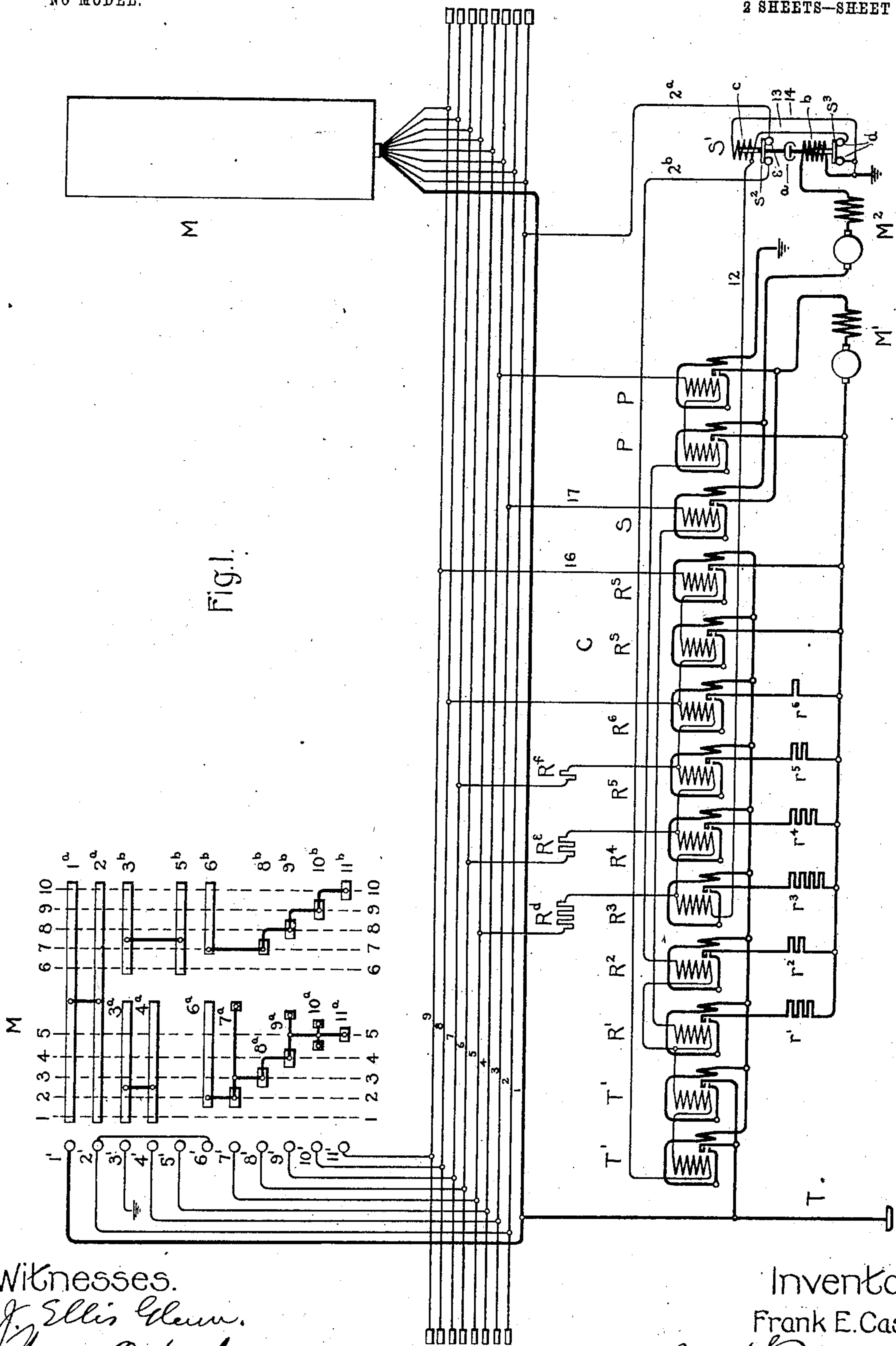


F. E. CASE.
SYSTEM OF MOTOR CONTROL.

APPLICATION FILED APR. 24, 1902.

NO MODEL.

2 SHEETS—SHEET 1.



Witnesses.
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Allen Oxford

Inventor:
Frank E. Case
by *Allen Oxford*
Atty.

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2 SHEETS—SHEET 2.

NO MODEL.

Fig. 2

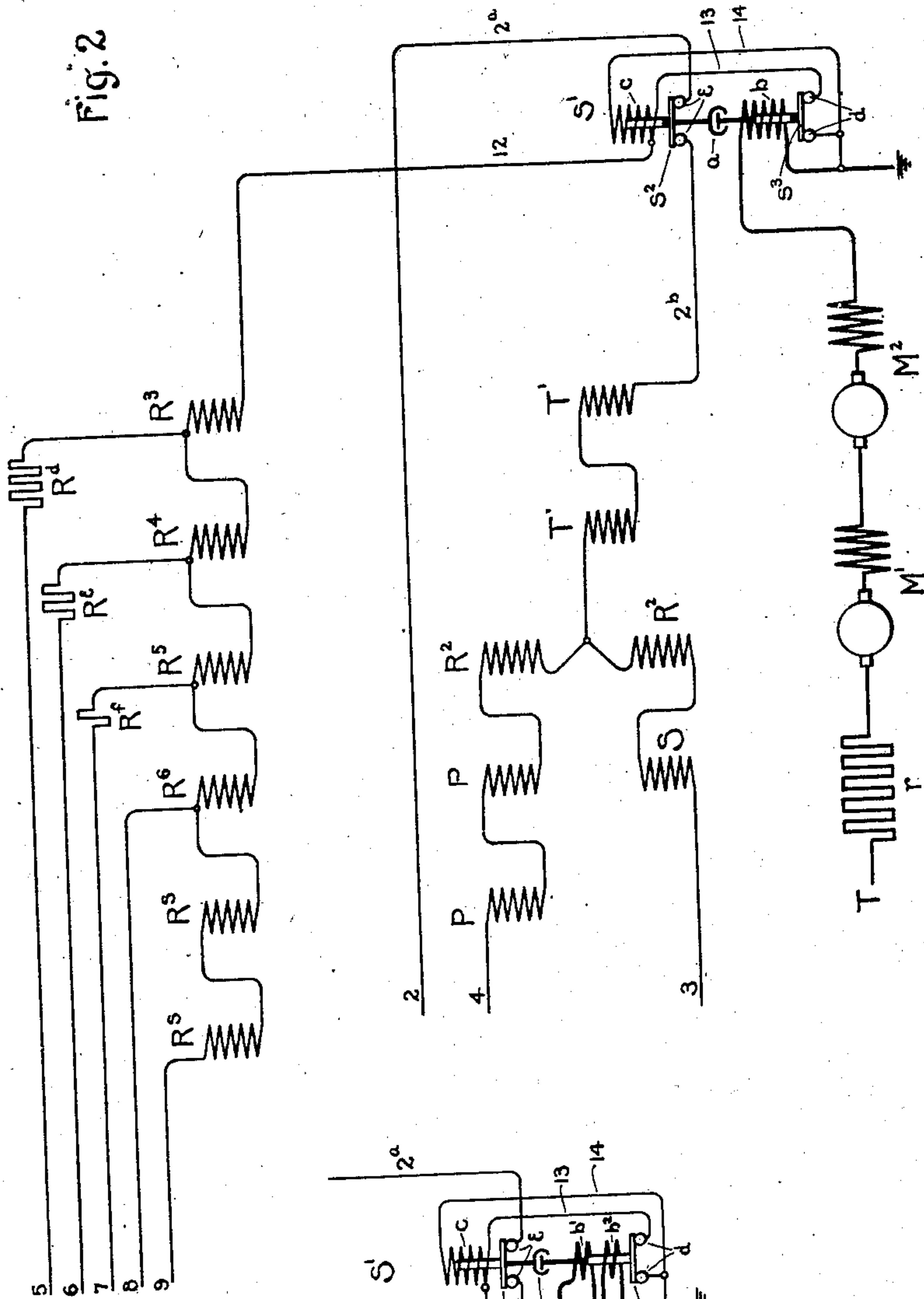
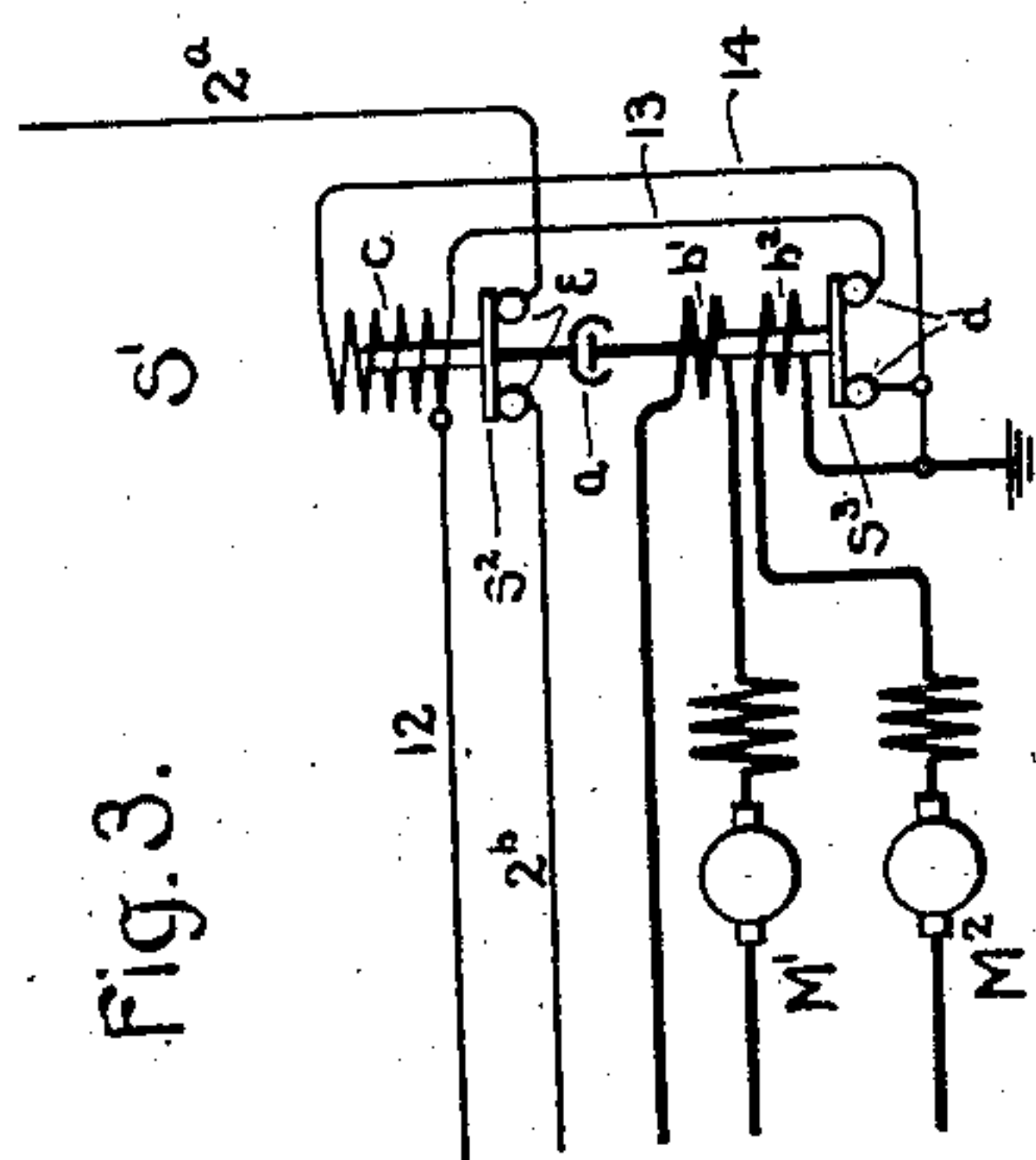


Fig. 3.



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UNITED STATES PATENT OFFICE.

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

SYSTEM OF MOTOR CONTROL.

SPECIFICATION forming part of Letters Patent No. 730,342, dated June 9, 1903.

Application filed April 24, 1902. Serial No. 104,479. (No model.)

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 Systems of Motor Control, of which the following is a specification.

My present invention relates to means for opening a motor or other circuit automatically whenever the current in said circuit reaches a predetermined limit, and is especially designed for systems in which the contacts which control the flow of current through the motor-circuits are electromagnetically operated through circuits connected to a master-controller located at any desired point. Such systems are now extensively used for controlling the propelling-motors on the several motor-cars of an electrically-operated train, and my invention is especially valuable in such connection, since it permits the motor-circuits to be opened at the controller-contacts on any car upon which an excessive flow of current occurs without affecting the circuit connections of the motor equipments on the other cars of the train and at the same time permits the motor-circuit to be again immediately closed as soon as the master-controller has been moved back to a position where a protecting resistance will be included in a motor-circuit.

My invention will be better understood by reference to the following description, taken in connection with the accompanying drawings, while its scope will be pointed out in the appended claims.

In the drawings, Figure 1 is a diagrammatic representation of the elements comprised in the equipment of one of the motor-cars of a train-control system, showing the manner in which the present invention may be applied to such a system. Fig. 2 is a diagrammatic representation of a portion of the control-circuits of the same system on a larger scale, showing more clearly the connections of the train-conductors to the actuating-windings for the controller-contacts and the relation of my invention thereto; and Fig. 3 is a diagrammatic representation of a modified form of connections.

In each of the figures similar reference char-

acters are used to designate corresponding parts.

In Fig. 1 the letters T, T', R', R², R³, R⁴, R⁵, R⁶, R^s, R^s, S, and P P indicate the various elements of a series-multiple controller C of the separately-actuated contact type. Each of these elements comprises a pair of switch-contacts connected to a power-circuit through which current flows from the trolley-shoe T to the motors M' and M² and thence to ground. The various control-circuits are connected to the train-conductors 2 to 9, inclusive, and each leads through certain of the actuating-windings of the controller C to ground. Trolley-current for operating the various controller-contacts is obtained through the conductor 1, which is directly connected to the trolley-shoe T. Connection between this conductor and the other conductors of the system to which the various control-circuits are connected is controlled through one of the master-controllers M, located at any desired point on the train. Preferably each motor-car is provided with two master-controllers, one located at each end. Of the two master-controllers shown in Fig. 1 of the drawings the one on the right is shown in outline only, while the one on the left is shown with its fixed and movable contacts developed on a plane surface in a manner now commonly used in illustrating such a structure. r' to r⁶, inclusive, represent resistance inserted in the motor-circuit, while R^d, R^e, and R^f represent resistance inserted in the master-controller circuit. The construction and arrangement of the several elements of the controller and the connections of the motor and master-controller circuits thereto constitute no part of the present invention. A more detailed description of the controller and connections herein shown is contained in the patent to Perry, No. 687,060, granted November 19, 1901.

My present invention comprises additional features especially designed for use in connection with a system of the character above described and in one of its aspects consists in combining with a system of the character described a device which will secure the opening of the motor-circuits at the controller-contacts whenever the current in the motor-

circuits rises above a predetermined limit and which will permit the closing of the same immediately as soon as the master-controller has been moved back to a point where a resistance sufficient to protect the motors when the circuit is again closed will be included in the said circuit.

In another aspect my invention consists in providing a motor-control system, which may be of any type whatsoever, with means which will operate automatically upon an excessive load of current to open the motor-circuit in case the controller is in a "low-resistance" or "running" position, but which will not operate when the controller is in an initial or "high-resistance" position. I thus am enabled to obtain the large current necessary for rapidly accelerating a heavy car or train at starting without danger of automatically opening the motor-circuit, while when the controller is moved forward into a running position the circuit-breaking means becomes immediately operative to open the motor-circuit in case of an excessive flow of current.

The circuit-opening device or relay is designated as a whole by S' , and, as shown in the drawings, is made up of the switch s^2 and the switch s^3 , connected together by the lost-motion connection a . The solenoid b , which is connected in the main power or motor circuit, actuates the switch s^3 whenever the said circuit becomes overloaded. The solenoid c , which is connected in the second master-controller circuit, actuates the switch s^2 . The solenoid b operates to open a shunt-circuit which is normally closed around the solenoid c at the contacts d , thus causing current to flow through the solenoid c , energizing said solenoid and operating the switch s^2 to open the first master-controller circuit which controls the circuit connections of the motors at the contacts e . The actuating-coils of the circuit-controlling elements of the motor-controller C are thus deenergized and the main power-circuit is opened at the points which they control. The solenoid c remains energized, thus maintaining the switches s^2 and s^3 open through the agency of the lost-motion connection a after the solenoid b has become deenergized until the master-controller has been returned to its first operative position, or if the motors are running in multiple to its first multiple position, at which time the circuit through the conductor 12 is broken and the relay S' is permitted to close automatically through the action of gravity. The relay S' may be assisted in closing by springs or weights and may be set to operate at any predetermined amount of current.

The operation of the device herein shown is as follows: Let us assume that the master-controller is in its second series position (indicated by 2 2) on the development of the master-controller in Fig. 1. The first master-controller circuit may be traced from trolley T through conductor 1, fixed contact $1'$, movable contacts 1^a and 2^a in the master-con-

troller M , train-conductor 2, conductor 2^a , contacts e of the switch s^2 , conductor 2^b , actuating-coils of the controller elements T' T' R' S , conductor 17, train-conductor 3, contacts $4'$, 4^a , 3^a , and $3'$ to ground in the master-controller M . The second master-controller circuit branches from the fixed contact $2'$ to contact $6'$, movable contacts 6^a and 7^a to $7'$, train-conductor 5, resistance R^d , actuating-coil of element R^3 , conductor 12, shunt 13 around the solenoid c , through the contacts d of the switch S^3 to ground. The main power-circuit may be traced from trolley T through the proper elements of the controller C , motors M' and M^2 , solenoid b to ground. So long as only the first master-controller circuit is closed the relay or circuit-opening device remains inoperative, for the reason that no current is flowing through the short circuit around the solenoid c ; but as soon as the master-controller has been moved into its second or any succeeding series position current is caused to flow through the conductor 12, and if now the motors M' and M^2 should become overloaded or an excess of current should for any reason flow through the motor-circuit the solenoid b would operate to open the switch s^3 . Through the agency of the lost-motion connection a the opening of the switch s^3 will not act mechanically to open the switch s^2 ; but since the switch s^3 controls the shunt 13 around the solenoid c it will be seen that the solenoid c will become energized, current flowing in the second controller-circuit through conductor 12, solenoid c , conductor 14 to ground. The first controller-circuit will be opened at the contacts e of the switch s^2 , and therefore the main power-circuit will be opened at the main controller C . It will be seen that only a slight movement of the switch s^3 is required to operate the circuit-opening device, since there will be little or no sparking at the contacts d of the switch s^3 . On this account the relay S' may be very delicately adjusted to operate between narrow limits.

It will be noted that whenever the master-controller is brought back to its first operative position the circuit-opening device or relay will be reset and also (which is another way of stating the same thing) that the circuit-breaker will not operate to drop the contacts of the main controller elements upon excessive flow in the motor-circuits until the master-controller has been moved into the second or some one of its succeeding positions. This results from the fact that the circuit in which the actuating coil or solenoid c of the circuit-breaker or relay is included is the second control-circuit, which is not closed until the master-controller has been moved into its second position.

In Fig. 3 I have shown the solenoid b divided into two parts b' and b^2 , one part, b' , being in series with the motor M' and the other part, b^2 , in series with the motor M^2 . By this arrangement an overload on either the

motor M' or the motor M², whether the motors are connected in series or in parallel, will operate to open the motor-circuit through the relay S'; otherwise the operation of the modification shown in Fig. 3 is the same as that above described with reference to Figs. 1 and 2.

I have shown my invention as applied to a train-control system, but do not intend to limit myself to such a system, as the invention is equally applicable to any system in which it is desirable to open a main power-circuit by opening an auxiliary controlling-circuit upon an overload in said main power-circuit, and though in the system which I have illustrated the circuit-opening device is inoperative only in the first series and the first multiple positions of the controller it will be understood that my invention is not limited to this particular arrangement, it being only necessary that the device shall be operative in the running positions of the controller and inoperative in such other positions as the particular conditions in the system under consideration may determine. Many changes may also be made in the system as a whole and in the details of construction without departing from the spirit and scope of my invention.

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

1. In combination, in a motor-control system, automatic means for securing the opening of the motor-circuit upon an abnormal flow of current therein, and means for rendering the same inoperative when a resistance sufficient to protect the motor is included in the motor-circuit.

2. In combination, in a motor-control system, a controller, a device for securing the opening of the motor-circuit upon an abnormal flow of current therein, means for causing said device to operate when the controller is in a low-resistance or "running" position, and means for preventing the operation of said device when the controller is in a high-resistance position.

3. In combination, in a motor-control system, a motor-controller, a master-controller for controlling the operation of said motor-controller, a device for securing the opening of the motor-circuit upon an abnormal flow of current therein, and means for rendering said device inoperative when the master-controller is in an initial or high-resistance position.

4. In combination, an electric motor or motors, a controlling device therefor, electromagnetic means for actuating said controlling device, a source of current-supply for said electromagnetic means, an electromagnetic circuit-opening device in circuit with said source, a shunt-circuit around the actuating-coil of said circuit-opening device, and means controlled by the current in the motor-circuit for opening said shunt-circuit to actuate said circuit-opening device.

5. In combination, an electric motor or mo-

tors, a controlling device therefor, a source for supplying current to actuate said controlling device, a master-controller controlling the application of current from said source, a circuit-opening device in circuit with said source, means controlled by the current in the motor-circuit for actuating said circuit-opening device, and means whereby the said circuit-opening device will be immediately closed when said master-controller has been returned to an initial or high-resistance position.

6. In combination, a controlling device for electric motors, electromagnetic means for operating said device, a source of current-supply, a master-controller for controlling the supply of current from said source to said electromagnetic means, a circuit-opening device in circuit with said source and said master-controller, automatic means for actuating said circuit-opening device to cut off the supply of current to said electromagnetic means thereby opening the motor-circuit at the said motor-controlling device, and means whereby the said circuit-opening device will be immediately closed when the said master-controller has been returned to an initial or high-resistance position.

7. In combination, a main circuit, a controller in said main circuit, electromagnetic means for operating said controller, a control-circuit for said electromagnetic operating means, an electromagnetic circuit-opening device in said control-circuit, a shunt-circuit around the actuating-coil of said circuit-opening device, and means actuated by an excess of current in said main circuit for automatically opening said shunt-circuit.

8. In combination, a main circuit, a controller for said circuit, a control-circuit for said controller, an electromagnetic circuit-opening device in said control-circuit, means for operating said circuit-opening device upon an excess of current in said main circuit, and means whereby the said circuit-opening device will be immediately closed as soon as the controller has been moved to an initial or high-resistance position.

9. In combination, a main circuit, a controller in said circuit, a control-circuit for said controller, a master-controller and an automatically-resetting circuit-opening device in said control-circuit, means for actuating said circuit-opening device upon an overload in said main circuit, and means for preventing said circuit-opening device from resetting until said master-controller has been returned to an initial or high-resistance position.

10. In combination, a main circuit, a controller in said circuit comprising separately-actuated contacts, electromagnets for operating said contacts, a master-controller, a plurality of control-circuits connecting said master-controller with said controller, an automatically-resetting circuit-opening device in one of said control-circuits, an actuating-coil therefor in another of said control-cir-

5 cuits, a shunt around said actuating-coil, a switch in said shunt, and a solenoid in said main circuit for opening said switch to actuate said circuit-opening device on an overload in said main circuit.

11. In combination, a motor-circuit, a motor or motors, a controlling device comprising separately-actuated contacts, electromagnets for actuating said contacts, a controlling-circuit for part of said electromagnets, a circuit-opening device in said circuit, a second control-circuit for the remainder of said electromagnets, an actuating-coil for the circuit-opening device in said circuit, a shunt around 15 said coil, a switch in said shunt and a solenoid in said motor-circuit for actuating said switch on an overload in said motor-circuit.

12. In combination, a main circuit, a control-circuit, an electromagnetic circuit-opening device in said control-circuit, a shunt 20 around the actuating-coil of said circuit-opening device, a switch in said shunt, a mechanical connection between said switch and said circuit-opening device, means in said 25 main circuit for opening said switch upon an overload in said main circuit, and means for preventing the closing of said shunt-switch until said circuit-opening device has been closed.

30 13. In combination, a circuit to be controlled, a controller comprising separately-actuated contacts, electromagnets for controlling the operation of said contacts, a control-circuit for securing the operation of cer-

tain of said contacts to close the circuit to be 35 controlled through a high resistance, another control-circuit for securing the operation of other contacts to reduce the resistance in the circuit to be controlled, a circuit-opening device included in the first control-circuit, an 40 operating-winding therefor, and means for including said winding in the second control-circuit upon the occurrence of an abnormal flow of current in the circuit to be controlled.

14. In combination, a motor-circuit, a controller therefor comprising separately-actuated contacts, electromagnets for controlling the operation of said contacts, a control-circuit for securing the operation of certain of 45 said contacts to close the motor-circuit through a high resistance, another control-circuit for securing the operation of other contacts to reduce the resistance in the motor-circuit, a circuit-opening device included in the first 50 control-circuit, an operating-winding therefor, means for including said winding in the second control-circuit upon the occurrence of an abnormal flow of current in the motor-circuit, and a master-controller for controlling 55 the supply of current to the said control-circuits. 60

In witness whereof I have hereunto set my hand this 23d day of April, 1902.

FRANK E. CASE.

Witnesses:

BENJAMIN B. HULL,
HELEN ORFORD.