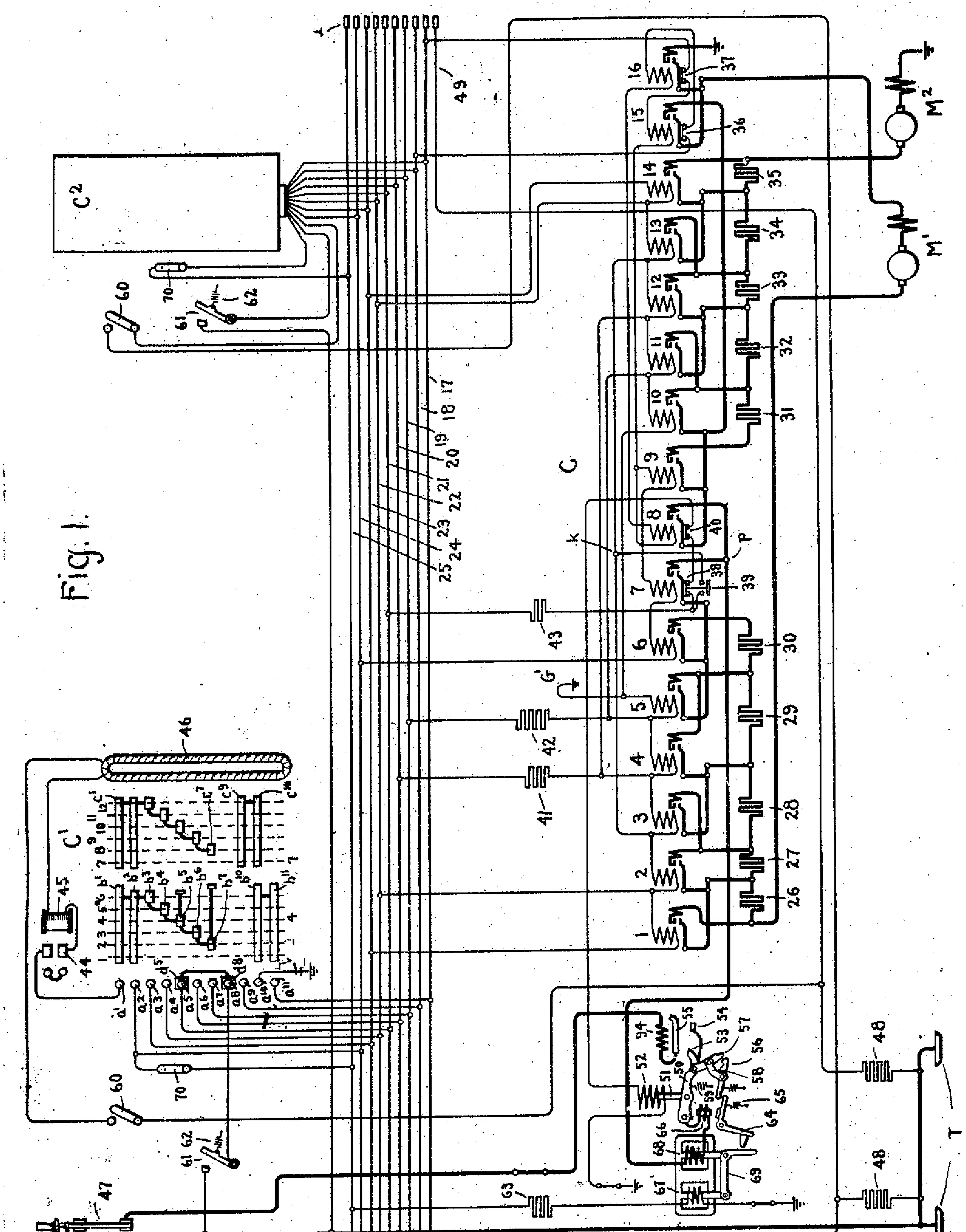
No. 818,349. PATENTED APR. 17, 1906.

F. E. CASE.

CONTROL SYSTEM.

APPLICATION FILED OCT. 10, 1904.

2 SHEETS—SHEET 1.



WITNESSES

J. Ellis Glen.

Helen Orford

INVENTOR

Frank E. Case.

by Albert G. Davis

Att'y.

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2 SHEETS—SHEET 2.

Fig. 2.

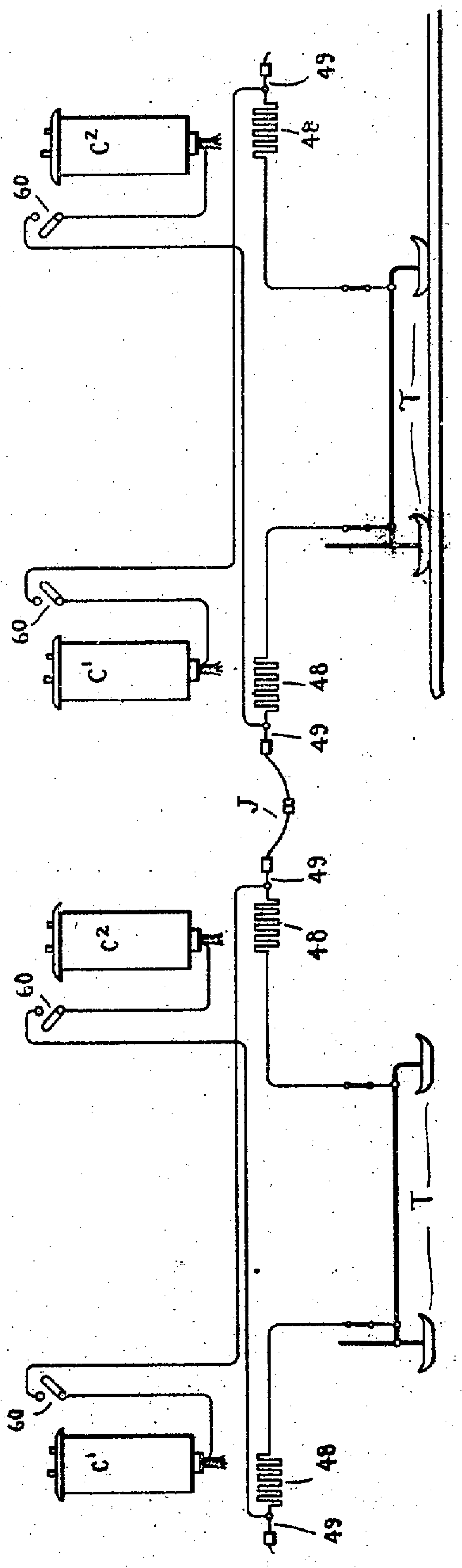
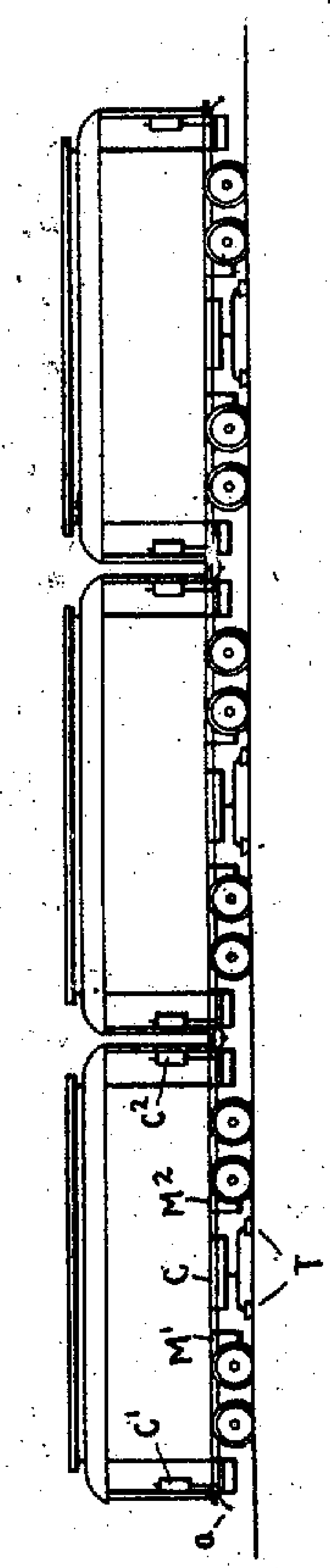


Fig. 3.



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Atty.

UNITED STATES PATENT OFFICE.

FRANK E. CASE, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

CONTROL SYSTEM.

No. 818,349. Specification of Letters Patent. Patented April 17, 1906.

Application filed October 10, 1904. Serial No. 227,812.

To all whom it may concern:

Be it known that I, Frank E. Case, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Control Systems, of which the following is a specification.

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

In my application, Serial No. 215,114, filed July 2, 1904, there is illustrated an electrical system of train control in which the circuit-breakers located in the motor-circuits of the several cars are maintained closed by means of an independent circuit from the current-collecting devices, this circuit being subjected to full-line potential at all times even when the control and motor circuits are deenergized, the current being, however, limited to some extent by means of resistances. It is evident that great precaution must be taken to insulate this circuit from the motor-control circuits, since a short-circuit between the two would cause the control system to be supplied with current irrespective of the position of the master-controller, and as a result the operator would lose control of the motors. In order to obviate the danger of such a condition of affairs, the train-wire for maintaining the circuit-breaker closed has been placed in a separate cable outside of the cable carrying the control-wires for the motors. This arrangement necessitates not only the expense of two cables and separate couplers therefor, but also materially affects the convenience and ease of making the connections between the cars.

One object of the present invention is to provide a safe and efficient circuit-breaker actuating and tripping system in which the train wire or wires may safely be placed in the control-cable, and to this end I have so arranged a circuit-breaker actuating and tripping system that the circuit-breakers may be opened at will and that they will open upon failure of control-current without a corresponding failure of the motor-current, but wherein the circuit-breakers will not be affected when both the motor and control currents are interrupted simultaneously, as occurs during the frequent stopping of a car or train in operation. It is frequently desirable in equipments electrical in character to have a train bus line or wire, which connects the respective current-collecting devices of the several cars, so that the control system may be provided with current even though the collecting devices on the car upon which the master-controller is situated fails for any reason to receive current, as when the collecting device is insulated from the rail or trolley-wire or bears upon a dead section. It is apparent that such a bus-wire is subjected to the entire line potential and that if for any reason a short-circuit occurs or one of the connecting devices is grounded or comes upon a dead section or upon a section having a lower potential than that upon which the other collecting devices bear the bus-wire must carry abnormally large currents, endangering the insulation and perhaps causing serious damage, and even where the abnormal current is not sufficiently great to produce serious results it may at least blow out the fuses in the bus-line and cause annoyance and perhaps material delay on account of repairs.

A further object of the present invention is to so arrange the connections between the several current-carrying devices and the master-controllers upon the cars of the train that the current which may pass through the bus-line under abnormal conditions is limited.

The present invention in its various aspects will be more clearly understood in connection with the following description and the accompanying drawings, disclosing a preferred form thereof.

In the drawings, Figure 1 is a diagrammatic view of a single-car equipment, arranged in accordance with the present invention. Fig. 2 is a diagrammatic view showing the current-collecting devices of two cars and the connections between the collecting devices and to the several controllers, and Fig. 3 is a side view of a train of cars equipped in accordance with the present invention.

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

The separately-actuated contacts 1 to 16, inclusive, of the motor-controller C are used for controlling the motors M′ and M². The said motor-controller C is under the control of the master-controllers C′ and C², which may be located at any desired point on the car or train. The master-controller C′ is shown in development, as is customary in illustrating such a structure, and the master-controller C² is merely shown in outline. Both of said master-controllers are connected to the train-wires 17 to 25, inclusive, which are operatively connected to the actuating-coils of the separately-actuated contacts of the motor-controller. The said train-wires may be connected to corresponding train-wires on adjacent cars of the train by means of the couplers a. The contacts 1 to 6, inclusive, operate to vary the amount of resistance which is connected in the circuit with the motor M′, the resistance-sections controlled by said contacts being represented by 26 to 30, inclusive. The contacts 7 and 8 represent the line-contacts, which are adapted to connect the trolley or main source of power to the circuits leading to the motors M′ and M². The contacts 9 and 14, inclusive, operate to vary the amount of resistance which is connected in circuit with the motor M², the said resistance-sections controlled by said contacts being represented by 31 to 35, inclusive. The series and parallel contacts 15 and 16, respectively, are supplied with auxiliary switches 36 and 37, which, respectively, prevent the completion of the control-circuit through the actuating-coils of the contacts 16 and 15 and serve as an interlock between the series and parallel contacts. The line-contact 7 is provided with the auxiliary switches 38 and 39, and the line-contact 8 is provided with the auxiliary switch 40. The function and operation of said auxiliary switches will be hereinafter described. The resistance-sections 41, 42, and 43 are employed to compensate for the resistance of the actuating-coils of the contacts of the motor-controller when said coils are cut out of circuit, thereby maintaining approximately a uniform current in the control-circuits.

The master-controller C′ includes the relatively fixed contacts-fingers a' to a^{11}, inclusive, and the movable contact-segments b' to b^7, inclusive, b^{10} and b^{11}, c' to c^7, c^9 and c^{10}. The movable member, on which said segments are mounted, also carries the contact-segments d^5 and d^8, which are electrically connected together and respectively engage fingers a^5 and a^8 when the master-controller is in its "off" position. For a more detailed description of these various parts, reference may be had to the patent to C. L. Perry, No. 687,060, granted November 19, 1901, and to my application previously mentioned.

The auxiliary cut-out switch, which is adapted to open the motor-circuit automatically whenever the controlling-handle is released by the motorman, is indicated at 44. A more detailed description of said auxiliary switch, and its actuating mechanism, may be obtained from my application, Serial No. 75,488, filed September 16, 1901. The blow-out coil for said auxiliary cut-out switch is indicated at 45, and 46 is the main blow-out coil of the master-controller. The main cut-out switch for the motor-circuit is indicated at 47.

One feature of the present invention consists in the arrangement of feeders for the control-circuits. Separate connections are provided from each master-controller to the current-collecting device T, and in each connection there is arranged a resistance-section 48 as great as the current requirement of the control-circuits will permit. A branch 49 from each connection extends to the end of the car opposite that to which the respective controller is situated and is provided with a coupling-terminal a. In Fig. 2 these controller connections are illustrated as applied to a train of two cars and as coupled together by the jumper J. It is evident from this figure that if the train is run in the direction in which the master-controller on the extreme left is brought into play this controller may take current from either set of trolley-shoes and through but a single section of resistance, while if the train is being run in the opposite direction and the master-controller on the extreme right is in service then the same current-receiving capability applies to this controller. At the same time, however, two sections of resistance are at all times situated between the current-collecting devices of adjacent cars. By this arrangement, should the shoes of the leading car leave the third rail or become insulated therefrom, current will be supplied to the control system and to the motors of the leading car; but the current which may flow through the coupler under abnormal conditions is greatly limited.

The means for controlling the circuit-breaker will now be described. The circuit-breaker may be of any desired form, the contact-arm 50 thereof being attached to a core or plunger 51 of the actuating-electromagnet 52. The said contact-arm comprises the usual brush-contact 53 and the auxiliary contact 54, which are adapted to engage with a fixed contact 55. The circuit-breaker is set by an energization of the actuating-electromagnet 52 and is held closed by a suitable catch 56, which engages with a projection 57 on one arm of the toggle 58. The toggle 58 is not moved into a straight line or buckled over center when the arm 50 is in its closed position. Therefore when otherwise free the arm 50 opens by gravity, assisted, if desired, by a spring 59. By employing a catch to hold the circuit-breaker closed it is possible to dispense with the continuously-energized wire, as illustrated in my prior application, for holding the circuit-breakers closed during ordinary operation of the car or train. The circuit through the closing or setting coil which is energized when it is desired to reset the circuit-breaker is completed at a switch 61, held normally open by means of the spring 62 and preferably located adjacent to the master-controller within easy reach of the operator or motorman. The means for tripping the circuit-breaker are as follows: A pivoted lever 64 is arranged adjacent the catch 56, but is normally held out of engagement therewith by gravity or by a spring 65. This lever or a portion thereof constitutes the armature of an electromagnet 66, energized by motor-current. When the motor-current reaches a predetermined maximum, the lever 64 is attracted by the electromagnet, tripping the catch 56 and allowing the circuit-breaker to open. A pair of electromagnets 67 and 68, energized by control-current and motor-current, respectively, are arranged adjacent the lever 64, and the cores of these electromagnets are connected by a link or arm 69, pivoted thereto. The arrangement is such that when both electromagnets 67 and 68 are energized or deënergized simultaneously the link or arm 69 moves parallel to itself without engaging with the tripping-lever 64, this being practically what takes place when the controller is moved from its "off" to a "running" position or back again, or when both control and motor currents or circuits are interrupted. If, however, for any reason the control-current fails or becomes ineffective, due to short-circuits or otherwise while the motor-current continues, then electromagnet 67 is deenergized and the core thereof drops, carrying with it one end of link 69 and swinging this link about its pivotal connection with the core of electromagnet 68 as a center and causing its free end to strike the tripping-lever 64, so as to oscillate said lever sufficiently to trip the catch 56, whereupon the circuit-breaker immediately opens. By this means it is impossible for the motors to receive current after the control-current fails. A resistance 63 is inserted in series with electromagnet 67 for the purpose of cutting down the current which flows through said electromagnet, very little current being required to hold the core thereof raised. The circuit through electromagnet 67 is completed through contact a^2 of the master-controller and through switch 70, so that the operator or motorman may trip the circuit-breaker at will by simply opening the switch 70, thereby causing electromagnet 67 to be deënergized. It is evident that train-wire 25 need be energized only during the time the motors are taking current, thus permitting this wire to be placed in the cable and jumper carrying the control-wires.

In the operation of the system when it is desired to set the circuit-breaker the master-controller C' is moved into its off position, then the normally open switch 61 is closed momentarily. A circuit is thereby completed from the trolley T, through the switch 61, thence through the contact-segments d^3 and d^5, contact a^5, train-wire 21, resistance 43, auxiliary switch 38, auxiliary switch 40, through the actuating-electromagnet 52 of the circuit-breaker to ground. The electromagnet 52 is thus energized and the circuit-breaker is closed, being maintained in its closed position by means of the catch 56. It will thus be seen that on account of the auxiliary switches 38 and 40, carried by the line-contacts 7 and 8, and the auxiliary contact-segments in the master-controller both the motor-controller and the master-controller must be in their off positions before the circuit through the setting-coil of the circuit-breaker can be completed. When the master-controller is moved into its first operative position and switch 60 is closed, a control-circuit is completed from the trolley, through resistance 48, switch 60, blow-out coil 46, blow-out coil 45, cut-out switch 44, contact-finger a', contact-segments b' and b^2, contact-finger a^2, train-wire 24, actuating-coils of the contacts 6, 7, 9, and 15, auxiliary switch 37, train-wire 17, contact-finger a^{11}, contact-segments b^{11} and b^{10}, contact-finger a^{10} to ground. The motor-controller contacts are operated to connect the motors in series with all the resistance, and the circuit through said motors may be traced as follows: from trolley T, main cut-out switch 47, blow-out coil 94 of the circuit-breaker, contact 55, contact-arm 50, overload-coil 66, contact 7 of the motor-controller, thence through contact 6 of said controller to the resistance-sections 30 29 28 27 26, motor M', contact 15, thence through contact 9 of said controller, through the resistance-sections 31, 32, 33, 34, and 35, through motor M^2 to ground. As the master-controller moves through its subsequent operative positions the resistance-sections are successively cut out of the motor-circuit until the motors are connected in series without resistance, then the motors are connected in parallel with resistance in circuit with each motor, and the resistance-sections are successively cut out until the motors are connected in parallel without resistance.

When the contact 7 is operated, the circuit through the actuating-electromagnet 52 of the circuit-breaker is broken at the auxiliary switch 38, thereby disconnecting the train-conductor 21 from said electromagnet and rendering it impossible to reset the circuit-breaker after it has been operated, so long as the contact 7 remains in its closed position, but by employing means, such as the auxiliary switch 39, it is possible to use the train-conductor 21 during the acceleration of the motors to control the contacts of the motor-controller corresponding to a certain resistance-step. Thus with the master-controller in its fourth position (indicated by 4 4) the control-circuit, in addition to that above traced, may be traced as follows: from contact-finger a', contact-segments b' and b^5, contact-fingers a^5, train-wire 21, resistance 43, auxiliary switch 39, through the actuating-coils of the contacts 3, 4, and 5 to ground at G'; also branching at the point k, through the actuating-coils of the contacts 12, 11, and 10 to ground at G'. Thus in said position of the master-controller the contacts 3, 4, 5, 6, 7, 9, 10, 11, 12, and 15 are operated and the resistance-sections 28, 29, 30, 31, 32, and 33 are short-circuited.

The control-circuit corresponding to the first parallel position of the master-controller (indicated by 7 7) may be traced as follows: from trolley T, resistance 48, switch 60, coils 46 and 45, cut-out switch 44, contact-finger a', contact-segments c' and c^2, contact-finger a^2, train-wire 24, actuating-coils of contacts 6, 7, 9, 8, and 16 of the motor-controller, auxiliary switch 36, train-wire 18, contact-finger a^9 of the master-controller C', contact-segments c^9 and c^{10}, contact-finger a^{10} to ground. The corresponding motor-circuits are as follows: from trolley T, through the switch 47, the circuit-breaker arm 50, overload-coil 66, contact 7, contact 6, resistance-sections 30, 29, 28, 27, and 26, motor M', contact 16 to ground; also branching at the point p through the contact 8, contact 9, resistance-sections 31 to 35, inclusive, motor M^2 to ground. It will thus be seen that the motors are connected in parallel with each other with the resistance-sections 26 to 30, inclusive, connected in series with the motor M' and the resistance-sections 31 to 35, inclusive, connected in series with the motor M^2.

If while the master-controller is in any one of its operative positions, the circuit-breaker is tripped, either intentionally, as by the opening of switch 70, or automatically by the operation of the overload-coil 66 or due to a loss of current in the control-circuit, it is impossible to reset said circuit-breaker without first moving the master-controller C' back to its off position, so as to bridge the contact-fingers a^5 and a^8. Any desired number of circuit-breakers may be controlled in this manner from any desired master-controller.

Although I have herein shown a specific form of circuit-breaker and tripping mechanism embodying my invention as applied to an electric-control system, I do not care to be limited thereto, as many modifications may be made without involving a departure from the spirit and scope of my invention, and in the claims hereto appended I aim to cover all such modifications and substitutions.

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

1. In a system of control, in combination, a plurality of circuits, a switch in one of said circuits, and means operable to open said switch only upon the deënergization of one of said circuits while the other remains energized.

2. In a system of control, in combination, a motor-circuit, a control-circuit, a normally closed circuit-breaker in said motor-circuit, and means operable upon the deënergization of the control-circuit while the motor-circuit remains energized to trip the circuit-breaker.

3. In a system of control, in combination, a motor-circuit, a control-circuit, a circuit-breaker in said motor-circuit, and means operable to trip the circuit-breaker when one of said circuits is deënergized but not when both are deënergized simultaneously.

4. In a system of control, in combination, controlled and control circuits, a circuit-breaker, and means operable to cause the circuit-breaker to open upon the deënergization of one of said circuits but not upon the simultaneous deënergization of both circuits.

5. In a system of control, in combination, controlled and control circuits, a circuit-breaker, and means operable to cause the circuit-breaker to open upon the deënergization of the control-circuit while the controlled circuit remains energized but not when both circuits are deënergized simultaneously.

6. In a system of control, in combination, a motor-circuit and a control-circuit, a circuit-breaker, means for setting said circuit-breaker, means for tripping the circuit-breaker on overload in the motor-circuit, and means for tripping the circuit-breaker upon failure of the current in the control-circuit while the motor-circuit remains energized.

7. In a system of control, a controlled circuit, a control-circuit, a normally closed circuit-breaker, and electromagnetic means under the influence of said circuits for tripping the circuit-breaker upon failure of current in the control-circuit while the controlled circuit remains energized.

8. In a system of control, a controlled and a control circuit, a circuit-breaker, an electromagnet in each of said circuits and adjacent the circuit-breaker, and means coöperating with said electromagnets for tripping the circuit-breaker upon the deënergization of one of said electromagnets while the other electromagnet remains energized.

9. In a system of control, a controlled and a control circuit, a circuit-breaker, an electromagnet in each of said circuits and adjacent the circuit-breaker, and means coöperating with said electromagnets for tripping the circuit-breaker upon the deënergization of the magnet in the control-circuit while the other remains energized the arrangement being such that the circuit-breaker is not tripped when both magnets are deënergized simultaneously.

10. In a system of control, a motor-circuit and a control-circuit, a normally closed circuit-breaker, means for tripping said circuit-breaker at will, means for tripping it upon

overload in the motor-circuit, and means for tripping it upon failure of control-current while the motor-circuit remains energized.

11. In a system of train control, comprising controllers on a plurality of cars operated through a train-line from a master-controller located at any desired point on the train, a circuit-breaker on each of the motor-cars, and circuit-breaker actuating means comprising an electromagnet included in the motor-circuit and an electromagnet connected to a conductor in the train-line, the said actuating means being so constructed and arranged that it will cause the circuit-breaker to open only in case current continues to flow in the motor-circuit after the electromagnet connected to the conductor in the train-line has been deënergized.

12. In a system of train control, comprising controllers on a plurality of cars operated through a train-line from a master-controller located at any desired point on the train, an automatic circuit-breaker on each of the motor-cars, means for normally maintaining each circuit-breaker in its closed position, and actuating means for the maintaining means of each circuit-breaker comprising an electromagnet included in the motor-circuit and an electromagnet connected to a conductor in the train-line, the said actuating means being so constructed and arranged that it will actuate the maintaining means to release the circuit-breaker only in case current continues to flow in the motor-circuit after the electromagnet connected to the conductor in the train-line has been deënergized.

13. In a system of train control, a connection between the current-collecting devices of a plurality of cars, a resistance in said connection, a controller and connections therefor so arranged that the circuit passing through said controller from the current-collecting devices of either car contains only a portion of the whole resistance.

14. In a system of train control, connections between the current-collecting devices of a plurality of cars, resistances in said connections, a controller upon each car, and connections therefor so arranged that the circuit passing through a controller from any current-collecting device contains less than the whole resistance between the several collecting devices.

15. In a system of train control, a connection between the current-collecting devices of two cars, a resistance in said connection, a controller on each of said cars, and connections therefor so arranged that the circuit passing through either controller from the current-collecting device of either car contains a portion only of said resistance.

16. In a system of train control, a connection between the current-collecting devices of two cars, a resistance in said connection, a controller upon each car, and connections therefor so arranged that the circuit passing through either car from the current-collecting devices of either car contains one-half of said resistance.

17. In a system of control, a car provided with two controllers and a separate connection from each controller to the current-collecting device of the car, a resistance in each connection and a lead extending from each connection from a point between the resistance and controller to one end of the car.

In witness whereof I have hereunto set my hand this 8th day of October, 1904.

FRANK E. CASE.

Witnesses:

EDWARD WILLIAMS, Jr.,

HELEN ORFORD.