No. 661,666. Patented Nov. 13, 1900.

C. B. MARTIN.

SYSTEM OF ELECTRIC TRAIN CONTROL.

(Application filed Oct. 23, 1897.)

(No Model.) 4 Sheets—Sheet 1.

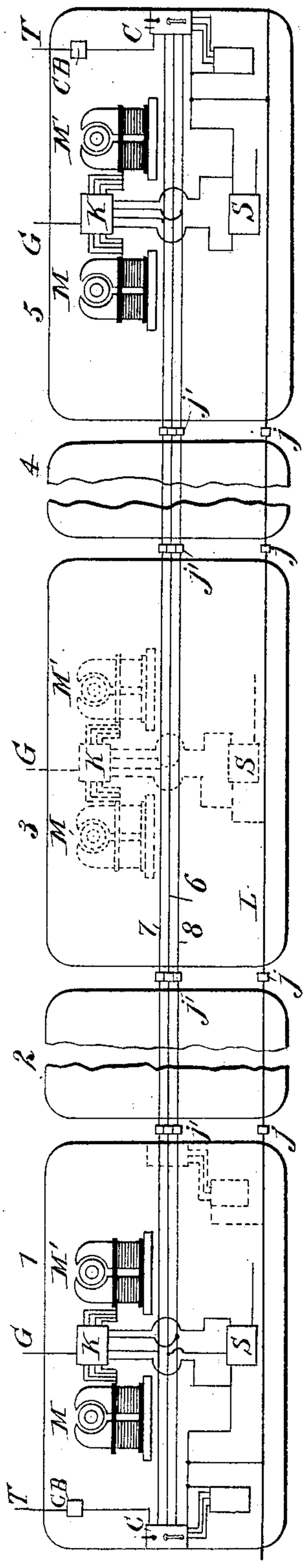


FIG. 1.

WITNESSES

M. V. Bidgood

Fred D. Haudrick

INVENTOR

Charles B. Martin

BY

Harry Peters & Co

ATTORNEY

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 661,666. Patented Nov. 13, 1900.

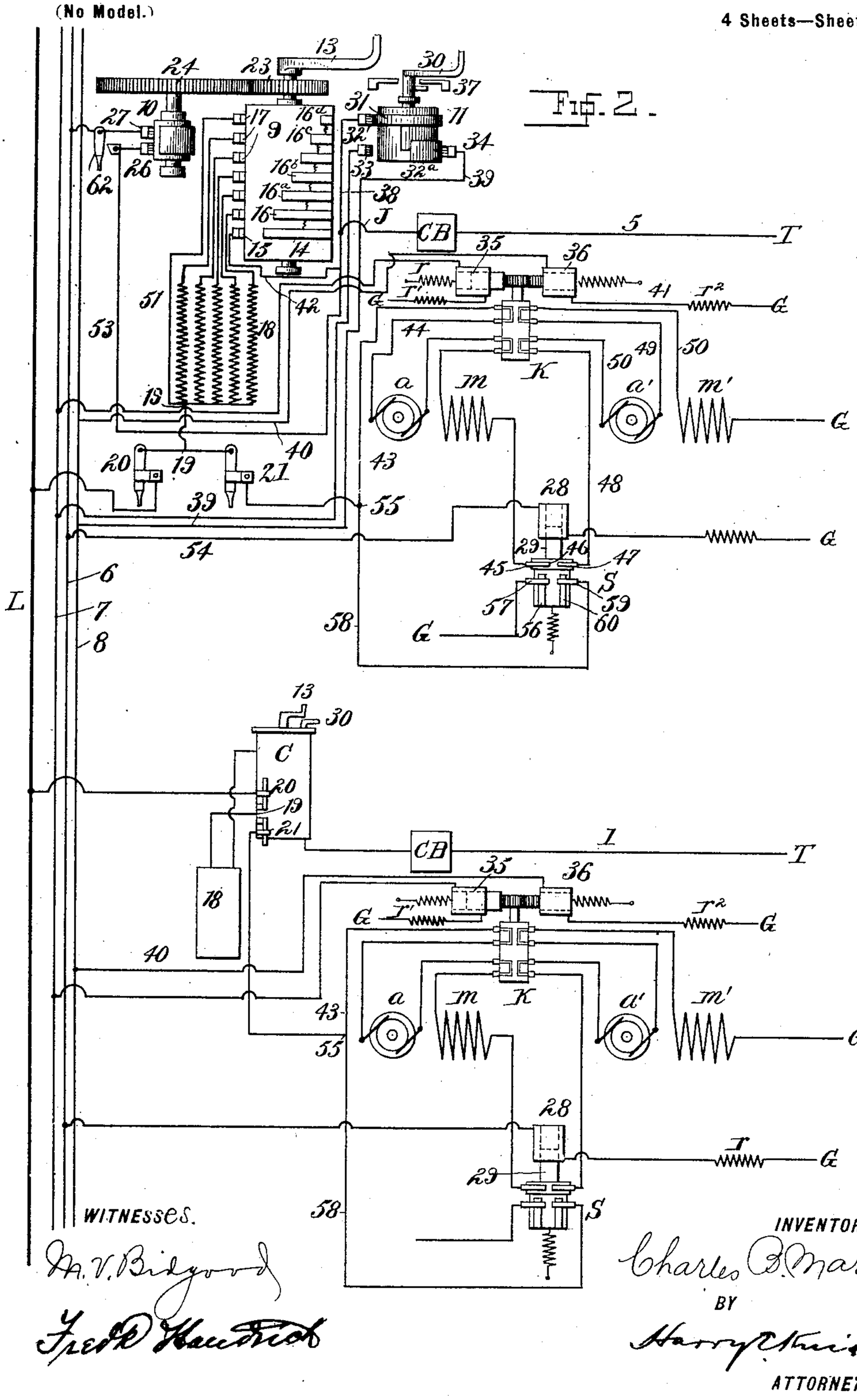
C. B. MARTIN.

SYSTEM OF ELECTRIC TRAIN CONTROL.

(Application filed Oct. 23, 1897.)

(No Model.) 4 Sheets—Sheet 2.

Fig. 2.



WITNESSES.

H. V. Bidgood

Fred D. Hendrick

INVENTOR

Charles B. Martin

BY

Harry Thurston

ATTORNEY

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 661,666. Patented Nov. 13, 1900.

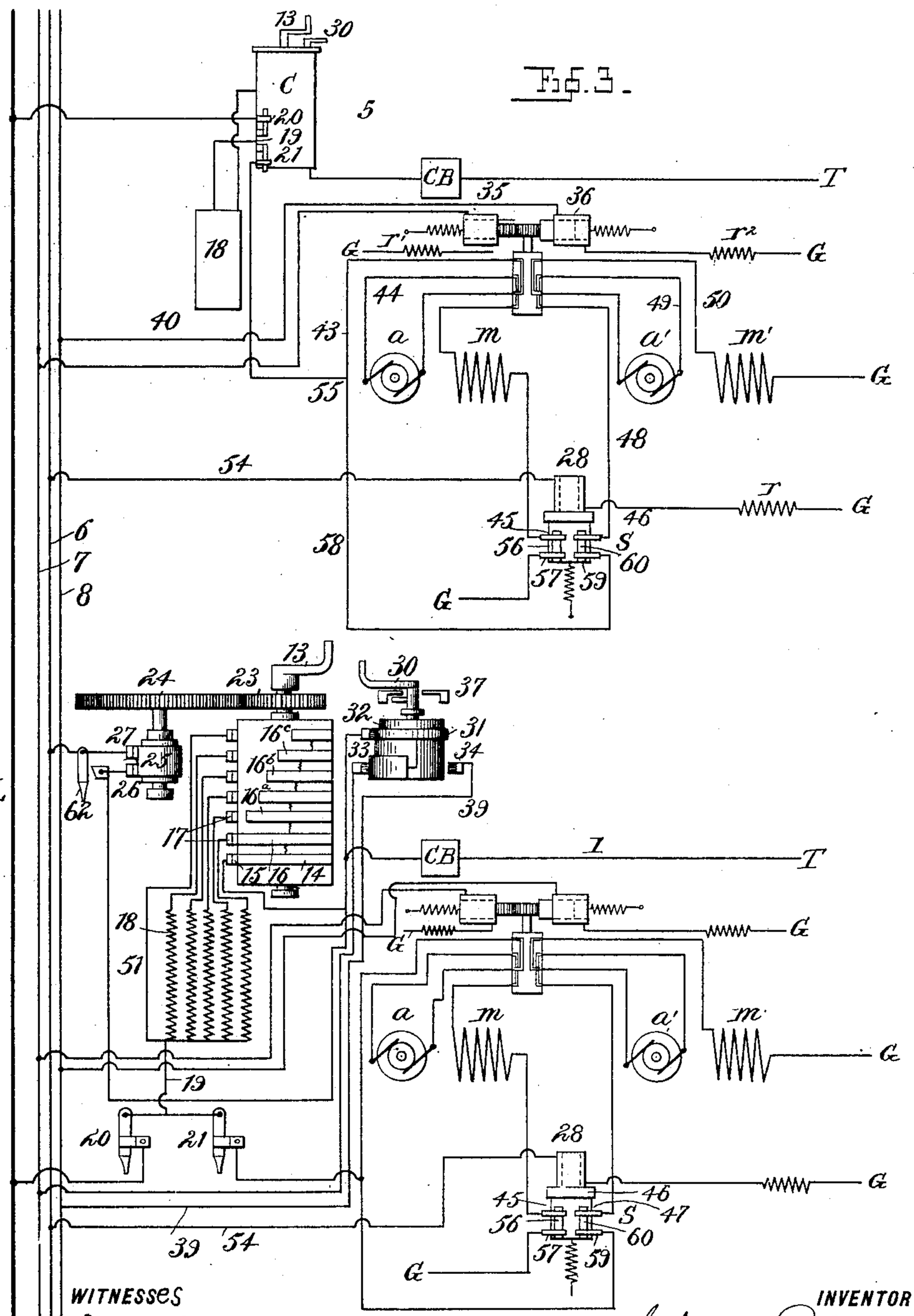
C. B. MARTIN.

SYSTEM OF ELECTRIC TRAIN CONTROL.

(Application filed Oct. 23, 1897.)

(No Model.) 4 Sheets—Sheet 3.

Fig. 3.



WITNESSES

Ed. V. Bidgood

Fred'k Hayward

INVENTOR

Charles B. Martin

BY

Harry E. Knight

ATTORNEY

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 661,666. Patented Nov. 13, 1900.

C. B. MARTIN.

SYSTEM OF ELECTRIC TRAIN CONTROL.

(Application filed Oct. 23, 1897.)

(No Model.) 4 Sheets—Sheet 4.

Fig. 5.

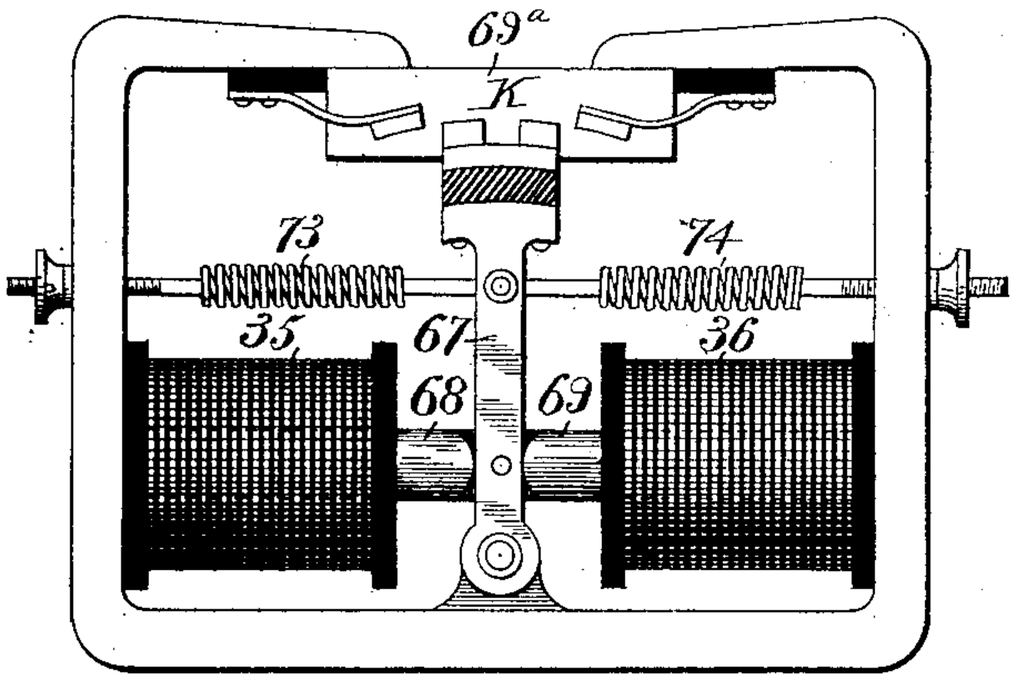


Fig. 4.

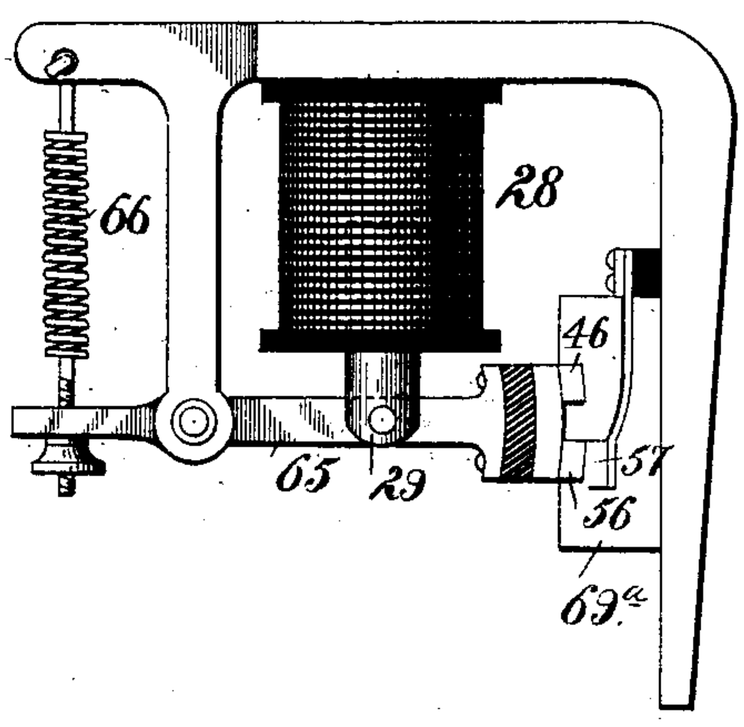
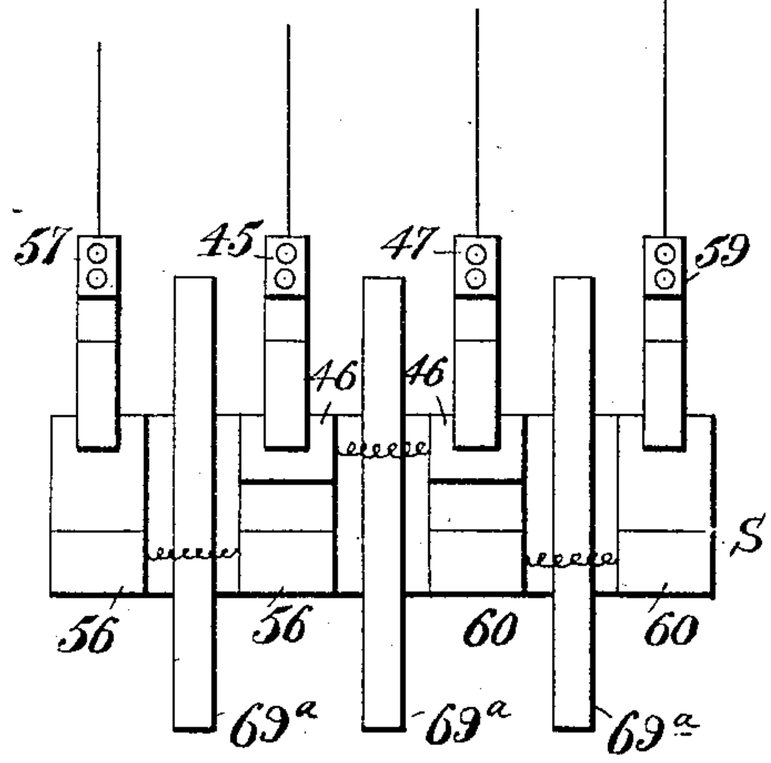


Fig. 6.



WITNESSES.

M. V. Bidgood

Fred'k Hardrick

INVENTOR

Charles B. Martin

BY

Harry E. Knight

ATTORNEY

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

CHARLES B. MARTIN, OF NEW YORK, N. Y., ASSIGNOR TO THE GENERAL ELECTRIC COMPANY, OF NEW YORK.

SYSTEM OF ELECTRIC TRAIN CONTROL.

SPECIFICATION forming part of Letters Patent No. 661,666, dated November 13, 1900.

Application filed October 23, 1897. Serial No. 656,134. (No model.)

To all whom it may concern:

Be it known that I, CHARLES B. MARTIN, a citizen of the United States, residing at New York, (Brooklyn,) county of Kings, and State of New York, have invented certain new and useful Improvements in Systems of Electric Train Control, of which the following is a specification.

This invention relates to a system for controlling electric motors, and especially to the control of a plurality of vehicles forming an electrically-propelled train. It has been proposed to operate such trains by means of separate motors placed on each car of the train, each such car having also one or more switches or controllers the operation of any one of which is effected simultaneously with the operation of all the others, the motors of each car being supplied and operated by separate branch circuits each under the control of one of the controllers. The separate operating-circuits of the several cars have in this case separate sliding contacts or connections with the supply wire or rail. One disadvantage of such a system lies in the multiplicity of controllers, each of which is charged with the performance of all the operations necessary for the complete control of the car, including variation of resistance, breaking of the motor-circuit, throwing from series to parallel, and reversal. Inasmuch as some of these operations are unavoidably attended with considerable arcing between the controller-contacts, the distribution of the controllers over the whole train introduces the possibility of serious arcing occurring at many points remote from the motorman.

The object of my invention is to concentrate the controlling action or that part thereof which is productive of most of the arcing at a few points, only one controller being used at a time—namely, the one situated at the point from which the motorman is for the time being operating the train. Thus while there may be any desired number of motor equipments and any desired number of controllers on a train only one of such controllers is operated at a time, and its operation controls simultaneously all of the motor equipments or as many of them as may be in operative connection. There may be any desired number of motor equipments; but it will in general be sufficient to have only the end cars equipped with motors, while in light trains—for example, three cars or less—there need be only a single motor-car. The controllers may also be located at any preferred points of the train; but in general it would be sufficient to provide one, or at most two, for every motor equipment, it only being necessary that there should be a controller at each end of the train.

My invention involves the use of a main supply system running through the train and connecting all the motor equipments, said system being so arranged that the flow of current to all the motors may be controlled from a single controller located at any desired point—as, for example, at the end of the train. The operation of any one of the controllers connected to the main supply system will control all of the motor equipments connected to this system; but it will not affect the position of the other controllers. Each controller thus acts independently.

In the specific arrangement which I have illustrated in this application the main supply system comprises a single main lead connected to each motor equipment and also to each of a number of controllers.

Inasmuch as it is desirable that certain operations usually performed by a car-motor controller—such as the reversal of the motors, the change from series to parallel relation, &c.—should be effected by separate devices on the respective cars, I have found it expedient to remove these devices from the controller proper and to place on each of the motor-cars circuit-changing switches performing these functions, the operation of these switches being controlled by auxiliary controlling-switches associated with the main controlling-switch of each controller. The controller as used by me comprises, therefore, a common or main controlling-switch directly controlling the flow of current from the source of supply to the motors and a plurality of auxiliary controlling-switches indirectly controlling the circuit connections of each of the motor equipments by means of circuit-changing switches on the several cars, the similar switches on the several cars be-

ing operatively connected with the corresponding auxiliary switch of the controller.

The direct function of the controller is primarily to open and close the connection from the main lead to the source of supply both in stopping and starting the car and at any other proper time, as in shifting from series to parallel, or vice versa. A subsidiary function naturally associated with this is the adjustment of resistance in this connection, so as to control and graduate the current supplied to the motors. The other functions of the controller, are performed indirectly through its connections with the electromagnetic actuating devices of the separate circuit-changing switches on the several motor-cars. The circuit-changing switches are located in part at least at points remote from the operating-controller, and their manipulation would be attended with arcing at points comparatively inaccessible to the motorman if they should be operated while current is flowing in the motor-circuits. In order, therefore, that the said switches may be operated when no current is flowing in the motor-circuits, I provide a controlling system therefor independent of the main supply system, and therefore independent of the motor-circuits, and I arrange the main controlling-switch so that the connection with the source of supply may be broken before the circuit-changing switches are operated. The brunt of the arcing comes, therefore, on the main controlling-switch and practically under the eye of the motorman. To insure against any accidental damage, however, I may, and preferably do, provide each of the circuit-changing switches with means for disrupting any arc that may form.

In the specific arrangement illustrated in this application the controlling system for the circuit-changing switches comprises three leads connected, on the one hand, to the actuating devices of the said circuit-changing switches and, on the other hand, to the auxiliary controlling-switches of the several controllers.

Further features and advantages of my system will appear from the following detailed description, while the scope of my invention will be pointed out in the appended claims.

In the accompanying drawings, Figure 1 is a general diagram of the arrangement and connection of the motor equipments and controllers on the cars of a train. Fig. 2 is a diagrammatic representation of the system of electric circuits and apparatus employed by me, showing the condition when the train is at rest. Fig. 3 is a similar view with the controller in the operative position. Figs. 4, 5, and 6 show details.

Assuming my system to be applied to a train of, say, five cars, the general arrangement of the train circuits and apparatus would be as roughly indicated in Fig. 1, wherein 1 2 3 4 5 represent the cars aforesaid. Preferably only the end cars would be provided with motor equipments, as shown, M M′ indicating a pair of motors, K the reversing-switch, and S the series-parallel switch therefor. Each end car is also preferably provided with means (indicated at T) for taking off the current from a supply wire or rail and with one or more controllers C, which control the connection from this source of supply to the motors and regulate the strength of the current. In cases where it is possible to turn the car end for end one controller will suffice, it being placed at the outer end, as indicated in full lines in cars 1 and 5; but where this is not possible a controller should be also placed at the other end of the car, as indicated in dotted lines in car 1. L is the main train-lead passing from end to end of the train, with couplers or joints between the several cars, which are so arranged as to keep it well insulated and protected. This lead is so connected that each controller can put it in direct connection with the source of supply independent of the action of the other controllers. It is also connected to each of the sets of motors, so that when the main controlling-switch of any one controller is operated current is supplied to all the motor-circuits simultaneously. The connections of the motors of each motor equipment are controlled by the reversing-switches K and the series-parallel switches S, which are in turn operated from the auxiliary controlling-switches of the controllers C through wires 6 7 8, which also pass from end to end of the train and have suitable coupling devices. The wires 6, 7, and 8 may be grouped together and coupled simultaneously in a single device by means of composite couplers of well-known construction. Circuit-breakers C B are interposed in the connections to the source of supply.

I have indicated in dotted lines in car 3 that a motor equipment may, if desired, be inserted at any point of the system independent of the location of the controllers.

In Figs. 2 and 3 I show the wiring for two motor equipments and two motor-controllers, as indicated in full lines in Fig. 1. In each of these figures one of the controllers C is shown in partial develop nent, while the other for simplicity of illustration is shown only in outline, it being understood that the connections of the two motor equipments and controllers to the "line" and to the train-leads are identical.

In Fig. 2 the motor-circuits are represented in open condition, the train being supposed to be at rest. Each controller C comprises a main controlling-switch cylinder 9 for making and breaking and controlling the resistance of the motor supply-circuit, an auxiliary controlling-switch 10 for controlling the series-parallel switches of the several motor equipments, and a second auxiliary controlling-switch 11 for controlling the several reversing-switches.

The controlling-cylinder 9 is mounted on a

shaft 12, having the usual removable controller-handle 13. A contact 14 on this controller-cylinder engages with fixed contact 15, which is connected to circuit-breaker C B and the line. A series of contacts 16 16^a 16^b 16^c, &c., on the controller-cylinder are all connected to contact 14 and engage with fixed contacts 17, the contacts 16 being of different length, as indicated, so as to come into contact successively. The several contacts 17 are connected through separate resistances of a rheostat 18 or, in case of the last contact of the series, through a short circuit 51 to a common junction-point 19, whence the connection is made, on the one hand, through a switch 20 to the main train-lead L, and, on the other hand, through a switch 21 to the motor equipment of the car upon which the controller in question is located, the latter connection including the series-parallel and reversing switches, as hereinafter described.

Associated with the main cylinder 9 and preferably inclosed in the same casing are the switches 10 and 11. Switch 10 may consist of a cylinder operated by gears 23 and 24 from the main controller-shaft 12 and carrying contact 25, engaging with fixed contact 26, connected to line connection J, and contact 27, connected to controlling wire or lead 6. In each car equipment a connection from this wire 6 is made to a magnet or solenoid 28, which by its armature or core 29 operates a series-parallel switch S. The switch 11, which takes the place of and performs indirectly the function of the usual reversing-cylinder, consists of a cylinder carrying contact 31, engaging with contact 32, connected to line connection J, and contact 32^a, connected with contact 31 and engaging with contacts 33 or 34, connected, respectiveiy, to the two train-wires 7 and 8. The latter are in turn respectively connected to magnets or solenoids 35 36, operating the reversing-switch K.

The removable handle 30 of the switch 11 has a guard, as indicated at 37, preventing it from being taken off except when the switch is in the middle or open position.

The general operation of the apparatus and circuits so far described is as follows: The motorman having put the handles 13 and 30 on their respective cylinder-shafts first turns the reversing-handle 30 to one side or the other, according to the direction in which it is desired to move the train. Assuming it to be thrown as shown in Fig. 2, circuit will be closed from the trolley or line through circuit-breaker C B to line connection J, thence through wire 38 to contact 32 of switch 11, and through contacts 31, 32^a, and 34 to wire 39, which is connected to the controlling wire or lead 8, running throughout the train. This circuit now proceeds by as many branches as there are car equipments in operation, each branch leading from wire 8 through wire 40 to magnet or solenoid 36 of the reversing-switch K of that equipment and thence through wire 41 to ground. The magnet 36 then draws the switch K into the position shown in Fig. 2. Thus the operation of the reversing-handle 30 causes the simultaneous operation of all the reversing-switches of the several equipments, determining the direction in which all of the motors shall run. Now when the motorman turns the main controller from the open position (shown in Fig. 2) into the first working position contacts 14 and 16 thereof strike contacts 15 and 17 and the motor-circuits are established as follows: from line connection J through wire 42, contacts 15 14 16 to contact 17, and thence through one of the resistances 18 to junction 19. Here the circuit divides, one branch passing through switch 20 to the main train-lead or supply-wire L and the other branch leading directly through switch 21 and wire 43 to reversing-switch K, which establishes connections through wire 44 to armature *a* and field-magnet *m* of motor M and thence to contact 45 of series-parallel switch S. The electromagnet of this switch not having been energized, the connections it establishes are such as to put the two motors in series, the circuit above traced leading from contact 45 through contact 46 of the switch to contact 47 and by wire 48 back to the reversing-switch K, which connects it through wires 49 and 50 to the armature *a'* and field-magnet *m'* of the motor M', from which it passes to "ground." At the same time all of the other motor equipments in the train are energized by that part of the current which passes from the point 19 to the maiu train-lead L, from which circuits branch through switches 20 and 21 to all other motor equipments connected to the lead, the circuit connections being otherwise similar to those traced above. All of the motors on the train are thus started simultaneously, and the current which supplies all of them comes from the single controller which has been operated, the other controllers remaining in open position. As the train accelerates the motorman decreases the ohmic resistance of the operating-circuit by further rotation of the main controller-cylinder 9, thus bringing contacts 16^a 16^b, &c., into successive action, and thus including successive resistances 18 in parallel connection in the usual manner, finally closing the connection 51, short-circuiting the resistances. The next step in the usual operation of the motors in case a continued acceleration is desired is to throw the motors from series to parallel relation. Accordingly the gearing or connection between the main controlling-switch cylinder 9 and the auxiliary controlling-switch 10 is so arranged that shortly after the resistances 18 have been short-circuited by the complete rotation of the cylinder 9 the cylinder of switch 10 is turned far enough to bring its contact 25 against contacts 26 and 27, thus closing a branch circuit from line connection J through wire 53 to contacts 26 25 27 and thence to the wire 6, running through the train, and from this wire passing by as many branches as

there are motor equipments to the operating-magnets of the several series-parallel switches, the circuit for each branch being completed from wire 6 through wire 54 to magnet or solenoid 28 and to ground. All of the series-parallel switches S will thus at once be shifted to the position shown in Fig. 3, putting the motors in parallel. At the same time or just before this the main-controller cylinder breaks the line connection of the motors by coming into its original position. The shifting of the series-parallel switches is therefore effected on a circuit which is practically dead, and the contacts of such switches are thus in little or no danger from arcing. Such arcing as may arise will generally be developed in the main controller, which is under the immediate inspection of the motorman and in which the usual provisions for its control may be easily made. The cylinder 9 having returned to its original position, the circuit is, as aforesaid, momentarily broken; but this being merely a transition point it is immediately closed again at contacts 14, 15, 16, and 17, and, as shown in Fig. 3, current will now pass from line connection J through the above-mentioned contacts and the first resistance to the junction 19, thence through the switch 20 to the main train-lead L and through switch 21 to the point 55, and thence through the reversing-switch K and the two motors M M′ in parallel to ground. One branch of this parallel connection leads from point 55 through wire 43 to the reversing-switch and thence through the armature and field-magnet of motor M to series-parallel switch S, which by contacts 45 56 57 completes connection to ground. The other branch leads from point 55 by wire 58 to the series-parallel switch S and by contacts 59 60 47 of that switch to wire 61, and so to the reversing-switch K, which establishes connection through armature and field-magnet of motor M′ to ground. Similar branch circuits lead from the main train-supply wire or lead L for each motor equipment through switches 20 and 21 and thence as traced above. All the motors will now operate in parallel, and the acceleration may be continued by successive lowering of resistance, as before, the controller-cylinder being adapted to make two complete revolutions for one revolution of switch 10. Contact 25 on the latter switch is long enough to maintain the circuit controlling the series-parallel switches during all of the second revolution of the main controller-cylinder. On turning back the controller these operations are of course reversed, and at or just before the moment at which the switch 10 is opened and the switches S are thereby thrown back from parallel to series the line connection is again broken and then reëstablished. Finally, when the handle 13 comes back to its original position the line connection is broken and power is cut off. The switches 20 and 21 serve to cut out any of the motor equipments when out of order or unnecessary. A switch 62 may be applied to close a circuit between the contacts 26 27 in shunt around the switch 10, thereby maintaining the switch S for that equipment in a parallel position. This may sometimes be desirable in running with a single equipment. In general, however, the switch would be open and the series-parallel switches would be entirely under the control of switch 10 and its circuit. The result of this is that not only when the main controller is in the open position, but also when for any reason current goes off of this branch circuit, as by break in the branch or stoppage of power on the supply-line itself, the switches S will remain in or at once go into the series position, and therefore there is no possibility of current coming suddenly onto the line with the motors connected in parallel. Resistances r r' r^2 may, if desired, be included, respectively, in the circuits of magnets or solenoids 28, 35, and 36. The reversing-switches K are shown in Fig. 3 in the opposite position from that shown in Fig. 2, thus reversing the current through the armatures a and a', while maintaining the current-flow in the field-magnet circuit in the same direction.

It will be noted that the reversing-switches K are protected to some extent from liability to arcing, in that the main controller is always brought to off position before the reversing-handle is thrown. I prefer, however, to so construct both these reversing-switches K and the series parallel-switches S that any arcs that do form therein will be ruptured, and for this purpose I may provide each of said switches with electromagnetic arc-rupturing devices, as indicated in Figs. 4 and 5.

The series-parallel switch S, as shown in Fig. 4, may consist of a lever 65, pivoted to a frame and carrying an armature or core 29, acted on by the magnet or solenoid 28 and a retracting-spring 66, serving to oppose the action of said magnet in well-known manner. The core of the magnet may be extended around into proximity with the contacts 46, 56, and 60 of the switch, so as to create a magnetic field capable of rupturing any arc that may form at these contacts.

The reversing-switches may be of somewhat similar construction, as shown in Fig. 5, the pivoted lever 67 carrying the reversing-contacts and the armatures or cores 68 69 of magnets or solenoids 35 36, the cores or magnetic frames of which extend around in proximity to the switch-contacts. In both the series-parallel and the reversing switches the contacts may be separated by arc-deflecting plates 69ª in the manner usual in such devices. Springs 73 74, acting oppositely on the switch-lever, tend constantly to hold it in or restore it to a central position, in which position it opens the motor-circuit. Thus if power goes off the line or if the circuit is broken for any reason, as by separation of the cars, the reversing-switches will stay in or return to the open position.

It will be seen that the system above de-

scribed provides for the operation of all the motor equipments in the train by a single controller acting independently of any other controller on the same train. For example, a five-car train provided with two motor equipments can be operated from either end, whether or not the motor-cars are situated at the ends of the train, and if at any time one of the motor-cars is removed the rest of the train may then in general be operated by a single motor equipment controlled by a single controller situated at either end of the train.

Having thus described my invention, the following is what I claim as new therein and desire to secure by Letters Patent:

1. In combination, one or more motor equipments, a main controlling-switch for controlling the supply of current to all the motors, a circuit-changing switch or switches in coöperative relation to each motor equipment, and means located at any desired point for operating the circuit-changing switch or switches without connecting the motor-circuits to the source of supply.

2. In combination, a plurality of motor equipments, a main supply system connecting said motor equipments, a common controlling-switch for controlling the supply of current to all the motors, a circuit-changing switch or switches in coöperative relation to each motor equipment, and an independent controlling system for controlling the operation of the circuit-changing switches.

3. In a system of train control, one or more motor equipments, a main controlling-switch, located at any desired point on the train, for controlling the supply of current to all the motors, a circuit-changing switch or switches in coöperative relation to each motor equipment, and means, independent of the motor-circuits, for controlling, from any desired point on the train, the operation of the circuit-changing switches.

4. In a system of train control, in combination, a plurality of cars provided with motor equipments, a main supply system connecting said motor equipments, one or more main controlling-switches for controlling the flow of current to all the motors in said equipments, a circuit-changing switch or switches in coöperative relation to each of said motor equipments, and an independent controlling system for controlling the operation of the circuit-changing switches.

5. In combination, one or more motor equipments, a main supply system connected to said motor equipment or equipments, a circuit-changing switch or switches in coöperative relation to each of said motor equipments, an independent controlling system connected to said circuit-changing switches, and a controller comprising means for controlling the flow of current to all the motor equipments and means for controlling the operation of the circuit-changing switches.

6. In combination, a plurality of motor equipments, a main supply system connecting said motor equipments, a circuit-changing switch or switches in coöperative relation to each of said motor equipments, an independent controlling system for said switches, and a controller comprising a main controlling-switch directly controlling the flow of current from the source of supply to the motor equipments and one or more auxiliary controlling-switches indirectly controlling the circuit connections of each of the motor equipments through said independent controlling system.

7. In a system of train control, a plurality of motor equipments, a main supply system connecting said motor equipments, reversing-switches in coöperative relation to each of said motor equipments, an independent controlling system for said switches, a main controlling-switch directly controlling the flow of current from the source of supply to the motor equipments, and an auxiliary controlling-switch for controlling the operation of said reversing-switches.

8. In a system of train control, a plurality of motor equipments, a main supply system connecting said motor equipments, series-parallel and reversing switches in coöperative relation to each of said motor equipments, an independent controlling system for said switches, and a controller comprising a main controlling-switch directly controlling the flow of current from the source of supply to the motor equipments, and auxiliary controlling-switches for controlling the operation of said series-parallel and reversing switches.

9. The combination with two or more sets of motors and two or more series-parallel switches, of a single rheostat coöperating with all of said switches

10. The combination with two or more sets of motors and two or more sets of series-parallel switches, of a rheostat, and a controller operating directly upon the said rheostat upon said series-parallel switches by an electromagnetic device.

11. The combination with two or more sets of motors, of two or more series-parallel switches, a rheostat, a controller for the rheostat, electromagnets for operating the said switches, and a circuit from the said magnets to the said controller, whereby the controller may operate the rheostat directly and the switches indirectly through said magnets.

12. The combination with two or more sets of motors, of a series-parallel switch in coöperative relation to each of said sets, a common source of current for all the motors, and a rheostat interposed between said source and the motors.

13. The combination with a plurality of electric motors, of a switch for connecting them in series or in parallel relation, an electromagnetic device for operating said switch, a rheostat, a controller, and circuit connections leading from the sections of the rheostat, and from said electromagnetic devices to the controller, whereby the controller acts

directly upon the rheostat and indirectly by means of said electromagnetic device, upon the series-parallel switch.

14. The combination with two or more sets of motors, of series-parallel switches therefor, a common rheostat for controlling the flow of current to all the said motors, and train-circuits having electromagnetic devices governing the said switches.

15. The combination with a plurality of electric motors located on two or more cars of a train, of a rheostatic controller for all of said motors located upon one of the cars, and series-parallel switches for controlling the circuits of the several motors, located on the respective cars, but controlled from one car of the train.

16. In a system of electric-power transmission and control, the combination with a source of electric supply and a plurality of electromotive devices, of a main lead connected to all of the electromotive devices, a main controlling-switch controlling the connection between said main lead and the source of electric supply, electromagnetically-controlled switches and connections for connecting said electromotive devices in either series or parallel relation, and an auxiliary controlling-switch and connections for controlling the operation of said series-parallel switches.

17. In a system of electric transmission and control, the combination with a source of electric supply, of a plurality of electromotive devices arranged in pairs, separate switching devices for connecting the electromotive devices of each pair in series or parallel relation, a main lead connected to all of the pairs of electromotive devices, and a controller controlling the connection between the main lead and the source of supply.

18. In a system of electric-power transmission and control, the combination with a source of electric supply, of a plurality of electromotive devices arranged in sets, a main lead connected to all of said sets of electromotive devices, a main controlling-switch for controlling the flow of current from said source to said electromotive devices, switches for connecting the electromotive devices in each of said sets in different circuit relations, and means for controlling the operation of said switches.

19. In a system of electric train control, the combination with a source of electric supply, of a plurality of electromotive devices arranged in pairs, separate electromagnetically-operated switches for connecting the electromotive devices of each pair in series or parallel relation, a main lead connected to all of the pairs of electromotive devices, a controller controlling the connection between the main lead and the source of supply, and contacts and connections operated by the controller at the time when the latter opens the supply connection, to control the electromagnetically-operated series-parallel switches.

20. The combination with a supply-circuit, of a plurality of motors connected thereto, a switch and connections for connecting said motors in series or parallel relation, an electromagnetic device operating said switch, means for connecting said electromagnetic device to the supply-circuit, and means rendered operative upon cessation of current in the circuit of said electromagnetic device for operating said switch to place the motors in series relation.

21. In a system of electric train control, the combination with a source of electric supply and a plurality of cars having motor equipments, of a main lead extending from car to car and connected to the several motor equipments, switches on the respective motor-equipped cars for connecting the motors of each equipment in series or parallel relation, electromagnetic devices for operating said switches, operating connections for said electromagnetic devices extending from car to car, and one or more controllers each comprising means for connecting the main lead with the source of electric supply, means for varying the resistance in the connection so established, and means for controlling the operating connection of the electromagnetic devices for operating the series-parallel control-switches.

22. In a system of electric train control, the combination with a source of electric supply, of a plurality of electromotive forces arranged in sets, a plurality of controlling devices for connecting the electromotive devices of each set in series or parallel relation, a main lead connected to all of said sets of motive devices, means for controlling the connection between said main lead and the source of electric supply, and means for operating all of the aforesaid series-parallel controlling devices from one point.

23. In a system of electric train control, the combination with a source of electric supply and a plurality of cars having motor equipments, of a main lead extending from car to car, and connected to the several motor equipments, switches on the respective motor-equipped cars for connecting in series or parallel relation the motors of each equipment, and one or more controllers, comprising means for connecting said main lead with the source of supply and means for controlling the series-parallel switches, said means being operatively related, and a single handle for operating both the connecting means and the series-parallel controlling means.

24. In a system of electric-power transmission and control, the combination with a source of electric supply, of a plurality of electric motors supplied therefrom, an electromagnetically-operated switch for connecting said motors in series or parallel relation, a controller comprising means for controlling the connection of the motors with the source of supply and means for controlling the electromagnetic device operating the series-parallel switch, said latter means comprising

contacts for connecting said electromagnetic device to the source, and a switch for closing a shunt around said contacts, so as to operate the series-parallel switch independently of the controller.

25. In a system of electric train control, in combination, a plurality of cars provided with motor equipments, a source of current-supply, a main lead to which the motor equipments of the several cars are connected, one or more main controlling-switches for controlling the flow of current from said source to said motors, circuit-changing switches for said motor equipments, and one or more auxiliary controlling-switches for controlling the operation of said circuit-changing switches.

26. In a system of electric train control, in combination, a plurality of cars provided with motor equipments, a source of current-supply, a main lead to which the motor equipments of the several cars are connected, a main controlling-switch for controlling the flow of current from said source to said motors, circuit-changing switches on each of said motor-cars, and means independent of the motor-circuits for simultaneously operating the corresponding switches on the several cars.

27. In a system of electric train control, in combination, a plurality of cars provided with motor equipments, a source of current-supply, a main lead to which the motor equipments of the several cars are connected, a main controlling-switch for controlling the flow of current from said source to said motors, a circuit-changing switch on each of said motor-cars, a lead or leads independent of the motor-circuits to which the operating-circuits of said circuit-changing switches are connected, and an auxiliary controlling-switch for simultaneously operating the circuit-changing switches on the several cars.

28. In a system of electric train control, in combination, a plurality of cars provided with motor equipments, a source of current-supply, a main lead to which the motor equipments of the several cars are connected, a main controlling-switch for controlling the flow of current from said source to said motors, circuit-changing switches on each of said motor-cars, leads independent of the motor-circuits to which the operating-circuits of said circuit-changing switches are connected, and auxiliary controlling-switches for controlling the circuit connections between the source and their respective leads.

CHARLES B. MARTIN.

Witnesses:
ARTHUR P. KNIGHT,
M. V. BIDGOOD.