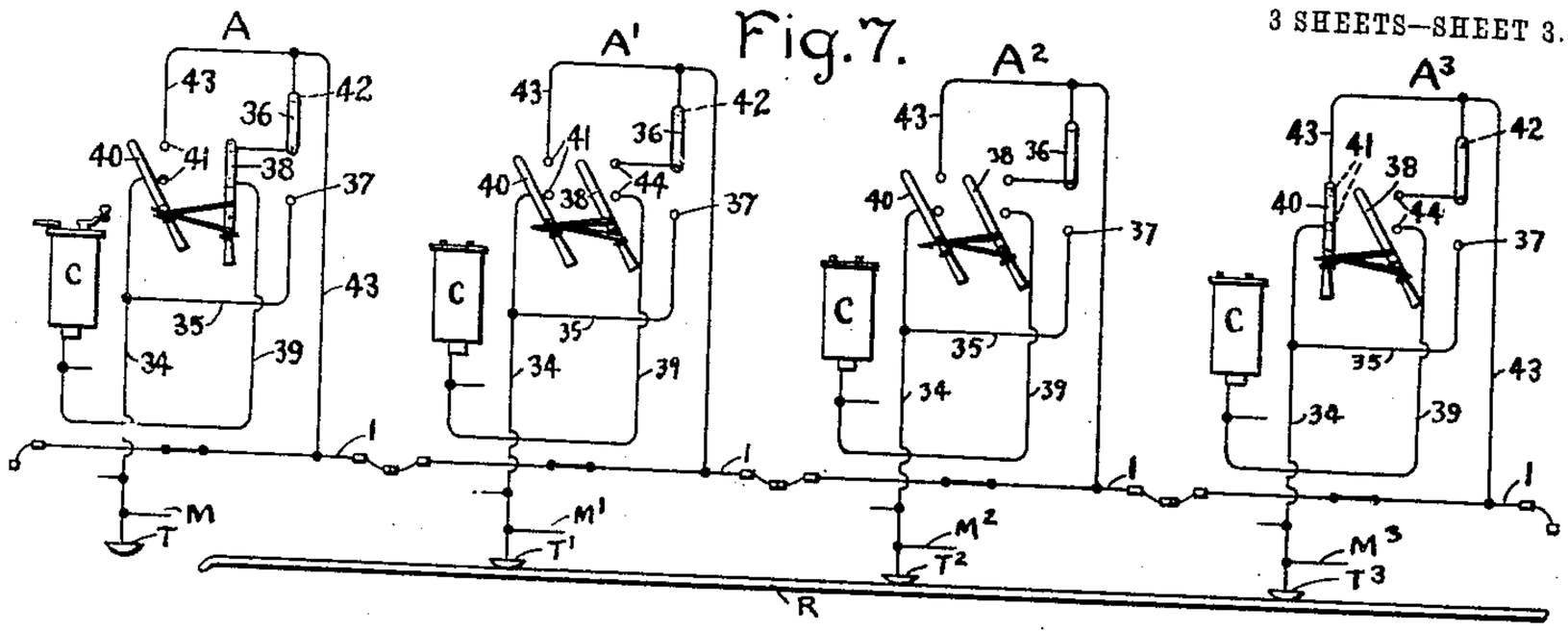

Fig. 8.

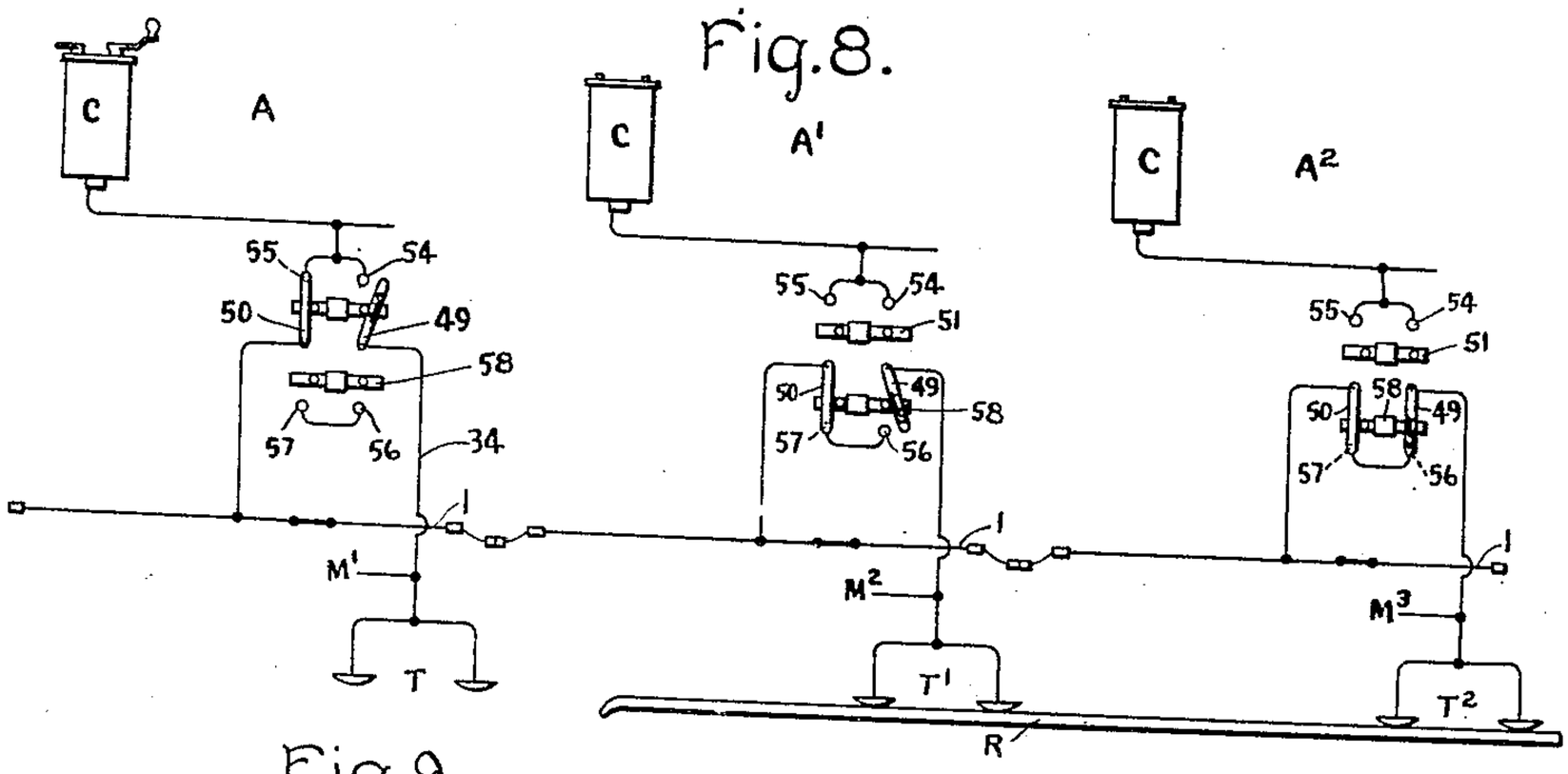

Fig. 9.

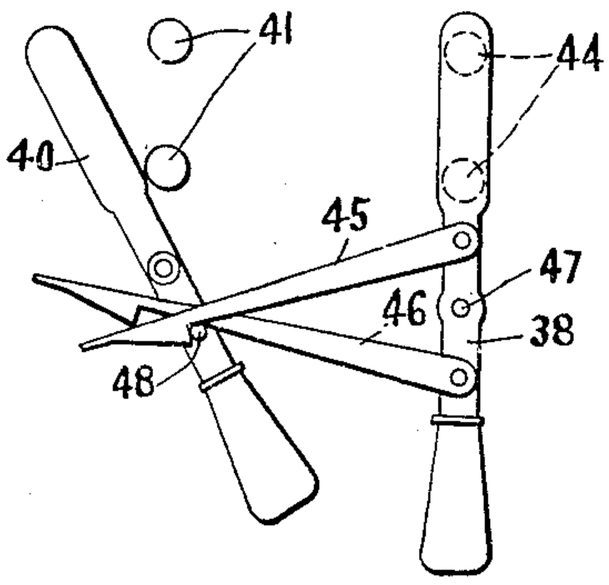

Fig. 10.

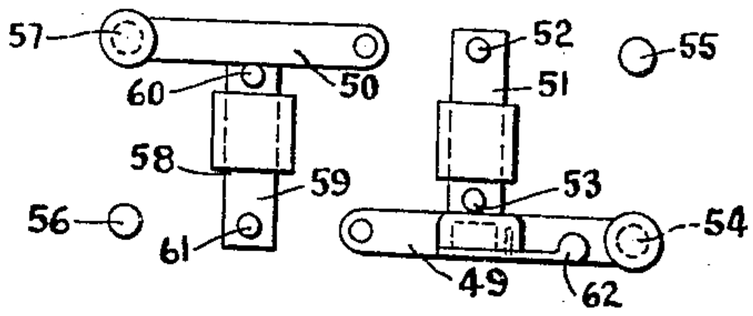

Fig. 11.

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UNITED STATES PATENT OFFICE.

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

SYSTEM OF MOTOR CONTROL.

No. 822,275. Specification of Letters Patent. Patented June 5, 1906.

Application filed November 17, 1904. Serial No. 233,067.

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 Systems of Motor Control, of which the following is a specification.

The present invention relates to systems of motor control, and particularly to electrical control systems in which it is desired to regulate the motors on several cars of a train from a single point.

In systems of train control electrical in character and in which no auxiliary source of current-supply is provided the control-current must be obtained from the collecting devices of the leading car or from a bus-line which is connected to the current-collecting devices of the several cars. In the former case failure of current upon the leading car from any cause may render the control system inoperative, although motor-current may be provided for the other cars. By employing a bus-line, which connects together the current-collecting devices of the several cars, control-current may be obtained if any current-collecting device is energized, although by reason of bad contact due to sleet or dirt or any other cause the remaining current-collecting devices do not receive current. If the bus-line consists of but a single wire connected directly to the several current-collecting devices, current may pass from one car through the bus-wire and to the motors of another car, necessitating the use of a heavy wire capable of carrying motor-current.

The object of the present invention is to provide a bus-line for furnishing control and other auxiliary current, which eliminates the difficulties and danger incident to the use of a main bus-line connected directly to the current-collecting devices of the several cars of the train.

Further objects of the present invention will be apparent from the following description of several forms thereof.

In the drawings, Figures 1 to 6, inclusive, indicate diagrammatically six different modifications of the present invention in which the arrangement is such that the leading car is automatically supplied with current from a following car upon failure of current from the leading car. Figs. 7 and 8 show further modifications of the present invention in which it is necessary to throw a manually-operated switch when it is desired to receive current from a following car upon failure of current on the leading car, and Figs. 9, 10, 11, are details of the systems illustrating Figs. 7 and 8.

Similar reference characters will be used to designate corresponding parts throughout the drawings and specification.

In Fig. 1, A and A′ indicate cars provided with master or motor controllers and propelling-motors, and B indicates a trailer-car arranged between the cars A and A′. R indicates a section of third rail, and T and T′ are the collecting-shoes of the motor-cars A and A′, respectively. M and M′ are wires leading to the motors of the respective cars. Each of the cars A and A′ is provided with controllers C and C′ at opposite ends of the car. In this figure, as in the following figure, the control-circuits are not shown, since they in themselves form no part of the present invention, and it is of course understood that the circuit passing out from the controller may be of any usual or desired character. 1 and 2 are train-wires, which are not, however, continuous. Two of these wires are provided in order to adapt the car equipments for operation when one or more of the cars of the train are reversed. If it is desired to connect the cars always in the same relative position, wire 2 may be omitted. These wires are in practice arranged in the same horizontal plane, but are here illustrated one above the other for the sake of clearness. Upon each motor-car there is arranged a switch-arm 3, which when in engagement with the contact 4 of train-wire 1 renders this wire continuous throughout that particular car, but which when moved out of engagement with contact 4 interrupts the continuity of this train-wire. Switch-arm 3 is connected to the core of an electromagnet 5, one terminal of the coil of which is connected to the ground and the other to the collector-shoe. It is evident that when the collector-shoe bears upon an energized rail-section current flows through the electromagnet, drawing in its core and

moving switch-arm 3 out of engagement with contact 4. This movement of the switch-arm brings it into engagement with contact 6, connected to the lead between the electromagnet and trolley-shoe. When this occurs, current flows from trolley-shoe T through contact 6, switch-arm 3, a portion of train-wire 1, wire 7 to controller C, providing current for the control system and also for lighting, if desired. Should the collector-shoe T leave the rail or for any other reason fail to receive current, electromagnet 5 will be deenergized, permitting its core to drop and switch-arm 3 to make contact at 4. If now collector-shoe T′ is receiving current, switch-arm 3 upon car A′ will be in engagement with contact 6 upon that car, and current will flow from collector-shoe T′, contact 6, switch-arm 3, train-wire 1 to car A, through contact 4, switch 3 of that car to the master-controller, as before. It is seen, however, that when the control-current is being supplied from the rear car train-wire 1 is entirely disconnected from the collector-shoe T, so that it is impossible for current to feed through the train-wire to the motors of the leading car. Similarly, when both sets of collector-shoes are receiving current there is no electrical connection between them through the bus-wire. Train-wires 1 and 2 are cross-connected at two points upon each car, and in these cross connections are placed the switches S and S′, one at each end of the car. When the cars are connected together, as shown, train-wire 2 and switches S and S′ do not come into play; but when one of the cars is reversed current will be supplied, as before, upon the closing of the switch S at the front end of car A and the switch S at the rear end of car A′.

In Fig. 2 the arrangement is the same as that shown in Fig. 1 except that instead of the manually-operated switches S and S′, I have provided a single switch-arm S^2, also connected to the core of the electromagnet 5. The switch-arm S^2 completes the portion of train-wire 2 carried by its respective car, and when electromagnet 5 is deënergized this switch-arm engages the fixed contact 8. When electromagnet 5 is energized, however, switch-arm S^2 is moved in unison with switch-arm 3, the two arms engaging with contacts 9 and 6 simultaneously, contact 9, as well as contact 6, being connected to the lead between the electromagnet and the collector-shoe. It will be seen that if car A′ is turned end for end, so that car-wire 20 is connected to train-wire 1 and car-wire 10 to train-wire 2 and current upon the leading car fails, car A′ will supply current through trolley T′, contact 9, switch S^2, wire 20, train-wire 1, as before; but in no case can current pass between the collecting-shoes on motors upon the two cars. In this modification the controllers C and C′ are connected to the train-wires 1 and 2, respectively, so that if the train is running in one direction train-wire 1 supplies the current, while if it is running in the opposite direction train-wire 2 is the one normally energized.

In Fig. 3 there is illustrated a system in which but a single train-wire is required. Three cars A A′ A^2 are shown, each of which is provided with a similar equipment, although of course cars similar to car B in Figs. 1 and 2 may be interposed if each of these cars is provided with a wire to complete the train connection. As in the system shown in Figs. 1 and 2, a main electromagnet 10 has its terminals connected to trolley-shoe and to ground, respectively. Upon the core of this electromagnet is carried the contact-plate 11, which when the electromagnets are deënergized engages with fixed contacts 12 and when the magnet is energized with the fixed contacts 13, in the latter case completing the circuit from the trolley-shoe to the controller. When the contact-plate 11 is in engagement with contacts 12, a circuit is completed between the master-controller and train-wire 1, provided the switch U is in its proper position. The switch U is in the nature of a reversing-switch, being provided with two sets of movable contacts u and u', which are adapted to engage with the fixed contact u^2. The switch U may be a double-throw switch, and before starting the train all of these switches may be thrown so as to point ahead, thereby giving the proper connections between the car equipments and train-wire, so that the leading car will be provided with current from the first succeeding car which is receiving current. Assuming that the switches U on the several cars have been properly positioned, as shown, and that trolley-shoe T leaves the rail, current will be supplied from shoe T′, contacts 13, plate 11 of car A′, contacts u u^2 of switch U, local to car A′; train-wire 1, contacts u and u^2 of car A, contacts 12 and 11 of car A to master-controller C, no current, however, passing between the shoes T′ and T. If collector-shoe T′ is receiving no current, electromagnet 10 of car A′ will be deënergized and current will be supplied from collector-shoe T^2 to the leading car. It is apparent that if the train is to be reversed and the master-controller upon car A^2 brought into service the several switches U may be reversed, bringing the contacts u' and u^2 into engagement, so that master-controller on car A^2 will be supplied with current from car A′ or car A, as the case may be, if no current is passing through collector-shoes T^2 and T′.

In Fig. 4 I have illustrated a train bus-line system employing but a single train-wire and entirely automatic in character. In this modification the train-wire is continuous, but is automatically disconnected from the trolley of any car when no current is being col-

lected by the shoe of said car. An electromagnet 14 is connected, as in the previous modifications, to the trolley-shoe and to ground. A contact 15, carried by the core of this electromagnet, engages with fixed contacts 16 when the electromagnet is energized and completes the circuit between the master-controller C and the trolley-shoe T. When no current is passing through shoe T, electromagnet 14 is deënergized; but if either car A′ or car A^2 is receiving current the master-controller on car A will be supplied with current from car A′ or car A^2, as the case may be. When one of the cars is being supplied with current from the following car, no current flows between the trolley-shoes of said cars unless the electromagnet 14 on the leading car fails to become deënergized, so as to disengage plate 15 from fixed contact 16. Even should this electromagnet fail to operate, only a momentary flow of current between the collecting-shoes would result, since contacts 16 are connected to the coil of electromagnet 14 at a point 17 intermediate the ends of the coil and if current should flow back through this coil to the collector-shoe the electromagnet would be positively deënergized, causing the core thereof to drop, and thus interrupt the circuit between the train-wire and trolley-shoe T.

Fig. 5 illustrates a further modification embodying but a single train-wire and in which the proper bus-line connections are made automatically. The core of the electromagnet 18 in this instance is U-shaped, and a coil is placed about each of the arms 19 and 20 of this core. An armature 21 is pivotally supported between the arms 19 and 20 and is operatively connected at its one end to a switch-arm 22. The arm 22 is also connected to a floating armature 22^a by means of links 22^b and 22^c. Thus when the electromagnet 18 is energized the armature 22^a is attracted and the contact-arm engages with contacts 23, thereby completing a circuit from collector-shoe T through a coil 24 surrounding the armature 21 to train-wire 1 and thence to the master-controller. The coils on the arms 19 and 20 and on the armature 21 are so wound that when all are energized by current flowing from collector-shoe T to the train-wire the armature is swung to the right and is positively held in that position. When collector-shoe T fails to receive current, the master-controller in the leading car receives current from collector-shoe T′ and collector-shoe T^2, as the case may be. If the coil surrounding the arms 19 and 20 and the armature 21 are deënergized, no current can pass from collector-shoe T, since the circuit is broken at contacts 23 upon the leading car. Should these coils, however, fail to be deënergized, a momentary flow of current between the collector-shoes would change the polarity of armature 21 and cause it to be positively swung from the right to the left, so as to move the switch-arm 22 out of engagement with the contacts 23.

The modification illustrated in Fig. 6 is similar to that shown in Fig. 2, but differs therefrom in that the train-wires are never entirely interrupted, so that the control-current is not interrupted even momentarily during the changes in connections from one trolley-shoe to the other. The electromagnet 24 operates the contact-plates 25 and 26, these being similar to the switch-arms 3 and S^2. When this electromagnet is energized, current flows from trolley T, fixed contact 27, contact-arm 25, the controller C, or, if the car is running in the opposite direction and C′ is in service, then from trolley T, fixed contacts 27 and 28, train-wire 2, controller C′. If the current through trolley T fails, the master-controller C receives current from car A′ and car A^2, and assuming that trolley T′ on car A′ is receiving current then the circuit is as follows trolley T′, contacts 27 and 25 on car A′, train-wire 1, contacts 29 and 25 on car A to master-controller. It is evident, however that if electromagnet 24 is deënergized, permitting its core to drop, the control-current will be interrupted, momentarily at least, as the contact-plate 25 passes from contacts 27 to contacts 29. In order to obviate this momentary interruption, a shunt 31 is placed about the fixed contacts, this shunt including a coil 32, surrounding the core of the electromagnet 24 and wound so as to have demagnetizing effect upon said electromagnet. A similar shunt 33, including coil 34, is placed about the contacts 30 in wire 2. Consequently when the current is interrupted on the leading car current will be supplied to the master-controller from a succeeding car through the shunt in wire 1 or wire 2, as the case may be, this current demagnetizing electromagnet 24 and hastening the closing of the main circuits at contacts 29 or 30, as the case may be

In Fig. 7 there is illustrated a modification in which the control-current is not automatically obtained from a succeeding car when it is interrupted upon the leading car, but in which the motorman must operate one or more switches in order to obtain current from a following car. Suitable interlocks are provided between the several switches of each car, so that in ordinary operation no current can pass between collector-shoes of different cars unless a switch is intentionally operated. Four cars A, A′, A^2, and A^3 are illustrated, the cars being similarly equipped. When current is being received from trolley T, the circuit is as follows: wire 34, wire 35, contact 37, switch 36, (which must be thrown downwardly,) master control-switch 38, wire 39, to the controller no current passing to the train-wire. If it is desired to take current from a succeeding car,

the trainman throws switch 40 on that car, so as to engage with contacts 41, and throws switch 36 into engagement with contact 42, as shown at the right hand of Fig. 7. Current now passes in this car from trolley T^3 to wire 34, switch 40, wire 43, to the train-line. If now the current is interrupted on the leading car, the motorman need only throw switch 36 into engagement with contact 42 on the leading car, whereupon current will pass from the train-line through wire 43, switch 36, switch 38, wire 39 to the controller, trolley T, however, being cut out of circuit. If without making any other changes the train were reversed, car A^3 being the leading car, and master-switch 38 on car A^3 were thrown into engagement with contacts 44, current would be supplied to the master-controller, but also to the train-line, so that if the switches in the following cars were set to energize the train-line current would pass, upon interruption of current at trolley T^3, from train-line to wire 43, switch 40, wire 34, trolley T^3, thus supplying the motors of car A^3 with current In order to break the connection of the trolleys with the respective wires 43 upon the closing of the master controller-switch, I have provided an interlock between the master controller-switch and the switch 40, as illustrated clearly in Fig. 9. This interlock consists of two hooks 45 and 46, pivoted to the operating-handle of the switch 38 on opposite sides of its pivotal point 47, these hooks being adapted to engage with a pin 48 upon the switch 40. It is evident that upon turning the master controller-switch in either direction, the switch 40 is moved out of engagement with fixed contacts 41 and can be moved into engagement with these contacts only after lifting the hooks 45 and 46 out of engagement with pin 48. These hooks must be so lifted in order to permit the switch 40 to assume the position shown upon car A^3; but when this car in turn becomes the leading car and the master controller-switch is thrown into engagement with contacts 44 switch 40 is simultaneously thrown out of engagement with its coöperating contacts 41 by means of the hooks.

A further modified form embodying manually-operated switches is illustrated in Fig. 8. Current passes normally from trolley T, wire 34, switch 49 to the controller. The switch 49 is interlocked with the second switch 50, which connects the master-controller of train-line 1, so that when one connects the controller to the trolley it is impossible for the other to connect the controller to the train-line. Any suitable form of interlock may of course be employed, the one shown, and shown most clearly in Figs. 10 and 11, consisting of a sliding bar 51, having pins 52 and 53 near its ends. The pins are adapted to engage with the switches 49 and 50, and the space between the pins is such that when one switch is moved into its operative position the other is positively forced out of position. A second set of fixed contacts 56 and 57 are provided, whereby current may be supplied directly to the train-line from the trolley, switches 49 and 50 being thrown into engagement with these latter fixed contacts for this purpose. A second interlock 58 is employed for normally preventing the two switches 49 and 50 from simultaneously engaging with contacts 56 and 57. This interlock is similar to the other interlock and consists of a bar 59 having pins 60 and 61. Switch 49 is provided with a small spring-pressed latch 62, which is normally in the position to engage with the stop 61 when the switch is thrown into engagement with contact 56; but by lifting this latch the switch is free to move past the pin 61, thereby enabling both switches to engage simultaneously with the stops 56 and 57, respectively. This position is illustrated in car A^2, and current on this car passes directly from trolley T^2 through these switches to the train-line, and if it is desired to utilize train-line current, the switch 50 upon that car is thrown into engagement with the fixed contact 55, causing switch 49 to break contact at 54, thereby supplying the controller with current from the rear car and isolating trolley T. If after switches 49 and 50 have been thrown to the position indicated upon car A^2 it is desired to reverse the direction of the movement of the train and use the car A^2 as the leading car, switch 49 must be thrown into engagement with contact 54, thereby breaking the connection to the train-line and preventing the reëstablishment thereof, unless the latch 62 is operated for that purpose, since otherwise if it is attempted to bring the switches 49 and 50 upon the fixed contacts 56 and 57 the interlock 59 will prevent one of the switches from engaging with its fixed contact. By this means feeding back from one trolley-shoe to the other is made impossible unless the switches are designedly set to accomplish this result.

In each of the several modifications of my invention it is possible to obtain current for the control system and for lighting and heating, if desired, as long as the collecting device of any one of the cars is taking current and without at any time causing or permitting the feeding of motor-current through the bus-line.

Although I have illustrated the present invention as embodied in several forms, the invention in its broader aspects is not limited to any particular modification, since it may be embodied in various forms.

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

1. In a system of train control, a motor-circuit upon each of a plurality of cars, means for supplying each of said motor-circuits with current from a local collecting de-

vice, a control-circuit, and means for supplying said control-circuit with current from any of said collecting devices and for isolating it from the remaining collecting devices.

2. In a system of train control, a motor-circuit on each of a plurality of cars, means for supplying each of said motor-circuits with current from a local collecting device, a control-circuit, and means for supplying said control-circuit with current from the collecting device carried by the car upon which the control-circuit is mounted or from the collecting device upon another car and for isolating the control-circuit from the local current-collecting device when current is taken from another car.

3. In a system of train control, a motor-circuit upon each of a plurality of cars, means for supplying each of said motor-circuits with current from a local collecting device, control-circuits upon a plurality of cars, and means for supplying any one of said control-circuits with current from the collecting device local to the car upon which the controller is mounted or from the collecting device upon another car and for isolating the control-circuit from the local collecting devices when current is being supplied from the collecting device of another car.

4. In a system of train control, a motor-circuit on each of a plurality of cars, means for supplying each of said motor-circuits with current from a local collecting device, a control-circuit, a train bus-line, and means for supplying said control-circuit with current from the collecting device local to the car upon which the control-circuit is situated or from the bus-line and for disconnecting the local collecting device from the control-circuit when current is being supplied from the bus-line.

5. In a system of train control, a motor-circuit on each of a plurality of cars, means for supplying each of said motor-circuits with current from a local collecting device, a control-circuit adapted to be connected to said collecting devices, and means for disconnecting said control-circuit from any collecting device which fails to receive current from the source of supply.

6. In a system of train control, a train bus-line, and means for automatically connecting it to the current-collecting devices of a plurality of cars of a train and for disconnecting it from any of said collecting devices which fails to receive current from the source of supply.

7. In a system of train control, a train bus-line, and means for automatically connecting it to the current-collecting devices of a plurality of cars and automatically disconnecting it from any of said devices which fails to receive current from the source of supply.

8. In a system of train control, a train bus-line, means for automatically connecting the bus-line to the current-collecting devices of a plurality of cars and for automatically disconnecting it from any of said collecting devices which fails to receive current from the source of supply, and a controller operatively associated with said bus-line.

9. In a system of train control, a train bus-line, local motor connections to the current-collecting devices on a plurality of cars, and means for connecting the bus-line to said current-collecting devices and for cutting out any of said collecting devices and the corresponding motor connections upon failure of the collecting devices to receive current from the source of supply.

10. In a system of train control, a train bus-line, local motor connections to the current-collecting devices on a plurality of cars, and means for automatically connecting said bus-line to said train-collecting device and for cutting out any of said collecting devices and the corresponding motor connections upon failure of the collecting devices to receive current from the source of supply.

11. In a system of train control, a train bus-line, local motor connections to the current-collecting devices on a plurality of cars, and means for connecting the bus-line to said current-collecting devices and for automatically cutting out any of said motor connections when the corresponding current-collecting device fails to receive current from the source of supply.

12. In a system of train control, a train bus-line, a controller operatively associated with said bus-line, local motor connections to the current-collecting devices on a plurality of cars, and means for connecting the bus-line to said current-collecting devices and for cutting out any of said motor connections upon failure of the corresponding collecting device to receive current from the source of supply.

In witness whereof I have hereunto set my hand this 15th day of November, 1904.

GEORGE H. HILL.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.