No. 679,362. Patented July 30, 1901.

F. E. CASE.

ELECTRIC BRAKE.

(Application filed July 17, 1897.)

(No Model.) 4 Sheets—Sheet 1.

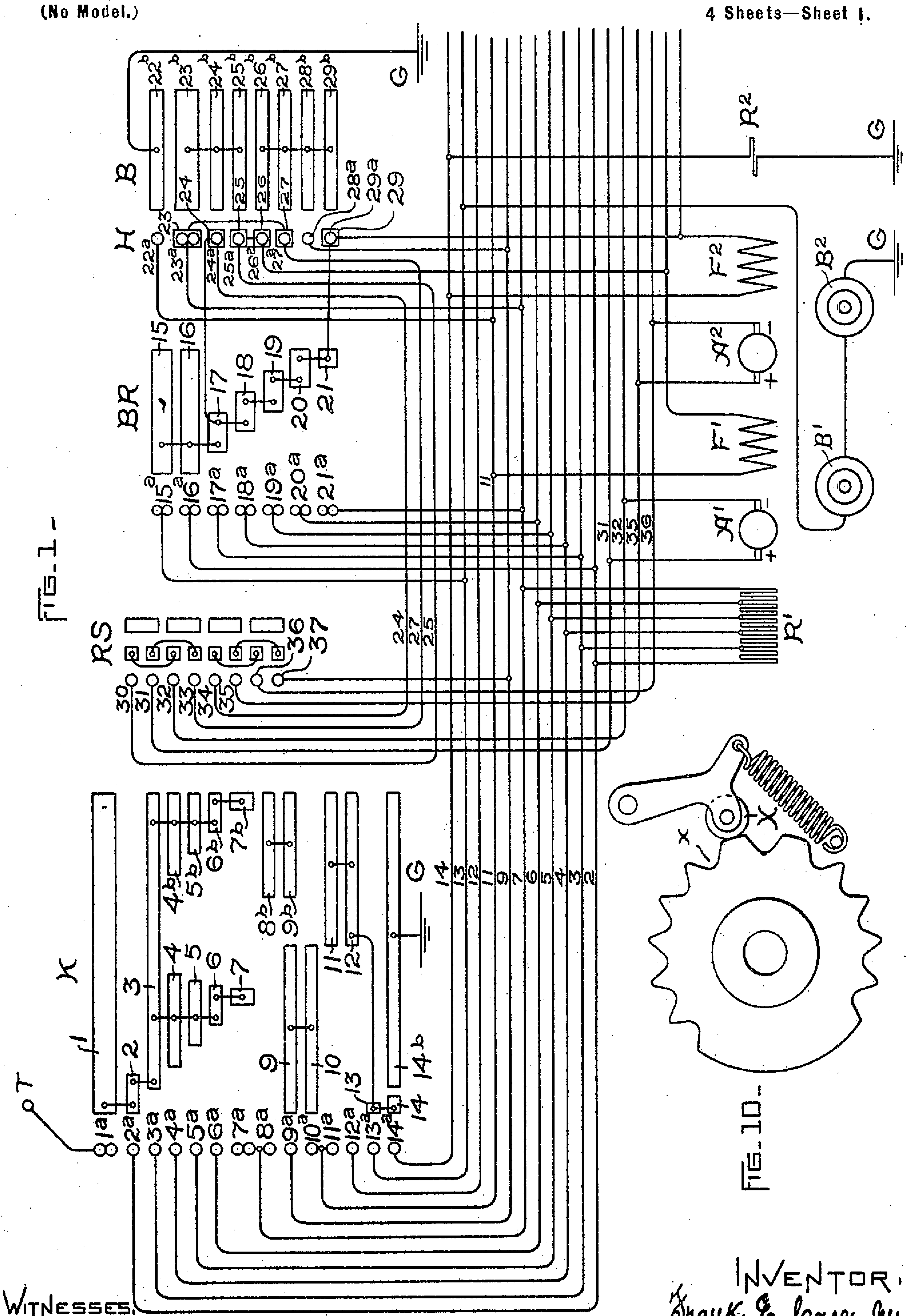

FIG. 1.

FIG. 10.

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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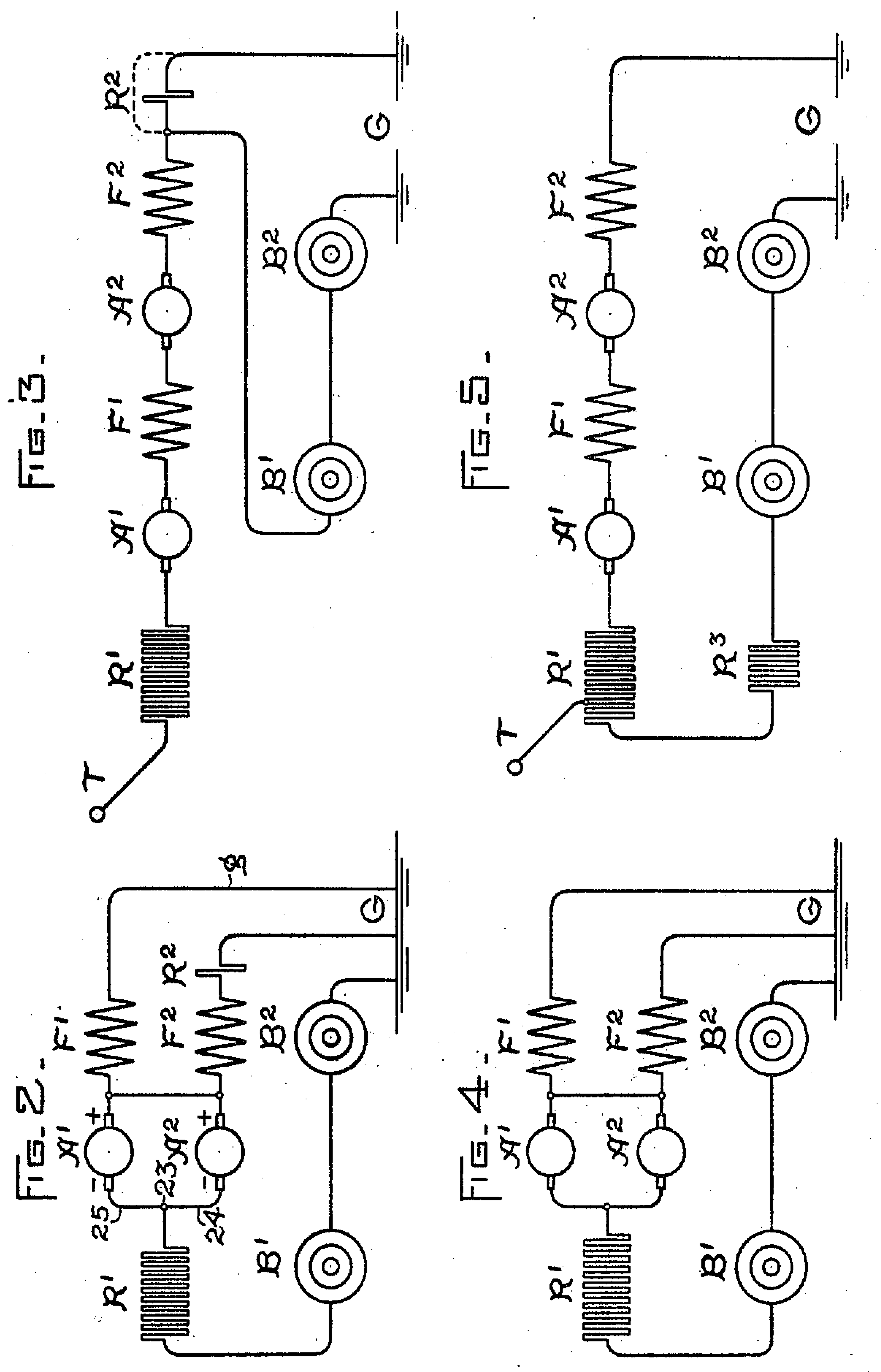

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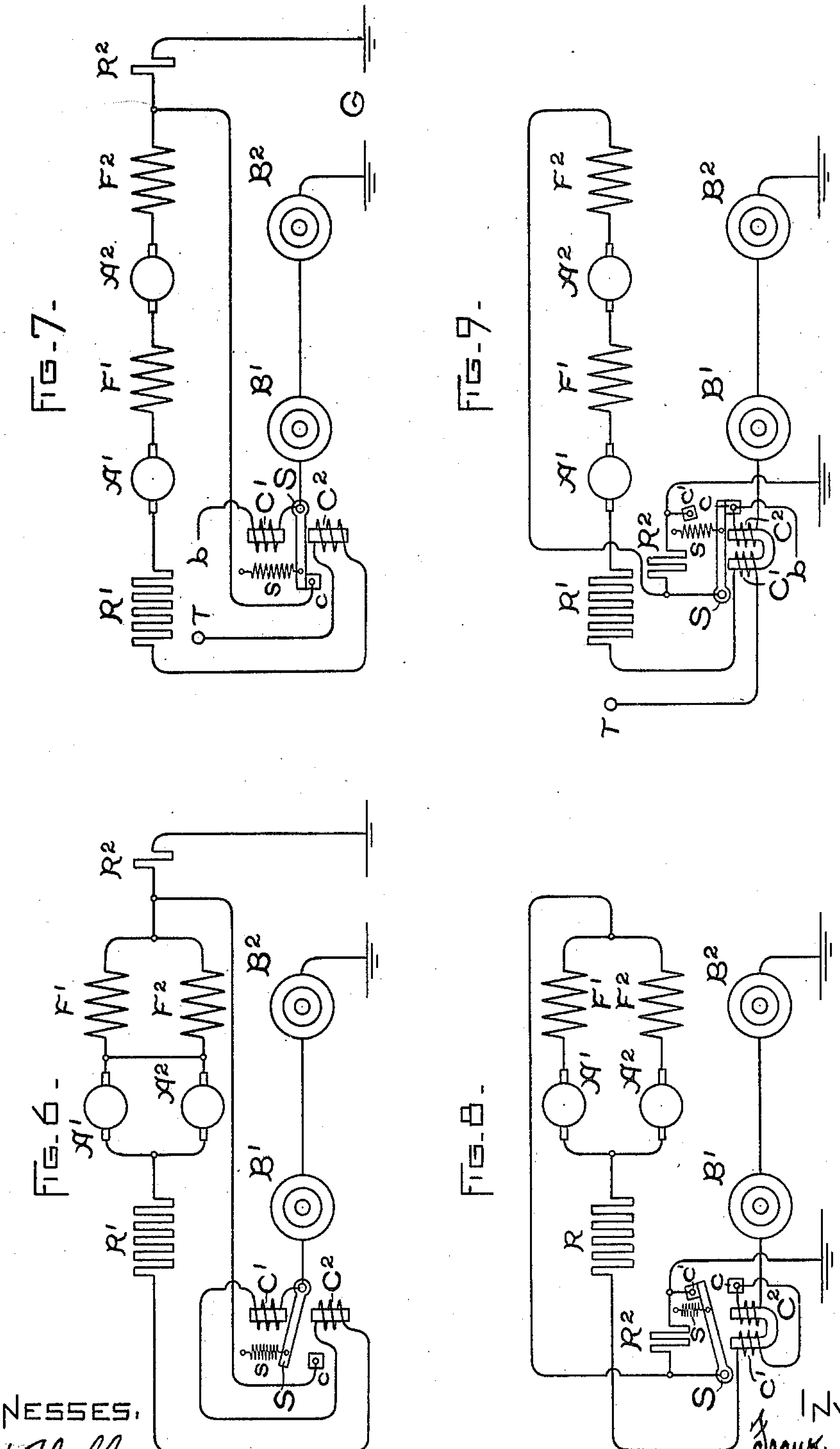

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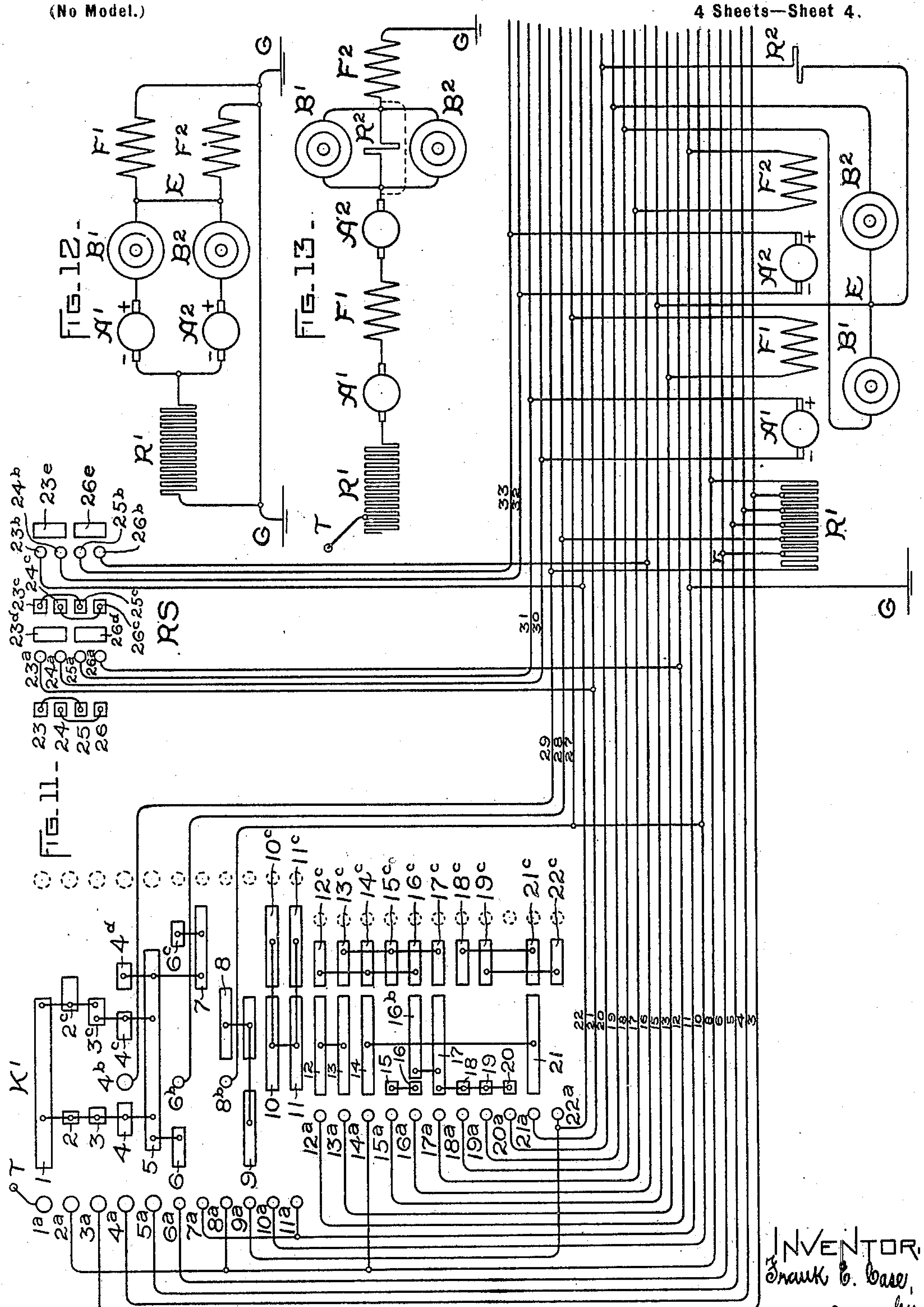

WITNESSES.

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UNITED STATES PATENT OFFICE.

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

ELECTRIC BRAKE.

SPECIFICATION forming part of Letters Patent No. 679,362, dated July 30, 1901.

Application filed July 17, 1897. Serial No. 644,884. (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, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Electric Brakes, (Case No. 402,) of which the following is a specification.

My invention relates to electric brakes, and particularly to a brake system on an electrically-actuated car or train, and has for its object to remedy a defect which sometimes arises with such apparatus.

In bringing a car to a stop by means of an electric brake it often happens that one or more of the brake-shoes will "stick." This sticking may occur in the operation of bringing the car to rest or after the car has been brought to rest and the current cut off from the brake-shoes. In the former case the car-wheels are caused to slip along the track, thereby greatly diminishing the braking effect and in addition wearing a flat space upon the wheel-tread, while in the latter the car is held from moving, so that when the trolley or other actuating current is turned on the motors have not only to exert a torque sufficient to overcome the inertia of the car, but also the friction of the sticking brake-shoe.

It is the object of my invention to so arrange and connect a brake system that whenever the brake-shoes stick a reverse current may be sent through the same, thereby demagnetizing and releasing them.

Referring to the drawings, Figure 1 shows diagrammatically a switch or controller with circuit connections arranged according to my invention. Figs. 2 and 3 show the circuit connections for certain positions of the controller shown in Fig. 1. Figs. 4 to 9, inclusive, show modifications. Fig. 10 is a detail of one of the mechanical features of the controller. Fig. 11 shows diagrammatically a switch or controller having modified circuit connections, and Figs. 12 and 13 show the circuit connections for certain positions of the controller shown in Fig. 11.

The controller itself may be of any suitable type. I have shown in Fig. 1 one of the types now well known, the contacts being developed on a plane surface and arranged in sets according to their different functions. The extended contacts of rectangular outline are movable with respect to the adjacent smaller contacts of circular outline, and, as is understood in this class of diagrams, the rectangular contacts, although shown on a plane surface, are in practice carried upon the circumference of a suitable cylinder adapted for rotation past fixed brushes. (Represented in the diagrams by the small circles.)

In Fig. 1, A′ represents the armature of one of the propelling-motors on a car; F′, the field-winding of the same; A^2 and F^2, the armature and field-winding, respectively, of a second propelling-motor; B′ and B^2, electric brake-shoes; R′ and R^2, resistances used in connection with said motors and brake-shoes, and K, RS, BR, H, and B the controller-contacts, K indicating the contacts by means of which current is supplied to actuate the motors on the car, RS the contacts for reversing the motor connections, B and BR the contacts for controlling the braking connections, and H certain contacts which are employed in the power positions of the controller. In the actual construction of the controller the contacts B, H, and BR may be arranged on the same cylinder with the contacts K, so that a rotation of the controller-handle in one direction from an off position operates the motors by trolley-current, while its rotation in the opposite direction employs the motors as braking-generators, such construction being well known in the art. The reversing-switch may be mounted on a separate cylinder, and the several switches should be provided with the usual interlocking devices. Assuming that the reversing-switch is thrown to the left, a movement of the controller-handle to the left operates the braking-contacts and causes the movable contacts 23, 24, 25, 26, 27, and 29 to move out of engagement with the fixed contacts 22^a to 29^a and immediately thereafter brings the movable contacts 22^b to 29^b into engagement with the same and at the same time brings the movable contacts 15 to 21 into operative relation with the fixed contacts 15^a to 21^a.

The circuit connections for the first position of the braking-contacts are shown in Fig. 2, the motors being connected in multiple with each other and in series with the brake-shoes and a resistance, so that the motors operating as generators furnish current to energize the brake-shoes. In this position of the braking-contacts an auxiliary resistance R^2, which is used to shunt the brake-shoes in the first power position of the controller, is included in series with the field-winding of one of the motors. This resistance is, however, small in amount, and in practice is so small that the additional length of the conductor *g* in circuit with the field-winding of the other motor is sufficient to make the resistance of the two motor-circuits equal. An equalizer connection is shown connecting corresponding points between the armatures and field-windings of the motors.

Referring to Fig. 1, the circuit connections may be traced as follows: Starting from the brush marked + of the armature A', the path of current-flow is to the conductor 31 through the reversing-contacts to conductor 33 and by way of conductor 27 to braking-contact 27^b. At this point an equalizer connection joins the circuits of the armatures A' and A^2, the path of current-flow from the brush marked + of the armature A^2 being by way of conductor 35 through the reversing-contacts to conductor 37 and by way of conductor 9 to braking-contact 28^b, a cross connection between the contacts 27^b and 28^b constituting the equalizer connection above referred to. Contacts 27^b and 28^b are joined by other cross connections to 26^b and 29^b. From contact 26^b the path of current-flow is through the field-winding F' to conductor 11 and by way of contact 22^b to ground. From contact 29^b the path of current-flow is through the field-winding F^2 to conductor 14 and through resistance R^2 to ground. From ground the circuit continues through the brake-shoes B^2 and B' by way of the conductor 13 to resistance-contact 15, through a cross connection to contact 16 by way of conductor 2, resistance R', and conductor 7 to braking-contact 23^b. Contact 23^b is connected by a second equalizer connection to 24^b and 25^b. From 24^b the path of current-flow is by way of conductor 24 through the reversing-contacts to conductor 36 and thence to the − brush of armature A^2. From 25^b the path of current-flow is by way of conductor 25 through the reversing-contacts to conductor 32 and thence to the − brush of armature A', thus completing the circuit. Further rotation of the braking-contacts operates only to cut out sections of the resistance R' through engagement of the movable contacts 17 to 21 with the fixed contacts 17^a to 21^a, thus regulating in the well-known way the braking effect of the motors acting as generators. During this rotation the movable contacts of K are not in engagement with their corresponding fixed contacts. When, however, the power is first turned on, the brake-shoes, for the reasons already pointed out, should be demagnetized, and this is accomplished in passing through the first power position of the controller, as follows: The controller-handle having been brought back to its zero position, the braking-contacts 23 to 29 are in engagement with the fixed contacts 23^a to 29^a and 15 to 21 are withdrawn from engagement with the fixed contacts 15^a to 21^a. A movement of the said handle to the right leaves the contacts 23 to 29 and 23^a to 29^a in engagement with one another and brings the motor-controlling contacts of K into engagement with the fixed contacts 1^a to 14^a. In the first power position current flows from the trolley T to contact 1, by cross connection to contact 2, by way of conductor 2 to resistance R', through said resistance and by way of conductor 7 to contact 23 of the row of contacts H, by cross connection to contact 27, through conductor 27 and through the reversing-contacts to conductor 31, through armature A', conductor 32, and other reversing-contacts to conductor 30, to contact 25, by way of cross connection to contact 26, to and through field-winding F' to conductor 11, to contact 10, by way of cross connection to contact 9, by and through reversing-contacts to conductor 35, through armature A^2, by conductor 36 through reversing-contacts to conductor 34, by way of cross connection between contacts 17 to 21 to contact 29, to and through field-winding F^2 to conductor 14, where the current divides, part flowing by way of resistance R^2 to ground and part through the cross connection between contacts 14 and 13 to and through the brake-shoes B' and B^2 to ground, the current passing through the brake-shoes in a direction opposite to the direction of current-flow in the braking position of the controller. As the controller-handle is moved still farther to the right, (it being understood that the first position is not a "running position" of the controller, but is a transition-point upon which the handle is not to be left,) the circuit connections are broken between the movable contacts 13 and 14 and the corresponding field-contacts 13^a and 14^a and a circuit closed between the fixed contact 14^a and the movable contact 14^b. The brake-shoes are thus cut entirely out of circuit, and the end of field-winding F^2 is connected directly to ground through contact 14^b. The connections above traced are illustrated in Fig. 3 of the drawings, the dotted lines indicating the condition of the circuits at the second position of the controller. A further movement of the controller in the same direction changes the motor connections in the manner customary in series-multiple controllers. These connections are well understood in the art, and inasmuch as they constitute no part of the present invention they will not be described.

In Fig. 10 I have shown the so-called "star-wheel" or ratchet device, by means of which the proper running positions of the controller are indicated to the motorman. It will be seen that the first part of the wheel is not provided with a notch, so that the first position of the controller is gradually passed through until the ratchet X drops into the notch x. Although advisable, this construction is not an essential feature of the controller, for the reason that the current sent through the brake-shoes for the purpose of demagnetizing them will be insufficient to apply them again after they have once been released, because of the increased reluctance of the magnetic circuit.

Fig. 4 shows the same arrangement of circuits as Fig. 2, except that the resistance R^2 is omitted. In this case I use in the first power position of the controller a resistance R^3, and I so arrange the controller connections that in this first position the brake-shoes are connected in circuit between the trolley and ground in series with the resistance R^3 and a portion of the main resistance R'. While this is not a preferred form, for the reason that it involves the use of a much greater resistance than is required with the connections shown in Fig. 3, it is evidently a form which may be used in carrying out my invention.

Figs. 6 to 9, inclusive, show other arrangements of apparatus for carrying out my invention. In these the connections of the controller may be as already described with reference to Fig. 1; but I employ an auxiliary or additional device for controlling the circuit of the brake-shoes and the auxiliary or shunting resistance. In Fig. 6 the connections of the motors, main resistance, and brake-shoes are the same as in Fig. 2; but the auxiliary resistance R^2 is connected in series with both motor-fields instead of with only one, and an additional device S is provided, which has two coils C' and C^2 acting upon a switch-lever which controls the connection of the auxiliary resistance. When the brake-circuit is completed, current passes from the armatures through the field-windings and the auxiliary resistance R^2 direct to ground, thence through the brake-shoes in series, through the coils C' and C^3 and resistance R', back to the armatures. The coils being wound for differential effect, the spring s keeps the switch-lever away from its contact c. The corresponding connections for the first power position are shown in Fig. 7. The circuit through the coil C' is opened, and the trolley-current is caused to pass through the coil C^2, resistance R', motors, and resistance R^2 to ground. The coil C^2 operates to close the switch-lever S, thereby shunting the brake-shoes around the resistance R^2, so that a portion of the trolley-current flows through them in a reverse direction, as in Fig. 3. The arrangements shown in Figs. 8 and 9 are in general similar to those of Figs. 6 and 7. In this case, however, the auxiliary resistance R^2 is short-circuited by the switch-lever S in the braking positions of the controller. Referring to Fig. 8, which shows the connections for the braking positions of the controller, it will be noted that the current passes from the armatures A' and A^2 through the fields F' and F^2 through the switch-lever S, short-circuiting the resistance R^2 to ground, and thence through the brake-shoes B^2 and B', through the coils C^2 and C', and the resistance R back to the armatures. The coils C' and C^2 are differentially wound and do not, therefore, energize the core upon which they are placed. The corresponding connections for the first power position of the controller are shown in Fig. 9. Current from the trolley passes through the coil C', the coil C^2 being open-circuited, to the resistance R', and through the motors in series to the resistance R^2 and the switch-lever S, which has been closed against its contact c by the coil C'. At this point the current divides, part going by way of the resistance R^2 directly to ground and part by way of the brake-shoes B' and B^2 also to ground, the shoes being thus in multiple to the resistance R^2. It will be observed that the closing of the switch-lever S against its contact c causes current to pass through the coil C^2 in such a direction as to assist the coil C', thereby holding the switch-lever with certainty.

In Fig. 11 I have shown a diagram illustrating controller connections somewhat different from those shown in Fig. 1, and in Figs. 12 and 13 I have shown the connections for the braking and first power positions, respectively.

Referring to Fig. 11, A' and A^2 represent the respective motor-armatures; F' F^2, the corresponding field-windings; B' and B^2, the brake-shoes; R', the main resistance; R^2, an auxiliary resistance; RS, the contacts of the reversing-switch, and K' the contacts on the main controller-cylinder. The controller is rotatable in both directions from its off position. When rotated in one direction, it controls the power-circuit, and when rotated in the other it completes the connections for braking.

The contacts of rectangular outline are movable with respect to those of circular outline. The latter are fixed in position and in the off position of the controller lie between the opposite sides of the rectangular contacts on the controller-cylinder. As shown in the drawings, the contacts are developed on a plane surface. It is therefore necessary to indicate the relative position of the fixed contacts with respect to both sides of the rectangular contacts. Accordingly these contacts 1^a to 22^a are shown on the left of the movable contacts in proper relative position to the left-hand side of said contacts, while on the right of the movable contacts these same contacts are shown in dotted lines in the position they occupy relative to the right-hand side of the movable contacts. Certain other contacts—namely 4^b, 6^b, and 8^b—occupy an intermediate position and are brought into engagement with the movable contacts either to the left or to the right, according to the direction of movement of the controller-cylinder. When the rectangular contacts are moved to the left, the power-circuit is closed; but when the said contacts are moved to the right the circuits for the brakes are completed. Assuming that the reversing-switch contacts are closed to the left and that the main controlling-cylinder is moved to its first position on the right, the circuit connections shown in Fig. 12 may be traced as follows: Starting from the plus side of the armature A′ current goes to the lead 31, to the contact 25 on the reversing-switch, contact 23, lead 21, contact 21^c upon the controller to contact 18^c, by lead 18 to the shoe B′, through that shoe to the equalizer, which I have indicated at E. Starting from the plus side of the armature A^2, current passes to the lead 33, to contact 25^c upon the reversing-switch, contact 23^c, to lead 22, to contact 22^c upon the controller to contact 19^c, by lead 19 through the shoe B^2 to the point E. The resistance R^2, it will be seen, is open-circuited at the brush 20^a upon the controller. The other path from the point E is as follows: By the lead 15 to the contact 15^c, upon the controller, at which point it divides, going first to contact 13^c and by the lead 13 through the field F′ to lead 27, to lead 10, to lead 10^c, by cross connection to contact 11^c, and by the lead 11 to ground, the lead 11 being the ground-wire of the controllers, to which all grounded connections go. The other connection from the contact 15^c is to contact 17^c, to lead 17, through the field F^2 directly to ground-wire 11. The circuit to the other side of the armature is completed from the ground-wire 11 by contact 7^a, which at this time is upon contact 7, and by the cross connection to the contact 4, upon which rests the brush 4^b, by which current passes to the lead 29, to the resistance R′, to lead 8, to contact 14^c. There it divides, going to contact 12^c by the lead 12 to reversing-switch contact 26, contact 24, lead 30, and so to the other side of armature A′, while (returning to contact 14^c) the other path of the current is to contact 16^c by the lead 16 to the reversing-switch at contact 26^c, to contact 24^c, and by the lead 32 to the other side of the armature A^2. Further rotation of the switch acts to cut out more and more of the resistance R′ to regulate the output of the motors as generators. If now the controlling-cylinder is moved to the left, to the first power position, the circuit connections shown in Fig. 13 may be traced as follows: The trolley is connected to the controller at contact 1, from which current passes by cross connection to contact 6, thence to the second point (marked *r*) of the resistance R′, through the resistance to lead 8, to contact 14, to contact 21, by lead 21 to the reversing-switch contact 23, contact 25, lead 31, armature A′, lead 30, contact 24, contact 26, lead 12, contact 12 upon the controller, contact 13, lead 13, through the field F′, lead 27, where it apparently divides; but the connection to lead 10 at this time is open at the controller and current passes to contact 8 by the brush 8^b, by cross connection to contact 9, lead 22, reversing-switch at contact 23^c, contact 25^c, lead 33, through armature A^2, lead 32, reversing-switch contact 24^c, contact 26^c, lead 16 to contact 16 upon the controller, by cross connection to contact 15, and by lead 15 to the point E between the brake-shoes. Here the current divides, a portion passing by the resistance R^2 to lead 20, another part through shoe B′ to lead 18, another by shoe B^2 to lead 19, these contacts being all connected at the controller to contact 17, thence by lead 17 current passes through the field F^2 to the ground-wire 11 and thence to ground. The next step of the controller open-circuits the connection to the point E, thereby cutting the brake-shoes and the resistance R^2 out of circuit and closing a circuit from the armature A^2 directly to the field-winding F^2, these circuit changes being made by the brushes 15^a, 16^a, and 17^a and their corresponding contacts. The brush 15^a opens the circuit at contact 15 and the brush 16^a is connected to 17^a through the contacts 16^b and 17, the connections being otherwise the same as before.

The circuit connections for the braking position of the controller illustrated in Fig. 11 are different from the corresponding connections of the controller illustrated in Fig. 1, as may be seen by comparing Fig. 12 with Figs. 2, 4, 6, and 8. In the latter figures the brake-shoes are connected in series with the two motors in multiple, while in the former the brake-shoes are included in circuit between the armatures of the respective motors and an equalizing connection and are so arranged that the brake-shoe in operative relation to any one axle is connected directly in circuit with the motor on the said axle. With these circuit connections when the armatures A′ and A^2 are generating substantially the same current practically no current flows in the equalizing connection E, the current from the armature A′ flowing through the brake-shoe B′ and the field F′ and the current from the armature A^2 flowing through the brake-shoe B^2 and the field F^2. If, however, the brake-shoe on either axle sticks so that the wheels on said axle slip along the track or even so that the rate of rotation of said axle becomes substantially less than that of the other, the magnetization of said shoe is automatically weakened by a reverse current which is caused to pass through the sticking shoe. If, for example, the armature A′, Fig. 12, is caused to slow down on account of an undue retarding effect of the shoe B′, the said armature will not only cease to supply current to the brake-shoe B′ and the field F′, but current from the armature A^2 will flow through the equalizing connection E, where it will divide, a portion flowing through the field F′ in a direction to maintain its magnetization and another portion flowing in a reverse direction through the brake-shoe B and the armature A′, thereby weakening the brake-shoe B′ and at the same time tending to drive A′ as a motor, thereby causing it to speed up until it is running again at the same speed as A^2. If the armature A^2 were caused to slow down, current would flow through the equalizing connection from the armature A′ and the brake-shoe B^2 would be correspondingly weakened. The important distinction between the controllers shown in Figs. 1 and 11 consist, then, in this: that in the former case connections are so arranged that in order to send a reverse current through the brake-shoes it is necessary to bring the controller to its first power position, while in the latter the connections are such that a reverse current may be caused automatically to flow through any brake-shoe which tends to stick in the operation of braking a car and also such that a reverse current may be caused to flow through the brake-shoes in the first power position of the controller.

While I do not specifically claim in this application controller connections so arranged that in the operation of braking a reverse current may be caused automatically to flow through any brake-shoe which tends to stick, I do make broad claims to any switch or controller having connections so arranged that thereby current may be supplied to brake-shoes to apply the same or a reverse current caused to flow through the said brake-shoes to release them, and while I have described my invention as applied to an electric-railway system it is evident that it is not limited thereto, but may be employed in any system where a plurality of rotating parts are independently and yieldably connected to the same load.

I claim—

1. In a control system for propelling motors and electric brake-shoes, a controlling device provided with contacts for supplying current to the motors, contacts for supplying current to actuate the brakes, and contacts at one of the power-points of the controlling device for sending a reverse current through the brake-shoes to demagnetize them.

2. In a control system for propelling motors and electric brake-shoes, a controlling device comprising a power-cylinder provided with contacts for controlling the supply of current to the motors, a brake-cylinder for controlling the supply of current to the brake-shoes, and contacts on the power-cylinder for sending a reverse current through the brake-shoes to demagnetize them.

3. A controlling device for an electric brake system, comprising contacts for regulating the speed of the motors, contacts for regulating their effect as braking-generators, and contacts at the first power-point connected to send a limited trolley-current through the shoes to reverse their magnetism.

4. A controlling device for use in electric brake systems, provided with contacts at one of its power-points for shunting a part of the trolley-current through the brake-shoes to demagnetize and release them.

5. A controlling device for electric brake systems, provided with contacts at one of its power-points, throwing the brake-shoes in multiple with a resistance for shunting a limited portion of the trolley-current through the shoes to demagnetize them.

6. In an electric brake system, means for regulating the motors and for regulating their effect as braking-generators, in combination with an auxiliary device controlled by the trolley-current for throwing the brake-shoes in multiple with a small resistance in the trolley-circuit.

7. In combination, a plurality of dynamo-electric machines, a plurality of electric brake-shoes, a controlling device or switch for controlling the connections of said dynamo-electric machines and said brake-shoes, and an electromagnetic switch for closing a circuit to send a reverse current through said brake-shoes.

8. In combination, a source of current-supply, a plurality of dynamo-electric machines, a plurality of brake-shoes, an auxiliary resistance, and a controlling device in one position connecting said dynamo-electric machines to furnish current to said brake-shoes, and in another position connecting said dynamo-electric machines to said source in series with said auxiliary resistance and said brake-shoes in shunt to one another.

In witness whereof I have hereunto set my hand this 2d day of July, 1897.

FRANK E. CASE.

Witnesses:
B. B. HULL,
A. F. MACDONALD.