No. 817,720. PATENTED APR. 10, 1906.

H. W. LEONARD.

AUTOMATIC ELECTRIC CIRCUIT CONTROLLER.

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FIG. 1

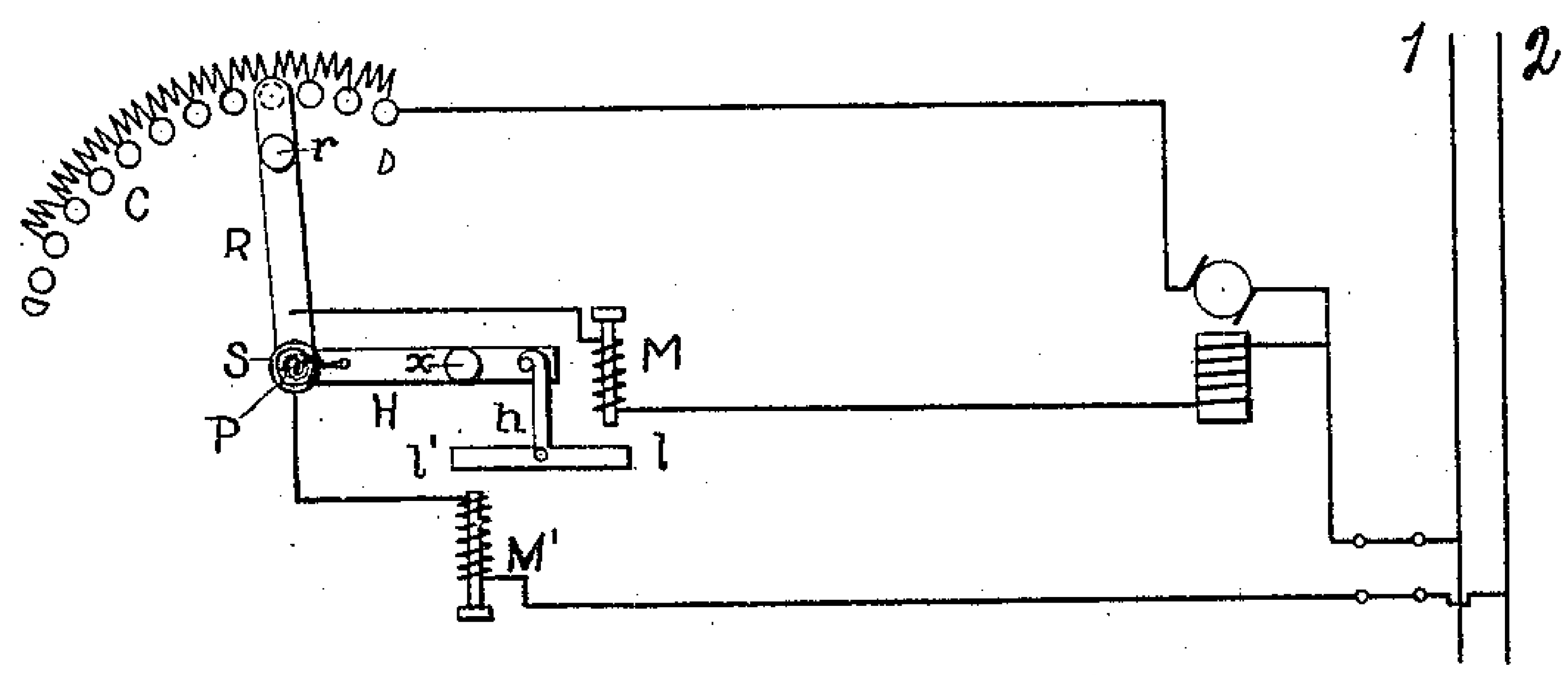
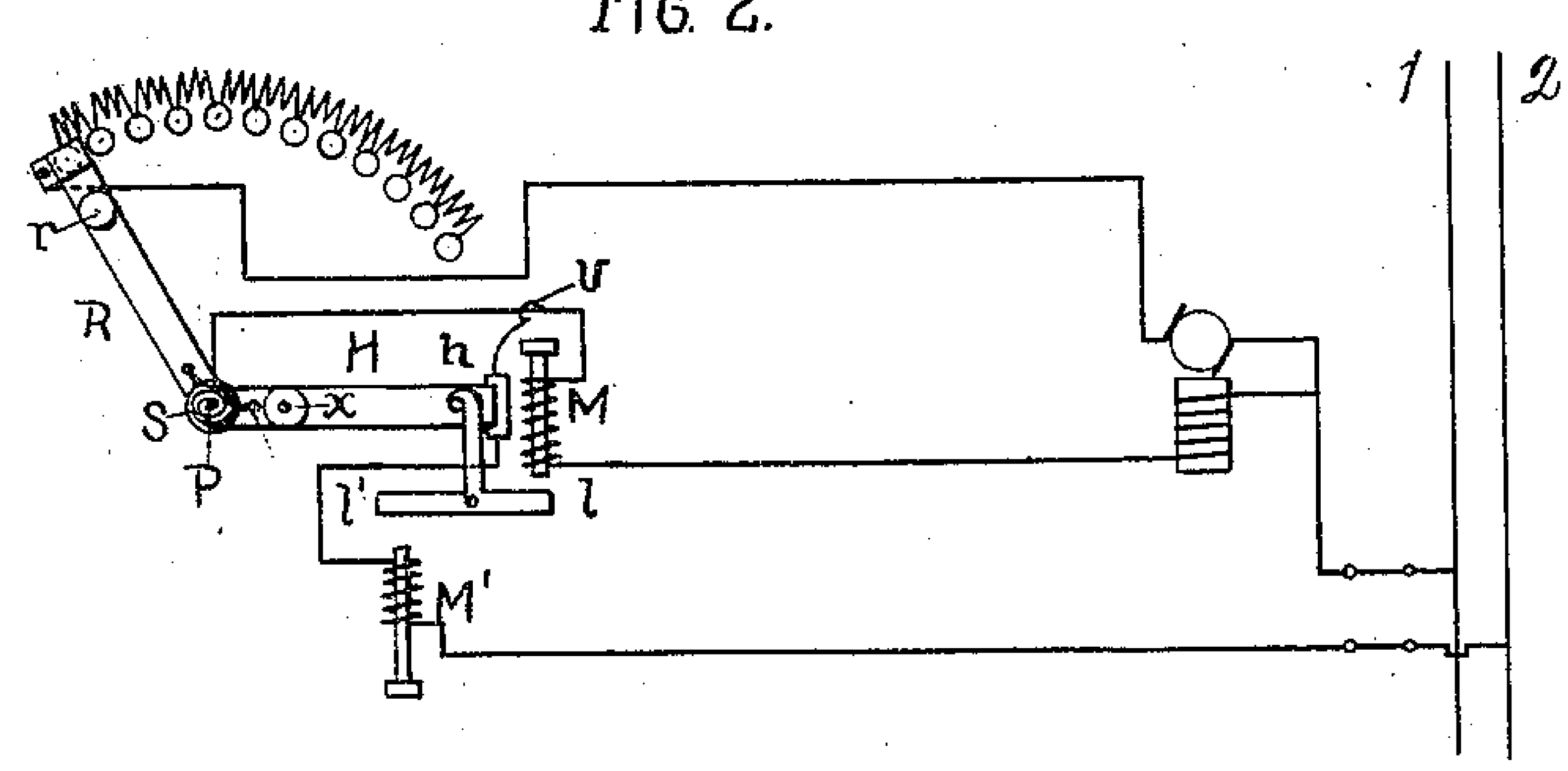


FIG. 2.



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AUTOMATIC ELECTRIC-CIRCUIT CONTROLLER.

No. 817,720. Specification of Letters Patent. Patented April 10, 1906.

Application filed January 26, 1903. Serial No. 140,506.

To all whom it may concern:

Be it known that I, HARRY WARD LEONARD, a citizen of the United States, and a resident of Bronxville, in the county of Westchester and State of New York, have invented a certain new and useful Improvement in Automatic Electric-Circuit Controllers, of which the following is a specification.

My invention relates to electrical-circuit-controlling devices provided with means for securing automatic operation under certain conditions in the circuit—such, for example, as "no voltage," "excessive current," &c.—and my invention relates more particularly to rheostats employed for starting and controlling the speed of electric motors.

In apparatus of this character it is desirable that the no-voltage device and the "overload" device should be independent of each other in their action, thus securing the greatest measure of reliability. It is also important that these two devices be so arranged that it will be impossible for the operator to manipulate them improperly. For example, in a rheostat it should be impossible for the operator to first cut out resistance and then close the circuit, making a short circuit. It is also important that the overload device should be free to respond to conditions of overload at all times, both while the controller is being operated and after it has been operated or adjusted.

In rheostats for controlling electric motors it is desirable to have a device which will automatically cause a change in the position of the contact-arms which will make necessary the movement of the rheostat switch-arm to its initial or starting position whenever a condition of no voltage occurs on the circuit of the motor, so that if the motor comes to rest and then the full electromotive force comes suddenly on the circuit again the motor and rheostat will be protected against an excessive current. It is also desirable to have the circuit protected by an automatic circuit-breaker which will open the circuit whenever from any cause the current exceeds a predetermined maximum.

By my invention I secure the features above stated, and my invention is illustrated in the accompanying drawings, in which—

Figure 1 is a diagrammatic view of a motor-speed-controlling rheostat and the circuit connections, and Fig. 2 is a diagrammatic view of a modified arrangement.

Referring to the drawings, 1 2 are the line conductors supplying a practically constant electromotive force.

R is the rheostat-switch, pivoted upon a stud P, which will be secured to a base of slate or other suitable insulating material, said switch being provided with the usual knob or handle *r* for moving it over the rheostat-contacts C. Since the rheostat illustrated in Fig. 1 of the drawings is one designed mainly for regulating the speed of electric motors or the energy delivered to other forms of translating devices, switch R is not provided with means for automatically restoring it to the initial or starting position, as is usual in motor-starting or similar rheostats which is the form shown in Fig. 2. Arm H is the hammer-blow arm and is normally held by a pivoted latch *h* against the action of spring S, one end of which is secured to arm H and the other end is secured to pivot P. M and M′ are two solenoids, and latch *h* is provided with two arms *l* and *l′*, with which the cores of solenoids M and M′ coöperate to release arm H. The current through the motor-armature passes from one supply-line, through the motor-armature and resistance, to arm R and then through the coil M′ to the other supply-line. The field-circuit of the motor includes the coil M, connection to arm R being indicated. When no voltage or a predetermined reduction in current passing through M occurs, the plunger or core of solenoid M falls and delivers a hammer-blow upon arm *l* of the latch, tripping the same and allowing the spring to throw arm H forward, causing its bumper *x* to strike arm R and return it to the initial position, where the circuit is opened. When overload occurs, the plunger or core of solenoid M′ rises and trips latch *h* by a hammer-blow on arm *l′*, the resulting action being the same as when no voltage occurs.

In the arrangement of Fig. 1 arm H carries no current and acts simply as the hammer for returning arm R to its initial or starting position. In Fig. 2 arm H is arranged to carry current, and for the purpose spring S has its end connected to the arms, as shown, so as to tend to drive them toward each other, and coil M′ instead of being connected to arm R or its pivot is connected to a

contact-plate U, with which arm H makes contact. By this arrangement when arm H is released it will break the circuit. To reset the controller, arm H is moved to its normal position by arm R through engagement with bumper *x*, and in doing so all resistance will be placed in circuit. In this construction under running conditions, as shown, the armature-current passes from one supply-line, through the motor-armature, to the final contact of the armature resistance, thence through arms R and H to contact U, through coil M′ to the other supply-line. Coil M′ will therefore act to protect the motor from abnormal overload-current.

I have shown the no-voltage winding as being in series with the shunt field-winding of a motor in both Fig. 1 and Fig. 2. In some instances this winding will be across the line, or it will be a series winding in series with the overload-winding, in which latter case it would be actuated by minimum current.

In using the term "circuit-controller" I intend to include any device which by its movement effects a change of condition in a circuit.

By the term "no-voltage electroresponsive device" I mean an electroresponsive device which is unaffected by the current passing through the translating device which is to be protected, but which responds to a condition of no voltage upon the translating device.

My invention may be embodied in a variety of modified forms of construction, and I do not wish or intend to be limited as to the scope thereof otherwise than as expressed in the following claims.

What I claim is—

1. In an automatic circuit-controller, the combination with a shunt-wound motor, a rheostat contact-lever, a spring-actuated arm, means which under normal conditions holds said arm in a definite position, and two electroresponsive devices arranged to release said arm under abnormal conditions, one of the said electroresponsive devices being responsive to the motor-armature current, and the other electroresponsive device being in series with the motor shunt-field, substantially as set forth.

2. In an automatic circuit-controller, the combination with a rheostat contact-lever, a spring-actuated arm, a pivoted locking device for said arm having two lateral arms, a solenoid whose core is normally up and arranged to drop on one of said arms to trip the locking device, a second solenoid whose core is normally down and arranged to strike a blow upon the other arm to trip said latch, substantially as set forth.

3. In an automatic circuit-controller, the combination with a rheostat contact-lever, a spring-actuated arm, a pivoted locking device for said arm having two lateral arms, a solenoid above one arm and whose core is normally up and arranged to drop on said arm to trip the latch, a second solenoid below the other arm and whose core is normally down and arranged to be drawn upward to strike the second arm of the latch to trip it, substantially as set forth.

4. In an automatic circuit-controller, the combination with a rheostat contact-lever, a spring-actuated hammer-arm, a locking device for holding said arm in its normal position, and two electroresponsive devices arranged to release said arm under abnormal conditions to impart a blow to the rheostat-lever and drive it to its starting position, substantially as set forth.

5. In an automatic circuit-controller, the combination with a rheostat contact-lever, a spring-actuated hammer-arm arranged to impart a blow to said rheostat-lever and drive it to the starting position, a pivoted locking device for said arm having two lateral arms, a solenoid whose core is normally up and arranged to drop on one of said arms to trip the latch, a second solenoid whose core is normally down and arranged to strike a blow upon the other arm to trip said latch, substantially as set forth.

6. In an automatic circuit-controller, the combination with a rheostat contact-lever, a spring-actuated arm pivotally connected thereto, a locking device for holding said arm in its normal position, and two independent electroresponsive devices for releasing said arm one of which responds to predetermined overload-current, and the other of which is independent of the current, and responds to abnormally low voltage, substantially as set forth.

7. In an automatic circuit-controller, the combination with a rheostat contact-lever, a spring-actuated arm pivotally connected thereto, a pivoted locking device for holding said arm in its normal position, and two independent electroresponsive devices for releasing said arm, one of which responds to predetermined overload-current, the other of which is independent of the current, and responds to abnormally low voltage, substantially as set forth.

8. An electric motor having a shunt field-winding, two switches in series with each other, and in series with the motor-armature, the first switch being a hand-actuated resistance-controlling switch, and the other switch being an automatic switch normally held closed against the action of a spring by a latch, a solenoid-magnet in series with the two switches and motor-armature which releases the latch on the occurrence of a predetermined overload-current, and a solenoid having a plunger which acts directly upon the same latch on the occurrence of "no current" substantially as set forth.

9. An electric motor having a shunt field-

winding, two pivotally-connected switches in series with each other and in series with the motor-armature, the first switch being a hand-actuated resistance-controlling switch, mechanical restraining means for normally holding the other switch closed against the action of a force, a magnet in series with the two switches and the motor-armature which releases the said restraining means on the occurrence of a predetermined overload-current, and electroresponsive means which releases the same restraining means on the occurrence of abnormally-reduced voltage.

10. A constant electromotive-force-supply current, and two pivotally-connected switches in series across the said constant electromotive-force circuit, one switch being a resistance-controlling switch, and the other switch being an automatic circuit-breaker responsive to independent magnetic means, the said means acting upon overload and no-voltage conditions in the circuit respectively.

11. An automatic circuit-breaker having in combination, a switch, a spring constantly tending to open the switch, a latch for normally maintaining the switch closed against the action of the spring, and two solenoids, the plungers of which act directly upon the said latch to release it one upon the occurrence of a predetermined overload-current, and the other upon the occurrence of "no voltage," substantially as set forth.

12. An automatic circuit-breaker having in combination a switch acted upon by a force tending to open the switch, mechanical restraining means for normally maintaining the switch closed against the action of the force, and two electroresponsive devices, one of which releases the restraining means on a predetermined overload-current, and the other upon the occurrence of an abnormal reduction in voltage, and a hand-actuated resistance-controlling switch which, when it is moved in the direction of inserting resistance, closes the circuit-breaker.

13. A shunt-wound electric motor, an automatic switch in series with the armature of the motor normally acted upon by a force constantly tending to open said switch, mechanical restraining means for holding said switch closed against the action of said force, electroresponsive means in series with the motor-armature which, upon the occurrence of a predetermined overload-current releases the said restraining means, electroresponsive means in series with the shunt field-winding of the motor which releases the said restraining means upon abnormal diminution of current in the motor shunt field-winding, and a resistance-controlling switch in series with said automatic switch and with the motor-armature, the two switches being so arranged that the resistance-controlling switch must be placed in a protective position before the automatic switch can be closed.

14. An electric motor connected to a constant electromotive-force-supply circuit, an automatic circuit-breaker in series with the armature of the motor and having in combination a switch, a spring constantly tending to open the switch, a latch for normally maintaining the switch closed against the action of the spring, and two solenoids, the plungers of which act directly upon the said latch to release it, one solenoid being responsive to excessive current through the motor-armature, and the other solenoid being responsive to abnormally low voltage at the armature-terminals, substantially as set forth.

15. A source of practically constant electromotive force, an automatic switch in series therewith, a spring tending constantly to open said switch, a latch which normally holds said switch closed, and two independent electroresponsive devices having plungers which act directly upon said latch, one of which releases said latch and thereby causes the opening of the automatic switch, when an excessive current is passed through the said switch, and the other of which releases the said latch, and thereby causes the opening of the automatic switch whenever the line electromotive force becomes abnormally low, substantially as set forth.

16. The combination with a motor having a field-winding energized by a current independent of its armature-current, of a resistance-controlling switch, an automatic switch normally acted upon by a force tending to move it, means which under normal conditions holds said automatic switch in a definite position, and two electroresponsive devices arranged to release said automatic switch under abnormal conditions, one of said electroresponsive devices being responsive to current in the motor-armature and the other electroresponsive device being dependent for its action upon current in the field-circuit of the motor.

17. The combination with a motor having a field-winding energized by a current independent of its armature-current, of a resistance-controlling switch, an automatic arm acted upon by a force tending to move it, means for holding said arm under normal conditions in a definite position, and two independent electroresponsive devices arranged to release said arm upon conditions of no voltage and overload-current respectively.

18. An electric motor having a shunt field-winding, two switches in series with each other and with the motor-armature, the first switch being a hand-actuated resistance-controlling switch, and the other switch being an automatic switch normally held closed against the action of a force, means for holding said automatic switch closed, a magnet in series with the two switches and motor-armature for releasing the said means on the occurrence of a predetermined overload-current, and a

magnet having a movable element affected thereby, which element acts directly upon the said means upon predetermined reduction of current in said magnet.

19. An automatic circuit-breaker having in combination a switch, a spring constantly tending to open said switch, a latch for normally maintaining the switch closed against the action of said spring, and two magnetic devices which act directly upon the said latch to release it, one upon the occurrence of a predetermined overload-current, and the other upon the occurrence of no voltage.

20. An electric motor having a field-winding energized by a current independent of its armature-current, a supply-circuit of constant electromotive force, an automatic switch in series with the armature of the motor, mechanical restraining means for normally holding said switch closed against a force constantly tending to move said switch, electroresponsive means in series with the motor-armature which upon predetermined overload-current releases said restraining means, electroresponsive means responding independently of the armature-current for releasing said restraining means upon abnormal conditions in the supply-circuit, and a spring-actuated resistance-controlling switch, which when moved in the direction of inserting resistance closes the said automatic switch.

21. An electric motor and constant-electromotive-force-supply circuit, an automatic circuit-breaker in series with the armature of the motor and having in combination a switch, a spring constantly tending to open the switch, a latch for normally maintaining the switch closed against the action of the spring, and two electromagnetic devices which act directly upon the said latch to release it, one of said devices being responsive to excessive current to the motor-armature, and the other of said devices being responsive to abnormally low voltage at the armature-terminals.

22. A source of practically constant electromotive force, an automatic switch in series therewith acted upon by a force tending to open the same, mechanical restraining means for normally holding said switch closed, and two independent electroresponsive devices having plungers which act directly upon said restraining means, one of which releases said restraining means when an excessive current is passed through the said switch, and the other of which releases the said restraining means when the line electromotive force becomes abnormally low.

23. In an automatic circuit-controller, the combination with a resistance-controlling switch, of a spring-actuated hammer-arm, a locking device for holding said arm in its normal position, and two electroresponsive devices arranged to release said arm under abnormal conditions to impart a blow to the said switch and drive it to its starting position.

24. In an automatic circuit-controller, the combination with a switch, of a spring-actuated hammer-arm, mechanical restraining means for holding said arm in its normal position, and an electroresponsive device for releasing said arm upon the occurrence of abnormal no voltage in the circuit to impart a blow to move said switch.

25. In an automatic circuit-controller, the combination with a switch, of a spring-actuated hammer-arm, mechanical restraining means for holding said arm in its normal position, and an electroresponsive device for releasing said arm upon the occurrence of either of two different abnormal conditions of the circuit to impart a blow to move said switch.

26. In an automatic circuit-controller, the combination of a resistance and a resistance-controlling switch, a spring-actuated hammer-arm, mechanical restraining means for holding said arm in its normal position, and an electroresponsive device for releasing said arm upon the occurrence of either of two different abnormal conditions of the circuit to impart a blow to move said switch.

27. The combination of an electric motor, an armature resistance, a resistance-controlling switch, a spring-actuated hammer-arm, mechanical restraining means for holding said arm in its normal position, and an electroresponsive device for releasing said arm upon the occurrence of either of two different abnormal conditions of the motor-circuit.

28. A constant-electromotive-force-supply circuit, an electric motor, a switch for controlling the armature-circuit, a movable arm, means for normally holding said arm in a fixed position and for releasing said arm on the occurrence of no voltage and overload-current, means for moving said arm when so released and causing the same to engage said switch and move the latter to a protective position.

29. A constant-electromotive-force-supply circuit, an electric motor, a variable resistance in circuit with one element of said motor, a switch for controlling the said resistance, a movable arm, means for normally holding said arm in a fixed position and for releasing said arm on the occurrence of no voltage and overload-current, means for moving said arm when so released and causing the same to engage said switch and move the latter to a protective position.

30. In an automatic circuit-controller, two pivotally-connected arms, one of said arms being a resistance-controlling arm which can be moved to a position so as to include any desired portion of resistance, the other arm being a spring-actuated arm normally held in a certain position, two electro-

responsive devices affecting the release of the said spring-actuated arm under different abnormal conditions, and means whereby the said spring-actuated arm when released moves the resistance-controlling arm.

31. The combination of an electric motor, two pivotally-connected arms, one being a resistance-controlling arm which can be moved to a position so as to include any desired portion of resistance, the other arm being a spring-actuated arm normally held in a certain position, two electroresponsive devices affecting the release of the said spring-actuated arm under abnormal conditions, one of said devices being connected in series with the motor-armature and the other of said devices in series with the motor-field, and means whereby the said spring-actuated arm when released moves the resistance-controlling arm.

32. The combination of an electric motor, two pivotally-connected arms, one being a resistance-controlling arm which can be moved to a position so as to include any desired portion of resistance, the other arm being a spring-actuated arm normally held in a certain position, two electroresponsive devices affecting the release of the said spring-actuated arm under abnormal conditions, one of said devices being connected in series with the motor-armature, and the other of said devices being connected in a circuit independent of the armature-current, and means whereby the said spring-actuated arm when released moves the resistance-controlling arm.

33. The combination of two pivotally-connected movable electric-circuit-controlling elements, and means for automatically controlling one of said elements, said means comprising two electroresponsive devices which respond independently of each other.

34. The combination of a circuit-controlling element, means for automatically controlling the movement of said element comprising two electroresponsive devices which respond independently of each other, and a second movable element through the movement of which said first-named element is caused to assume its normal operative position.

35. The combination of an electric motor having a field-winding energized by a current independent of its armature-current, two independently-movable switches in series with each other and with the motor-armature, a single means for controlling the closing movement of said switches, and means for controlling the automatic movement of one of said switches comprising two electroresponsive windings, one of said windings being in series with the motor-armature and the other of said windings being in series with said field-winding.

36. The combination of a motor having a field-winding energized by a current independent of its armature-current, two switches in series with the motor-armature, means whereby said switches can be closed only in definite sequence, and means for causing the automatic protective movement of one of said switches comprising two electroresponsive windings, one of said windings being in series with the motor-armature and the other in series with said field-winding.

37. The combination of two independently-movable switches in series with each other, a single means for controlling the closing movement of said switches, and means protectively related to one of said switches comprising two independent electroresponsive windings.

38. The combination of an electric motor, an automatic switch in series therewith, a non-automatic switch also in series therewith whose movement effects the closing of said automatic switch, and means for automatically and independently protecting the circuit under two different abnormal conditions, said means comprising two independent electromagnetic windings.

39. The combination of a controlling-switch, a mechanical detent for holding said switch in its restrained position, a current-controlling device the movement of which effects the movement of said switch to its restrained position, and two electroresponsive devices for effecting the release of said restraining means upon the occurrence of abnormal current and voltage.

40. The combination of an electric motor, a protective switch, a mechanical detent for holding said switch in a restrained position, a current-controlling device the movement of which effects the closure of said switch, and means for automatically protectively controlling said detent comprising two electroresponsive windings, one of said windings being in series with the motor-armature and the other of said windings being in a circuit other than that of said motor-armature.

41. The combination with an automatic circuit-breaker comprising two independently-functioning electroresponsive windings controlling the automatic operation of the circuit-breaker in response to two different circuit conditions, of a current-controlling device by the operation of which the closure of said circuit-breaker is effected.

42. The combination of an electric motor, an automatic circuit-breaker and a resistance-controlling switch in series therewith, means for effecting the closure of the circuit-breaker by the movement of said switch, and means for effecting the automatic opening of the circuit-breaker when the current through the motor-armature exceeds a certain amount and when the supply electromotive force becomes abnormally low, said means comprising two electroresponsive wind-

ings each having a magnetic mass moved by the resultant effect of gravity and magnetism.

43. The combination with an automatic circuit-breaker comprising two electromagnetic windings, each of said windings having a magnetic mass automatically movable under the resultant influence of magnetism and gravity, of a current-controlling device independently movable and by the movement of which the circuit-breaker is moved to its normal protective position.

This specification signed and witnessed this 16th day of January, 1903.

H. WARD LEONARD.

Witnesses:
BESSIE DEVINE,
KATE HYLAND.