No. 860,976. PATENTED JULY 23, 1907.

G. H. HILL.

SYSTEM OF CONTROL.

APPLICATION FILED NOV. 14, 1905.

2 SHEETS—SHEET 1.

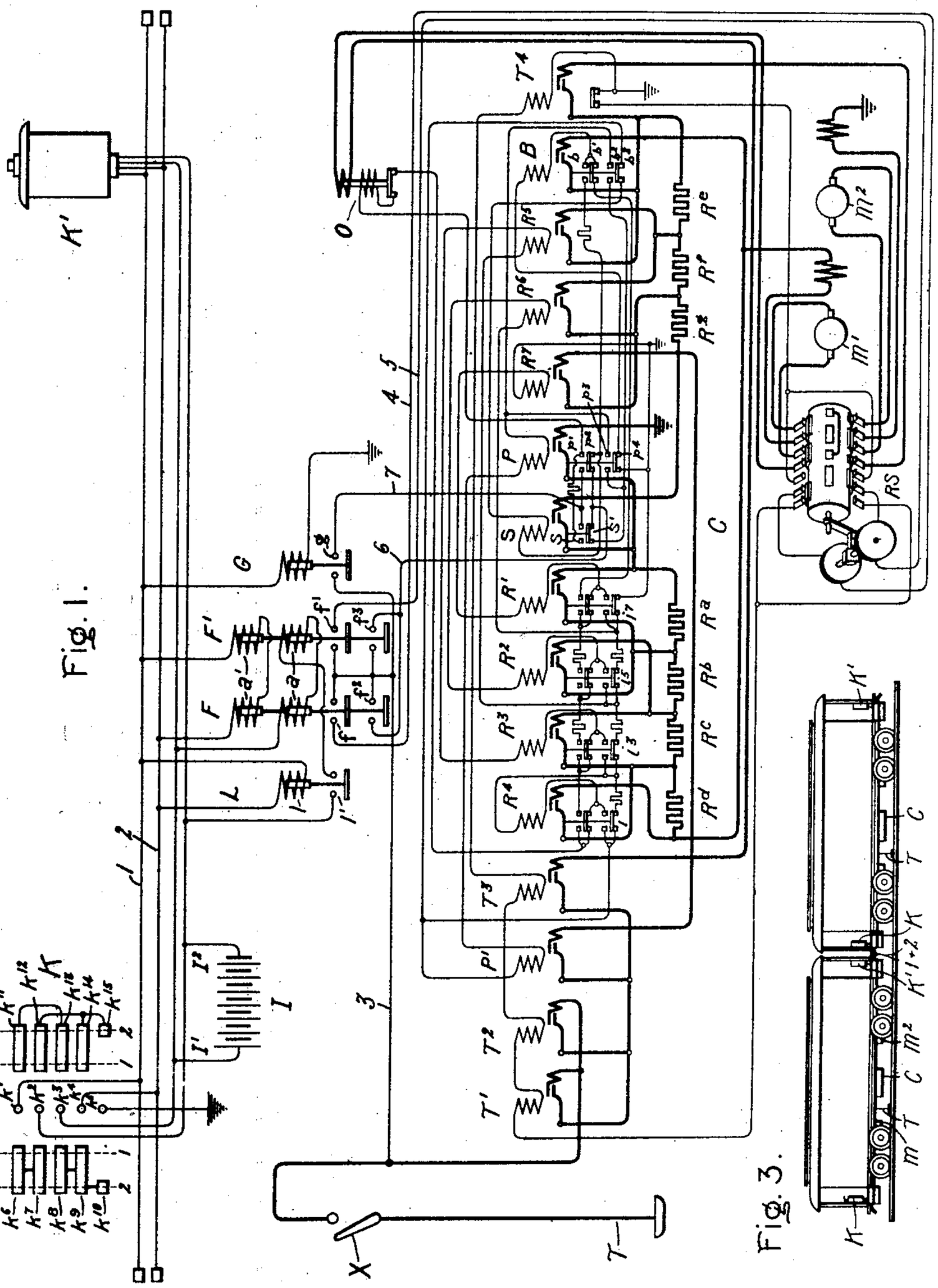

Fig. 1.

Fig. 3.

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Margaret E. Woolley

Inventor:
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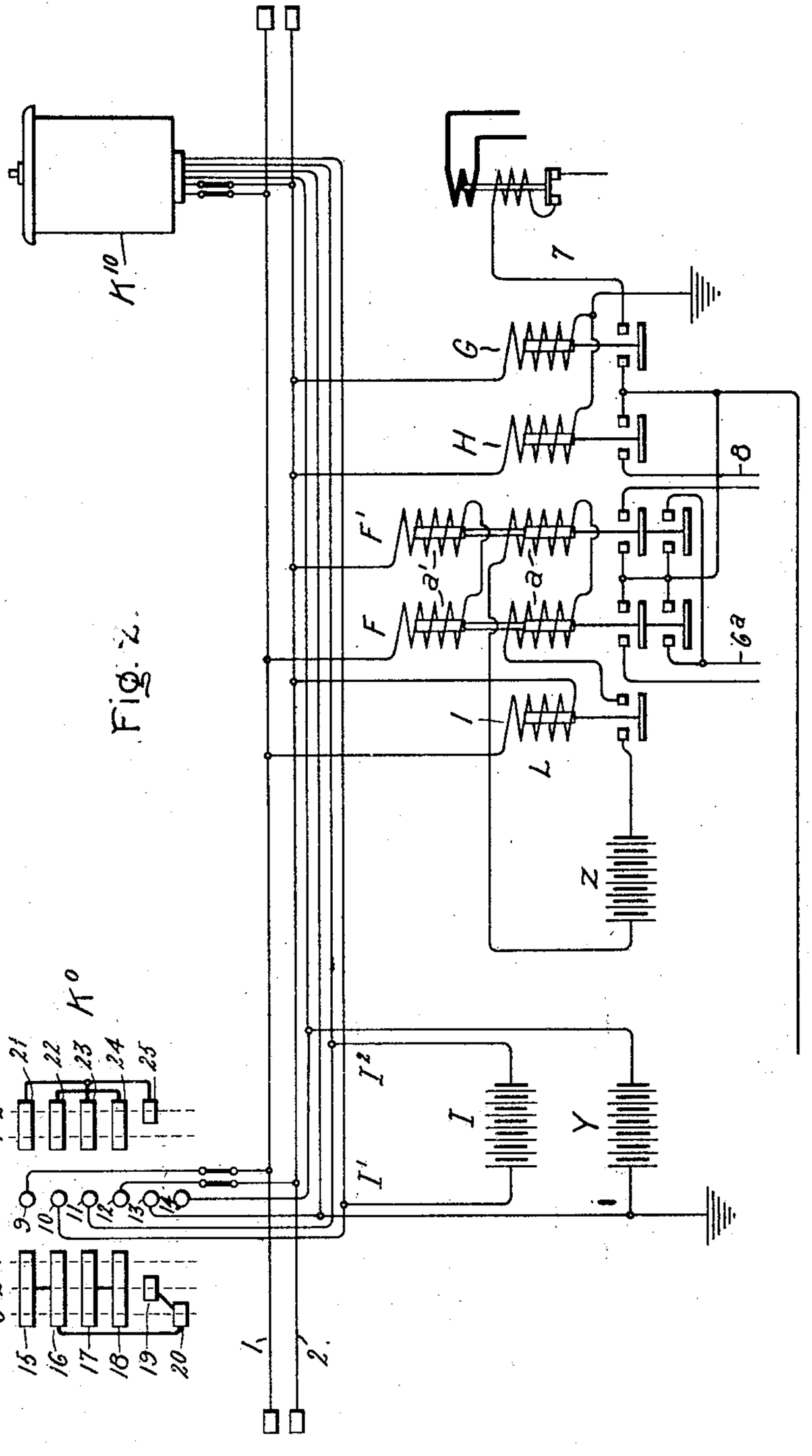

Fig. 2.

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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 CONTROL.

No. 860,976. Specification of Letters Patent. Patented July 23, 1907.

Application filed November 14, 1905. Serial No. 287,256.

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 Control, of which the following is a specification.

The present invention relates to apparatus for controlling the operation of motors from a distant point, and more particularly to systems wherein a plurality of motors or groups of motors, as for instance, the several motors on the cars of a train, are controlled from a single station.

The object of the present invention is to simplify the construction and operation of apparatus of the character specified and particularly those parts forming the train system, whereby an efficient and positive control is obtained with but few connections between cars.

In one of its aspects the present invention may be considered as comprising improvements on the system shown in my application, Serial No. 261,293, filed May 20, 1905. In said application each of the motor cars of a train is provided with a local motor controller and all of these motor controllers are in turn governed in their operation by a pneumatic train system, which, when energized in the proper manner, simply closes control circuits for effecting the proper action of the controller. It is very frequently desirable in train control systems to have local motor controllers and an entirely independent train control system without, however, using compressed air which involves the employment of air compressors and considerable piping.

In carrying out the present invention I make use of a source of electrical power for the train system proper which shall be independent of the line which supplies current to the motors. In this way the train system is made independent of the line supply of current as in my prior application and, by reason of a peculiar construction and organization of parts, a much more simple and compact system of train connections is produced than is possible wherein pneumatic system is employed.

The present invention will be more fully understood from the following description thereof taken in connection with the accompanying drawings.

In said drawings, Figure 1 shows diagrammatically a complete equipment for one motor car arranged in accordance with the present invention; Fig. 2 is a similar view of a modification, the motor and motor controllers being, however, omitted; and Fig. 3 shows a train of two cars, equipped in accordance with the present invention.

Reference being had to the drawings, M^1 and M^2 indicate two railway motors; C is a motor controller including a series of individual switches or contacts T^1, T^2, T^3 and T^4 for connecting the motor circuit to the source of supply indicated by a collector shoe or trolley T; S for connecting the motors in series; P and P^1 for producing the parallel connections of the motor; R^1 to R^7 for governing the resistance sections R^a to R^g; and B for connecting a shunt about the resistance and series switches, whereby the motor circuits are prevented from being opened during the change from series to parallel; RS is a reversing switch for determining the direction in which current flows through the motor armature. These parts, together with the controlling relay O, are identical with corresponding parts in my aforesaid application. The number of auxiliary interlocking contacts remains the same, (the series switch having two, *s* and *s'*; the bridging switch four, *b*—b^3; parallel switch P, four, *p'*—p^4; and the resistance switches the usual number) but they are connected in a somewhat different manner. It is of course understood that all these parts, which comprise the local units of a train, may take any usual or desired forms, the one illustrated being simply illustrative and representing apparatus which has operated successfully in practice.

When the switch X is closed, (reference being had to Fig. 1) current passes from trolley T through a wire 3 and thence through contacts controlled by relays F, F^1, and G to wires 4 and 5 passing from contacts *f* and *f'* closed by relays F and F^1, respectively, and controlling the reversing switch, to wire 6, which is energized upon the closing of either of contacts f^2 or f^3, associated with relays F, F^1, respectively, and controlling the series and parallel switches, to wire 7, which is energized either upon the closing of switch *g* of relay G, and which controls the automatic progressive action of the resistance controlling switches.

Each car is provided with a storage battery I which may be connected to the train wires 1 and 2 by means of the controllers K or K^1, and to a circuit containing contacts controlled by a relay L. The circuit controlled by the relay L includes corresponding coils *a* of the relays F and F^1; these coils, when the relay L is closed, being connected in series across the terminals of the battery. Assuming that it is desired to make the car or train travel in the forward direction, the controller K is turned to the right until the contacts K^2 engage along line 1 1 with the row of fixed contacts K^2. A circuit may now be traced from terminal I^1 of the battery through contacts k^3, k^8, k^9, k^4 to wire 2, and thence through the coil *l* of relay L to train wire 1, contacts k^1, k^6, k^7 and k^2 to terminal I^2 of the battery. Another circuit extends from wire 2 to the coils a^1 of the relays F and F^1, in series, to wire 1. The energization of the relay L closes the contacts l^1 and completes the circuit through the coils *a* at the same time that the coils a^1

are energized through the train wires. The coils *a* and a^1 are so proportioned and wound that, in the case assumed, the two coils on the relay F^1 substantially neutralize each other, while the action of the coils on the relay F is cumulative. Consequently relay F^1 remains open and relay F closes and, in closing, completes the circuit to wires 4 and 6 through contacts *f* and f^2. The energization of these two wires operates the reversing switch in the proper direction for forward rotation of the motor and completes the circuit of the motors between trolley and ground, the motors being connected in series with each other and in series with all the resistance. The control circuits and the motor circuits may readily be traced as they are substantially identical with those in my prior application.

It is evident that when train wires 1 and 2 are energized, current flows through the coils *l* and a^1 of all the cars of the train; each of the relays L completing the local circuit from the local battery through the coils *a* of the reversing relays F and F^1. Thus the motors on all the cars will be connected properly to the line.

When it is desired to increase the speed of the motors, the controller is moved to its second running position, namely, until the movable contacts K^3 engage along line 2—2 with the fixed contacts K^3. The battery circuits previously traced remain unchanged, but a new circuit is established from terminal I^2 of battery through contacts k^2, k^7, k^6, k^1 to train wire 1, through the actuating coil of relay G to ground, and thence to contact k^5, contact k^{10}, contact k^8 and k^3 to terminal I^1 of the battery. Contact *g* is thereby closed and current flows from trolley through wire 7 to the actuating coils of the resistance switches; the resistance being cut automatically step-by-step, until finally the bridging switch B closes and forms a shunt connection about resistance and series switches and causes these latter switches to open. At this point the controller actuating system departs somewhat from the system of my prior application. The operation of the bridging switch B interrupts the circuit of the series and resistance switches at interlock b^3 and prepares the way for the operation of the parallel switches as in the previous system, but the series switch, in opening, permits current to flow from wire 6 through interlocks s^1, b^2, actuating coils of parallel switches P and P^1, through the lowermost interlocks *i*, i^3, i^5 and i^7 of the resistance switches, and thenceto ground. The parallel switches, in closing, break the circuit of the bridging switch in the well-known manner and complete maintaining circuits for themselves and for the resistance switches which are automatically actuated as before. Thus in moving the master controller into its first running position the motors are made to operate in series with each other and with all resistance in circuit; then by bridging the controller into its next position, the motor circuits may be progressively and automatically changed to the full parallel condition. If it is desired to run at less than full parallel speed, the controller may be kept in the second position until the desired speed is attained and then returned to the first position, thereby stopping the automatic progression of the switches at the desired point.

When it is desired to reverse the motors or run the train in the opposite direction, the controller is moved to the left and, in the first position, train wires 1 and 2 are again connected to the battery, but in reverse order, namely, train wire 2 is now connected to terminal I^2 and train wire 1 to terminal I^1 of the storage battery. By this means the polarity of the coils a^1 of the reversing relays is reversed and it is now the coils on relay F which oppose each other and those upon relay F^1 which assist each other. Thus wire 4 remains deënergized and wire 5 becomes energized, causing the reversing switch to be actuated to the opposite position from that which it previously occupied. The further operation of the relays is the same as previously described.

In Fig. 2 I have illustrated a somewhat different system. Instead of a single battery, a plurality of batteries are employed, and the parallel relay is operated by connecting it to two of the batteries in series with each other, whereas the reversing relays and the accelerating relay operate when but a single battery is connected to the train wires. Each car is provided with an idependent battery Z, the sole purpose of which is to energize the coils *a* of the reversing relays when the relay L is actuated. The system is also shown as adapted for operation in connection with a motor-controller actuating system having separate series and parallel control wires, 6^a and 8 as in my prior application. A separate parallel relay H is therefore provided.

Assuming that the controller K is moved to the right until the contacts K^{20} engage along line 1 1 of the fixed contacts K^{30}, a circuit may be traced from terminal I^1 of the battery I, through contacts 10, 16, 15, 9, to train wire 1, and thence to train wire 2 through the coils *l* of relay L and the coils a^1 of the reversing relays and thence through contacts 12, 18, 17 and 11 to the opposite terminal I^2 of the battery I. As before, the coils *a* and a^1 on relay F^1 neutralize each other while the two coils on the relay F assist each other and close the contacts associated therewith. In the second position of the controller a further circuit may be traced from terminal I^1 of battery I, through contacts 10, 16, 20, 19 and 13 to ground, and from ground through the actuating coils of relays G and H to train wire 2 and thence through contacts 12, 18, 17 and 11 to terminal I^2 of battery I. The current now flowing through the coil of relay H is insufficient to actuate the relay, but the relay G is actuated and completes the accelerating circuit through wire 7 as before. In order to operate the parallel relay H the controller is moved to the third running position, the circuit for relay G being momentarily broken and current then flows from the terminal I^1 of the battery I through contacts 10, 16, 20 and 14, through the battery Y to ground, and from ground through the coils of relays G and H to train wire 2, contacts 12, 18, 17 and 11 back to terminal I^2 of the battery I. The relays G and H are now being supplied with current at the combined potential of the batteries I and Y, and both relays operate, completing the parallel and resistance controlling circuits in the usual manner.

When it is desired to reverse the car or train, the controller is moved to the left and the direction of current flow through the train wires is reversed, thereby causing the two coils on the relay F^1 to assist each other and the coils on the relay F to oppose each other, relay F^1 being the one which will operate in

this case. It will now be seen that by means of a few train wires, the polarity of which is changed in order to bring about a change in the direction of rotation of the motors, a positive control is obtained over the motors of the several cars of a train so that all the motors may operate in unison.

While I have described the present invention as embodied in but two of its forms I do not desire to be limited to the exact forms shown and described since, in its broader aspects, many changes in the construction and mode of operation, other than those specifically pointed out in the specification, may be made without departing from the spirit and scope of the present invention.

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

1. In a system of train control, motors or groups of motors, electromagnetically actuated switches for controlling the speed and direction of rotation of said motors or groups of motors, local circuits for the actuating coils of said switches, relays for controlling said local circuits, and means including two train wires and a controller for operating said relays whereby the first mentioned switches are actuated to vary the speed and direction of rotation of said motors.

2. In a system of train control, motors or groups of motors, electromagnetically actuated switches for controlling the speed and direction of rotation of said motors or groups of motors, local circuits for the actuating coils of said switches, relays for controlling said local circuits, and means including two train wires, a controller and an independent source of current for operating said relays whereby the first mentioned switches are actuated to vary the speed and direction of rotation of said motors.

3. In a system of train control, motors or groups of motors upon a plurality of cars, separate motor controllers for governing the direction of rotation and speed of each of the motors or groups of motors, local actuating means for said controllers, local relays controlling the operation of said actuating means, a master controller, and two train wires connecting said master controller to said relays, the arrangement being such that both train wires are energized during each cycle of operations the polarity of the train wires determining the direction of rotation of the motors.

4. In a system of train control, motors or groups of motors upon a plurality of cars, separate motor controllers for governing the direction of rotation and the speed of each of said motors or groups of motors, local actuating means for said controllers, relays for controlling the operation of said actuating means, an electric train system comprising a plurality of wires for governing said relays, and means for changing the polarity of certain of said wires to change the direction of rotation of the motors.

5. In a system of control, a motor or group of motors, a motor controller including means for determining the direction of rotation of the motor or motors, actuating means for said controller, a plurality of relays including a pair of reversing relays for governing the operation of said controller, said reversing relays each having two coils, a source of current supply, and a master controller for connecting said relays to said source of current supply and varying the polarity of one of the coils on each reversing relay relative to the other in order to vary the direction of rotation of the motor or motors.

6. In a system of control, a motor or group of motors, a motor controller including means for determining the direction of rotation of the motor or motors, actuating means for said controller, local circuits for energizing said actuating means, a plurality of relays including a pair of reversing relays for controlling said circuits, said reversing relays each having two coils, a source of current supply, a circuit from said source of current supply for energizing a corresponding coil on each reversing relay, a switch in said latter circuit, and a master controller arranged and connected to close said switch and govern the polarity of the remaining coils of the reversing relays.

7. In a system of train control, motors or groups of motors upon a plurality of cars, separate motor controllers including means for governing the direction of rotation and speed of each motor or group of motors, actuating means for said controllers, a plurality of relays including a pair of reversing relays upon each of said cars, each of said reversing relays having two coils, a source of current supply upon each of said cars, and a train system arranged to control said relays and to connect one of the coils of each reversing relay to the local source of current supply and to vary the polarity of the coils of the reversing relays with respect to each other.

8. In a system of train control, motors or groups of motors upon a plurality of cars, reversing controllers for each of said motors or groups of motors, controlling relays including reversing relays local to each of said cars, said reversing relays each having two coils, each of said cars having a source of current supply and an electromagnetically actuated switch for connecting one coil of each reversing relay thereto, a train system including a train circuit connected to the actuating means of each of said switches and to the remaining coils of said relays, and means for changing the polarity of said train circuit.

In witness whereof, I have hereunto set my hand this 13th day of November, 1905.

GEORGE H. HILL.

Witnesses:
BENJAMIN B. HULL,
MARGARET E. WOOLLEY.