No. 801,238. PATENTED OCT. 10, 1905.

G. H. HILL.

MEANS FOR CONTROLLING CIRCUIT BREAKERS.

APPLICATION FILED AUG. 8, 1904.

2 SHEETS—SHEET 1.

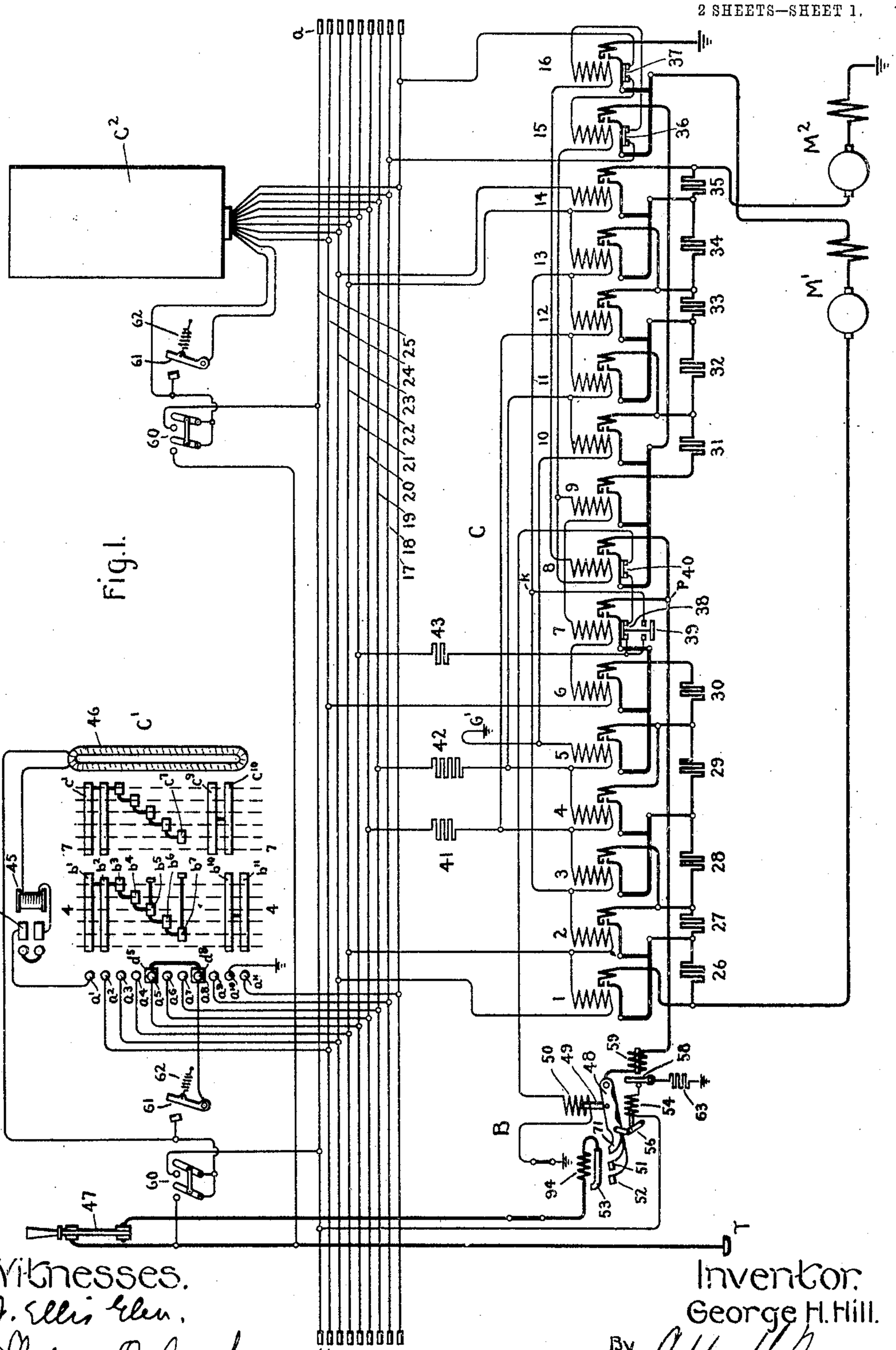

Fig. 1.

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2 SHEETS—SHEET 2.

Fig. 2

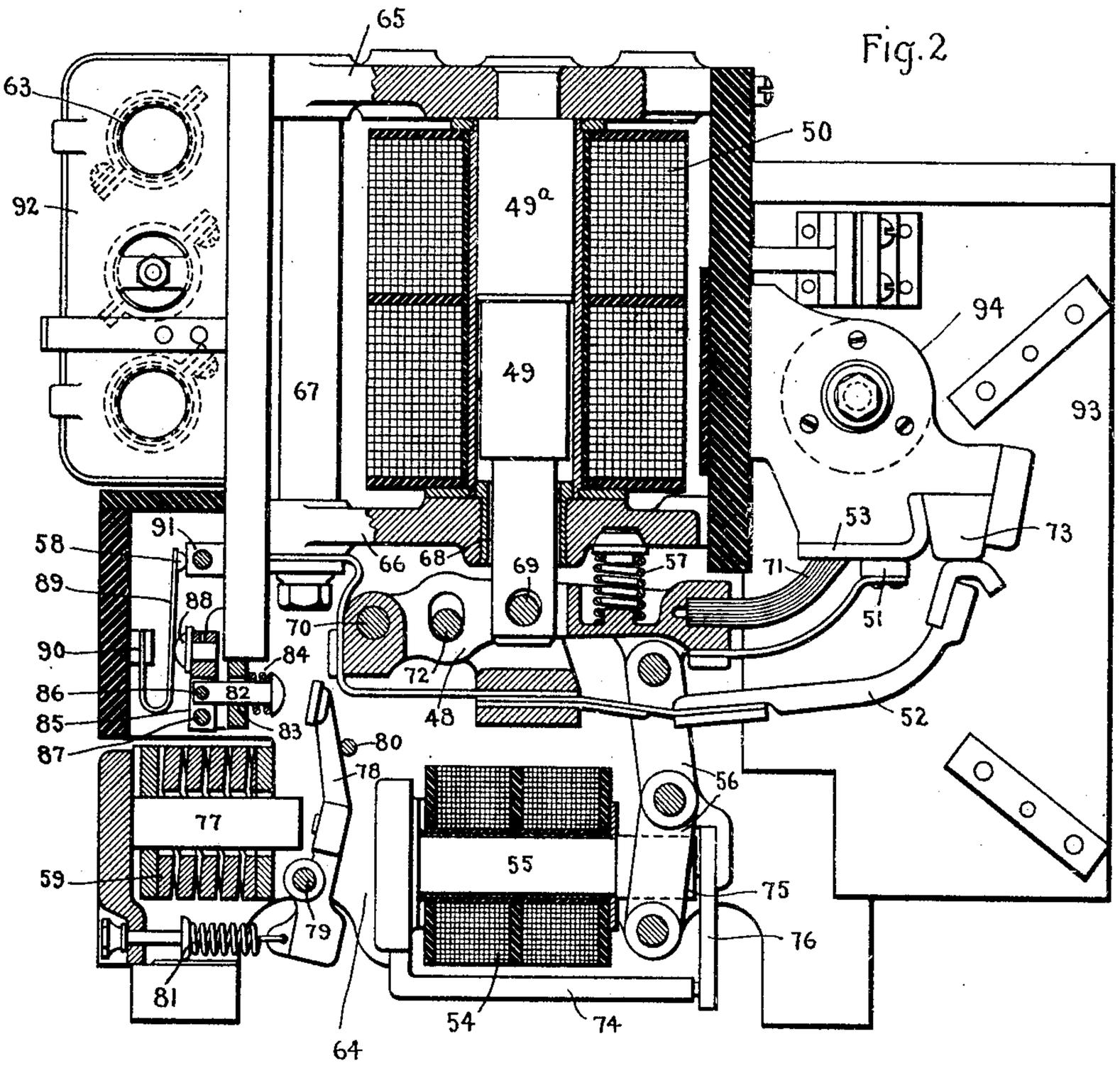


Fig. 3.

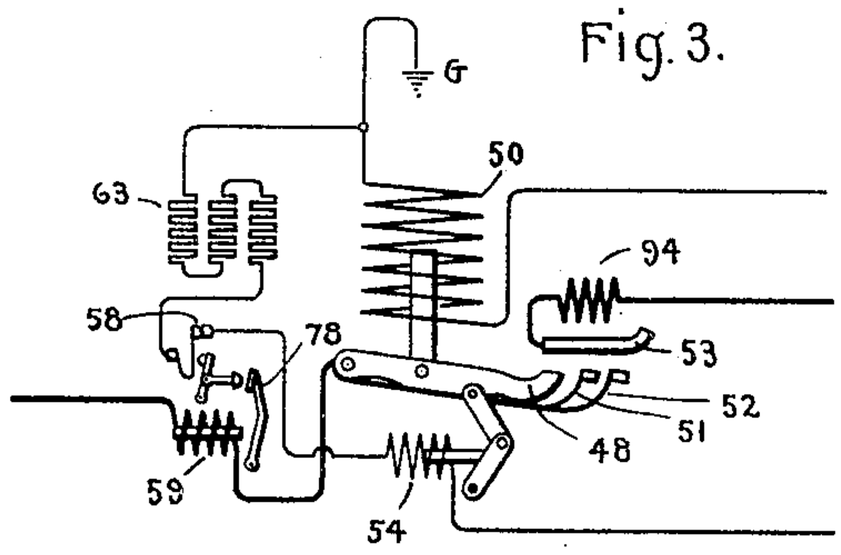
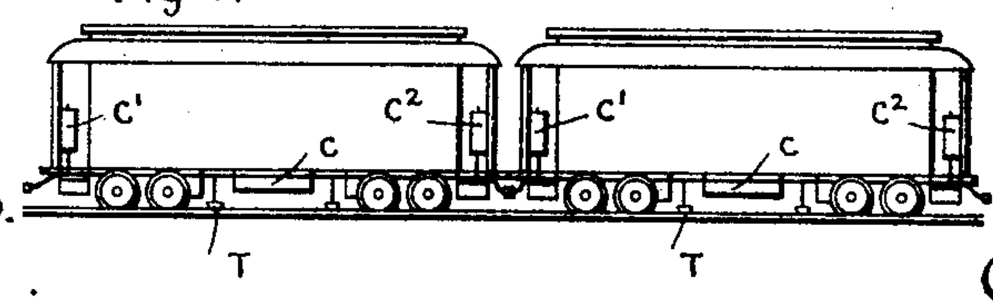


Fig. 4.



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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.

MEANS FOR CONTROLLING CIRCUIT-BREAKERS.

No. 801,238. Specification of Letters Patent. Patented Oct. 10, 1905.

Application filed August 8, 1904. Serial No. 219,864.

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 Means for Controlling Circuit-Breakers, of which the following is a specification.

My invention relates to means for controlling the operation of circuit-breakers, especially circuit-breakers of the type particularly adapted for use in systems of motor control.

In electrically-propelled railway-vehicles it has been customary to employ circuit-breakers which automatically open the motor-circuit whenever the current in said circuit rises above a predetermined value. These circuit-breakers are usually mounted under the hoods of the vehicle-platforms or adjacent to the controller within easy reach of the motorman, so that they can be reset by hand whenever they have operated. In motor-control systems as applied to electrically-propelled vehicles, and especially as applied to a plurality of electrically-propelled vehicles coupled together to form a train, there has been a tendency toward using larger and larger cars, which require considerable current to operate them. For the control of such heavy currents the automatic circuit-breakers must necessarily be made large and bulky, and it is objectionable to have said circuit-breakers located in the motorman's cab or under the hood covering the platform. Furthermore, as it is not advisable to employ a heavy bus-line or train-wire which will conduct the current for all the motors on the train through a single circuit-breaker located adjacent to the master-controller, from which the train is being at the time controlled by the operator, separate circuit-breakers should be provided to take care of the overload in the motor-circuits of each of the cars constituting the train, and it would cause considerable trouble and annoyance to be obliged to reset each of said circuit-breakers by hand when they operate automatically.

The object of my invention is to produce an efficient circuit-breaker-control system which is especially applicable for use in connection with systems of train control and simple in operation, which permits the circuit-breaker to be located at any desired point on the car or train adjacent to or remote from the controlling-point.

In carrying out my invention I employ a circuit-breaker provided with means adapted to be controlled from a distant point for setting it and also with normally energized means adapted to be controlled from a distant point for holding said circuit-breaker set and for tripping it.

My invention also comprises means operatively related to the hand-operated controlling device or master-controller whereby unless the master-controller is returned to its initial or "off" position or to such position that the motors will be properly protected by a resistance when the circuit-breaker is reset after it has operated the said circuit-breaker cannot be reset.

In the accompanying drawings, which illustrate the preferred embodiment of my invention, Figure 1 represents diagrammatically the equipment of a single car of a train-control system using a motor-controller of the separately-actuated contact type and equipped with my invention. Fig. 2 is a vertical section through my preferred form of circuit-breaker. Fig. 3 is a diagram of the circuit-breaker connections on a larger scale, and Fig. 4 illustrates diagrammatically a train of two motor-cars equipped with my invention.

Referring now to Fig. 1, the separately-actuated contacts 1 to 16, inclusive, of the motor-controller C are used for controlling the motors M' and M^2. The said motor-controller C is under the control of the master-controllers C' and C^2, 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 C^2 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 in 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 circuit with the motor M', the resistance-sections controlled by said contacts being repre-

sented 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 contact-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. 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 Patent No. 750,947, granted February 2, 1904, on an application filed by Frank E. Case. 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. The contact-arm 48 of the circuit-breaker B is attached to the core or plunger 49 of the actuating-solenoid 50. The said contact-arm comprises the brush-contact 71 and the auxiliary contacts 51 and 52, which, together with said brush-contact, are adapted to engage the fixed contact 53. The blow-out coil for the said circuit-breaker is indicated at 94. The circuit-breaker is set by an energization of the actuating-coil 50 and is held set by means of the normally energized holding-coil 54, the core of which is operatively connected to the toggle 56. The toggle 56 is not moved into straight line or buckled over center when the arm 48 is in its closed position. Therefore when the circuit through the holding-coil 54 is broken either at the switch 58, controlled by the overload-coil 59, or at the hand-operated switch 60, located adjacent to the master-controller, the circuit-breaker is tripped, and the arm 48 moves to open the circuit by gravity, assisted, if desired, by a spring or other mechanism. The circuit through the closing or setting coil, which is energized when it is desired to reset the circuit-breaker, is completed at the 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 resistance 63 is inserted in circuit with the holding-coil 54 for the purpose of cutting down the current which flows through said coil, very little current being required to hold the circuit-breaker set after it has been set by the momentary energization of the actuating-coil 50.

Referring now to Fig. 2, it will be seen that the circuit-breaker is mounted in a frame 64. The actuating-coil 50 is held in position between the heads 65 and 66, which are held firmly in the desired relative position by the rods 67 and are properly fastened in said frame. Projecting into the coil 50 and rigidly attached to the upper head 65 is a fixed core 49ª. The movable core 49 of said coil operates through an opening 68 in the lower head 66 and is pivoted to the contact-arm 48 at 69. The contact-arm 48 of the switch or circuit-breaker is pivoted to the frame 64 at 70 and is maintained normally in the open position by its own weight, assisted by the spring 57. The contact-arm 48 carries the brush-contact 71 and the auxiliary contact 51, which are adapted to engage the fixed contact 53. The said arm also has loosely pivoted to it at the point 72 the long auxiliary spring contact-finger 52, which is adapted to engage the carbon contact-block 73, carried by the fixed contact 53 and forming part thereof. The contact-finger 52 engages the block 73 before and leaves after the brush 71 makes and breaks contact with the fixed contact 53, and thereby bears the limit of the arc which tends to form when the circuit-breaker is tripped. The poles of the holding-magnet are indicated by 74 and 75 and when the holding-coil 54 is energized act upon the armature 76, carried by the upper toggle-link, to hold the toggle 56 in a position slightly removed from a straight line, as shown in Fig. 2. The pole 75 is an extension of the core 55, on which the coil 54 is mounted. The overload-coil 59 when energized by current in the motor-circuit magnetizes the core 77 and attracts the armature 78, pivoted in the frame 64 at 79. The strength of current at which the overload-coil 59 is adapted to operate to trip the circuit-breaker may be varied by adjusting the tension of the spring 81, which maintains the armature 78 normally in engagement with the stop 80. The upper end of the armature 78 is adapted to strike

the head of a bolt 82, reciprocally mounted in an opening 83 in the frame 64 and maintained in the position shown in Fig. 2 by means of the spring 84. Said bolt is pivoted at 86 to the lever-arm 85, pivoted to the frame 64 at 87. The arm 85 carries at its upper end a button 88, which rests against the spring contact-finger 89, one end of which is rigidly fastened at 90 and the other end of which engages with the fixed contact 91. The resistance 63 is mounted in a frame 92, attached to the back of the frame 64. The contacts of the circuit-breaker operate in a blow-out chute 93, one of the side plates of which has been removed to more clearly show the position of the contacts and the blow-out coil 94.

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 and the switch 60 is closed permanently. A circuit is thereby completed from the trolley T through the switch 60, thence through the switch 61 to contact-finger a^8, thence through the contact-segments d^8 and d^5, contact a^5, train-wire 21, resistance 43, auxiliary switch 38, auxiliary switch 40, through the actuating-coil 50 of the circuit-breaker to ground. The coil 50 is thus energized and the circuit-breaker is closed, being maintained in its closed position by the normally energized holding-coil 54, the circuit through which is controlled by the switch 60 and may be traced as follows: from trolley T through switch 60, train-wire 25, coil 54, switch 58, resistance 63 to ground. 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 the motor-controller and master-controller must be in their off position 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, a control-circuit is completed from the trolley through the 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 53, contact-arm 48, overload-coil 59, 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-coil 50 of the circuit-breaker is broken at the auxiliary switch 38, thereby disconnecting the train-conductor 21 from the core 50 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-finger 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, 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 48, overload-coil 59, 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 60, or automatically, by the operation of the over-

load-coil 59, or due to a loss of current in the motor-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.

Referring now to Fig. 3, which illustrates diagrammatically, on a larger scale, the circuit connections of the circuit-breaker, the motor-circuit is as follows: through the blow-out coil 94, fixed contact 53, contact-arm 48, and overload-coil 59. The actuating-circuit passes through the actuating-coil 50 and thence to ground at G. The holding-circuit passes through the holding-coil 54, switch 58, and resistance 63 to ground at G.

I do not claim, broadly, means for controlling the circuit-breaker from a distance nor the arrangement of motor-control apparatus which permits one of the control-conductors to be used for setting the circuit-breaker and which makes the operation of the setting means of the circuit-breaker dependent upon the position of the motor-controller, since these, among other features, form the subject-matter of an application of Frank E. Case, filed July 21, 1904, Serial No. 215,114. Neither do I claim the structural details of the circuit-breaker contact, since the mechanical construction of the circuit-breaker forms, among other features, the subject-matter of an application of Samuel B. Stewart, Jr., filed March 20, 1905, Serial No. 250,895.

Although I have herein shown a specific form of circuit-breaker embodying my invention as applied to an electric control system, I do not care to be limited thereto, as many modifications may be made and other actuating and controlling power may be substituted for that shown 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 combination, a circuit-breaker, means adapted to be controlled from a distance for setting said circuit-breaker, and normally energized means for holding said circuit-breaker set.

2. In combination, a circuit-breaker, means adapted to be controlled from a distance for setting said circuit-breaker, normally energized means for holding said circuit-breaker set, and means located at a distance for de-energizing said holding means to trip said circuit-breaker.

3. In combination, a circuit-breaker, a coil for setting said circuit-breaker, and a normally energized coil for holding said circuit-breaker set.

4. In combination, a circuit-breaker, a coil for setting said circuit-breaker, a normally energized coil for holding said circuit-breaker set, and a switch located at a distance for de-energizing said holding-coil to trip the said circuit-breaker.

5. In combination, an electric circuit, a circuit-breaker therein, a coil for setting said circuit-breaker, a normally energized coil for holding said circuit-breaker set, and means controlled by current in said circuit for de-energizing the holding-coil to trip said circuit-breaker.

6. In a circuit-breaker, means for setting the circuit-breaker, means for controlling the operation of said circuit-breaker-setting means from a distant point, a holding-coil for maintaining said circuit-breaker in its set position, and an overload-coil adapted to open the circuit through the holding-coil to permit the circuit-breaker to open.

7. In a circuit-breaker, means for setting the circuit-breaker, means for controlling the operation of said circuit-breaker-setting means from a distant point, a holding-coil for maintaining said circuit-breaker in its set position, an overload-coil adapted to open the circuit through the holding-coil to trip the circuit-breaker, and a switch in circuit with the holding-coil and located at a distant point for opening the circuit through said holding-coil to trip the circuit-breaker independent of the overload-coil.

8. In combination, a circuit-breaker, a coil for setting said circuit-breaker, a switch for completing the circuit through said setting-coil, a holding-coil for maintaining said circuit-breaker set, an overload-coil adapted to open the circuit through the holding-coil to trip the circuit-breaker, and a switch located at a distant point for opening the circuit through said holding-coil to trip the circuit-breaker independent of the operation of the overload-coil.

9. In a system of motor control, a motor-circuit, a motor-controller, a master-controller, a circuit-breaker, means for setting said circuit-breaker, and means for rendering said setting means inoperative when the master-controller is in any of its operative positions.

10. In a motor-control system, a motor-circuit, a motor-controller for the motor or motors in said circuit, a master-controller for said motor-controller, a circuit-breaker in said motor-circuit, means for setting said circuit-breaker, means for controlling the operation of said circuit-breaker-setting means, and means for preventing the setting of said circuit-breaker unless the master-controller is in its "off" position.

11. In a motor-control system, a motor-circuit, a motor-controller in said circuit, a master-controller, a circuit-breaker in said motor-circuit, means for setting said circuit-breaker, means for controlling the operation of said circuit-breaker-setting means, and means for preventing the setting of said cir-

cuit-breaker unless the motor-controller and master-controller are both in the "off" position.

12. In a motor-control system, a motor-controller of the separately-actuated-contact type, a master-controller, a circuit-breaker in the motor-circuit, setting means for said circuit-breaker, a plurality of conductors connecting the actuating means of the motor-controller contacts to the master-controller, auxiliary means attached to certain of said motor-controller contacts for connecting one of said conductors to the circuit-breaker-setting means when said motor-controller contacts are open and for connecting it to the actuating means of a motor-controller contact when said first-mentioned motor-controller contacts are closed, and means operatively connected to the master-controller whereby the circuit-breaker is prevented from being set when the motor-controller contacts are open unless the master-controller is in its "off" position.

13. In a train-control system, a plurality of motor-controllers, a master-controller, a plurality of circuit-breakers, means for setting said circuit-breakers, means for holding said circuit-breakers set, and means independent of the master-controller for controlling said holding means so that said circuit-breakers may be maintained set independently of the position of the master-controller and may be tripped at will.

14. In a train-control system, a plurality of motor-controllers, a master-controller, a plurality of circuit-breakers, a holding-coil for each circuit-breaker, a train-conductor to which said holding-coils are all connected, and means independent of the master-controller for controlling said train-conductor so that the circuit-breakers may be maintained set independent of the position of the master-controller and may be tripped at will.

15. In a train-control system, a plurality of motor-circuits, a plurality of motor-controllers for controlling the motor or motors in said circuits, a master-controller for said motor-controllers, a circuit-breaker in each of said motor-circuits, means for setting each circuit-breaker, means separate from said master-controller for controlling the operation of said setting means, and means for preventing the setting of said circuit-breakers unless the master-controller is in its "off" position.

In witness whereof I hereunto have set my hand this 5th day of August, 1904.

GEORGE H. HILL.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.