No. 694,425. Patented Mar. 4, 1902.

J. RYAN.

ELECTRIC RAILWAY SYSTEM.

(Application filed Oct. 6, 1900.)

(No Model.) 3 Sheets—Sheet 1.

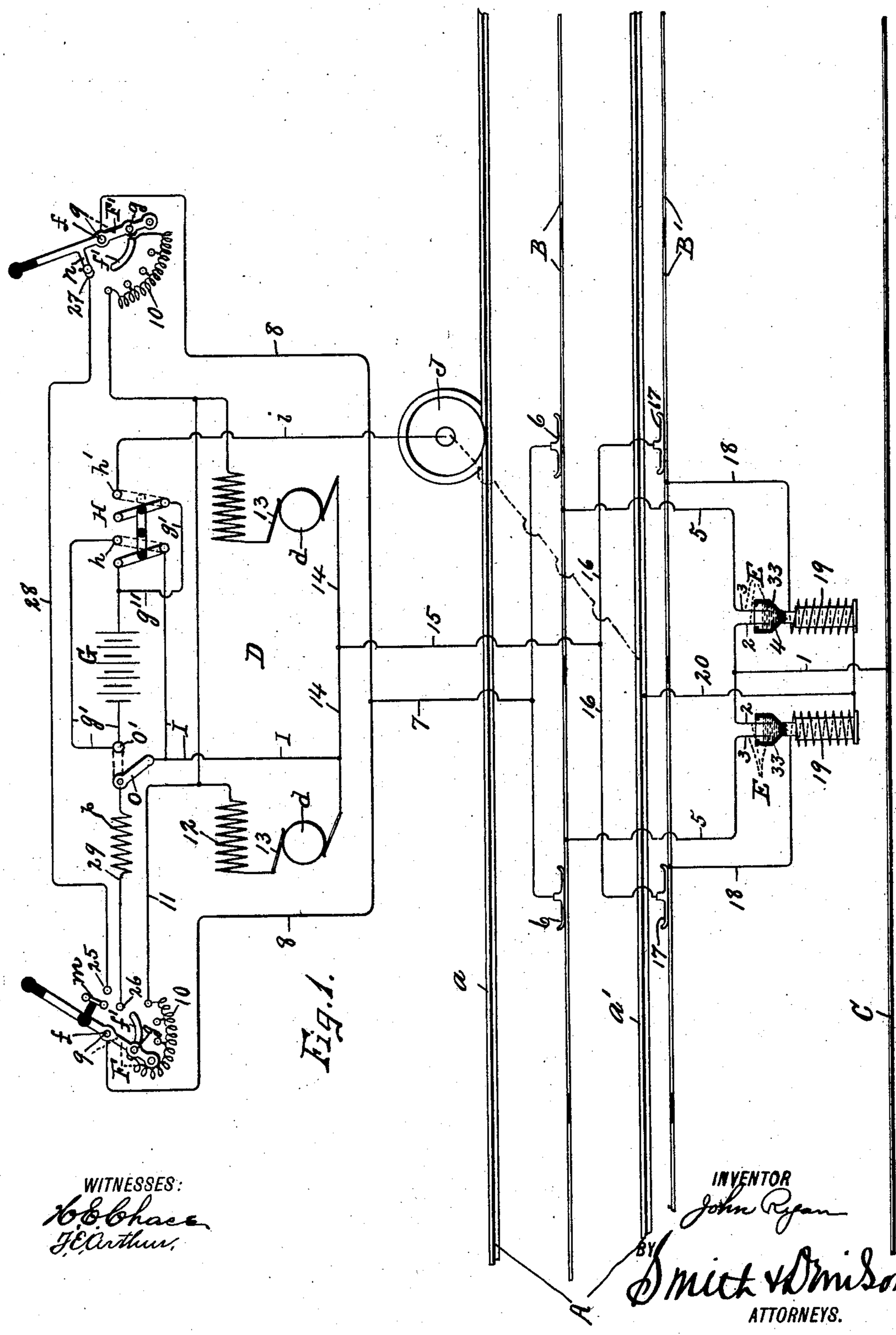

Fig. 1.

WITNESSES:
K. B. Chase
F. E. Arthur.

INVENTOR
John Ryan
BY
Smith & Davison
ATTORNEYS.

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(No Model.) 3 Sheets—Sheet 2.

Fig. 2.

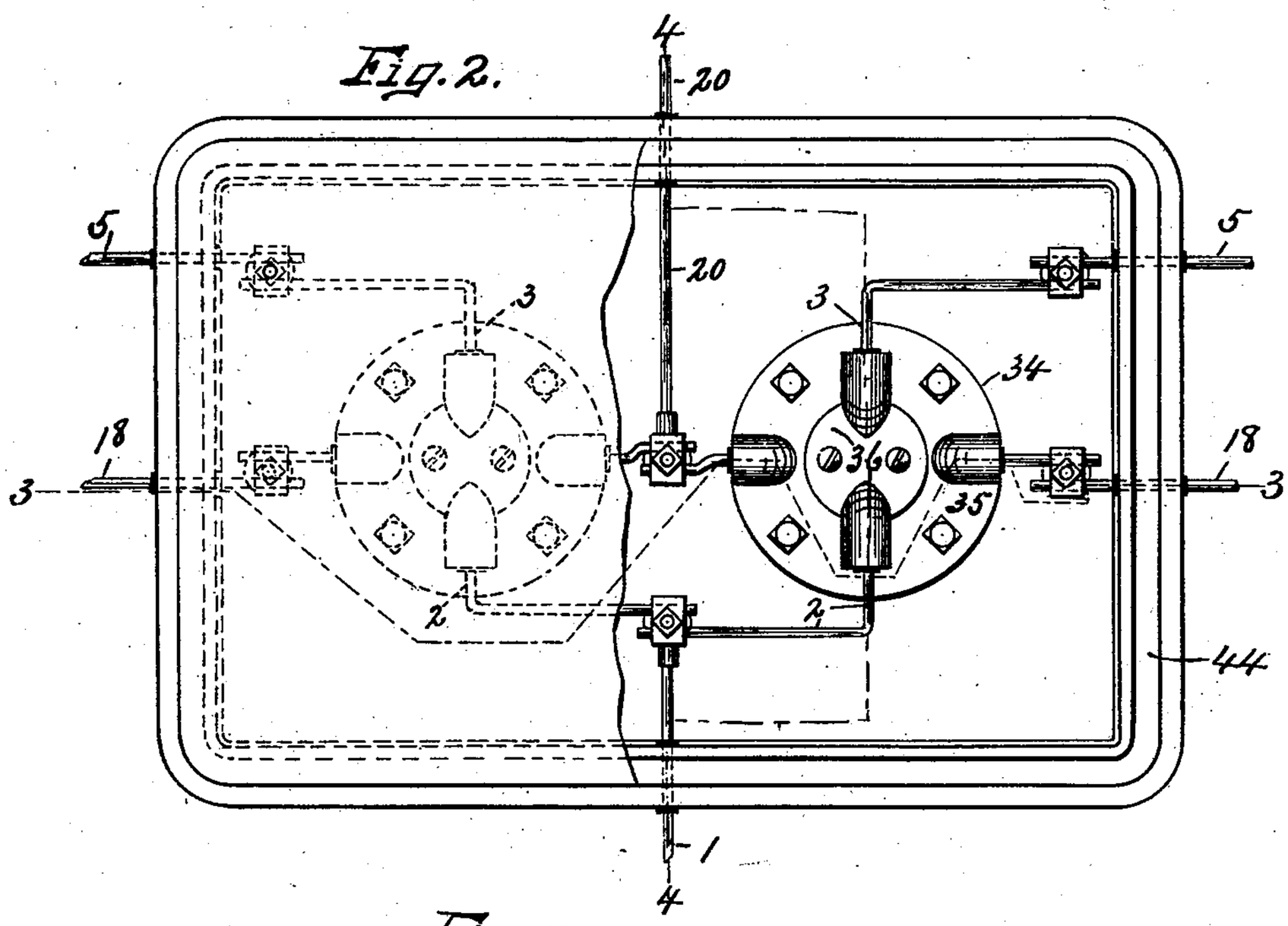
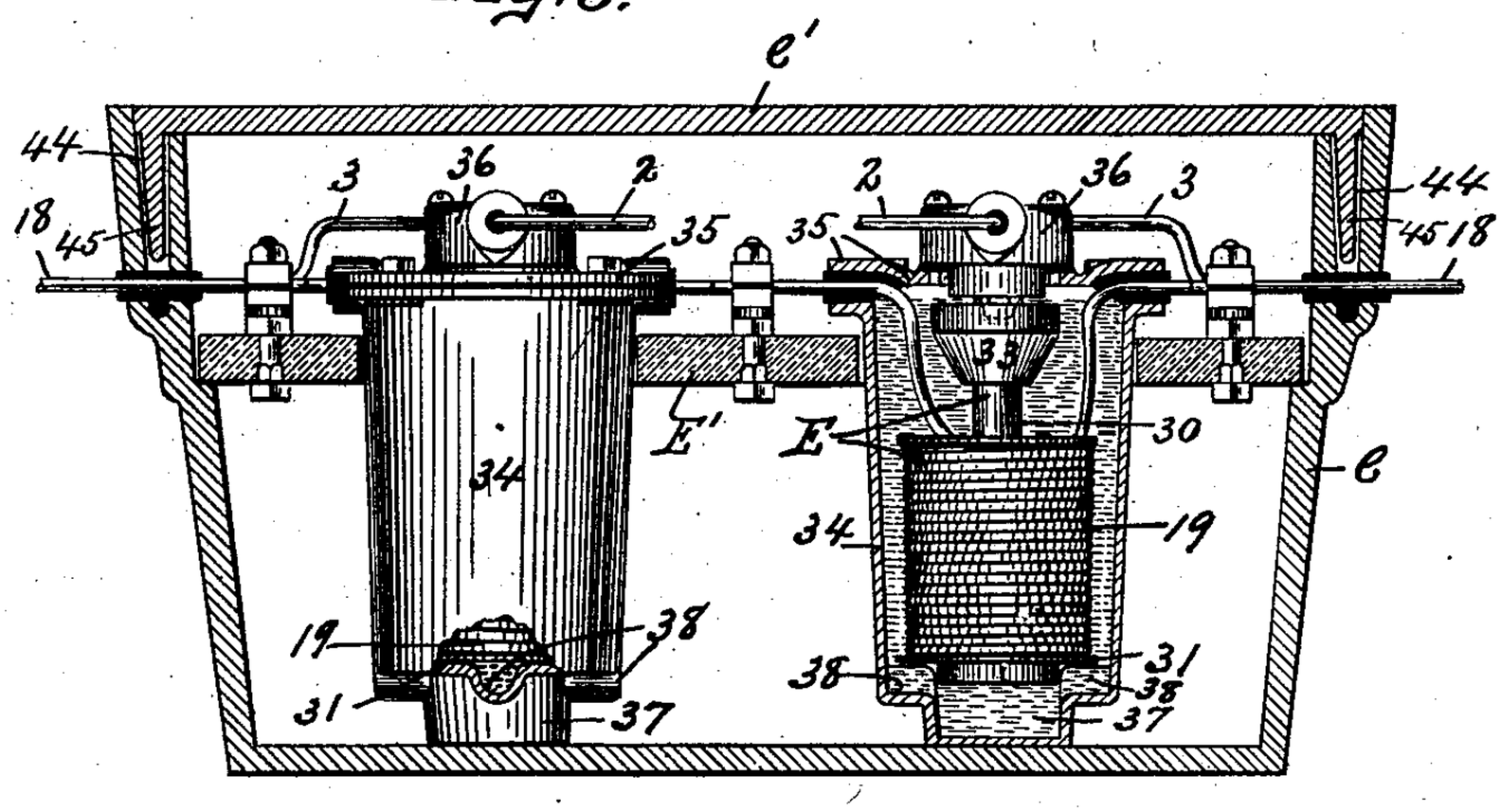


Fig. 3.



WITNESSES:
H. C. Chase
F. E. Arthur.

INVENTOR
John Ryan
BY
Smith & Davison
ATTORNEYS.

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J. RYAN.

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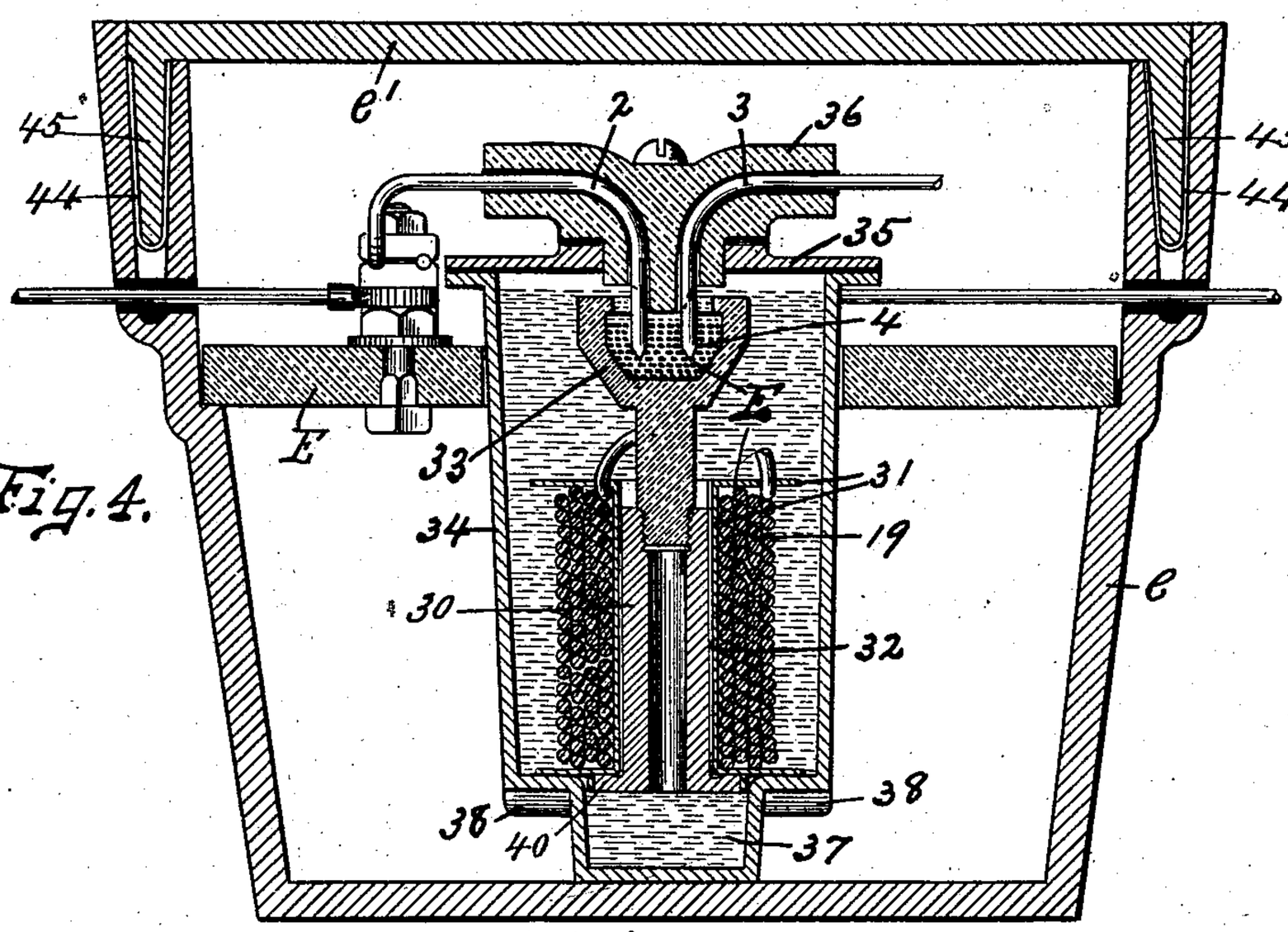
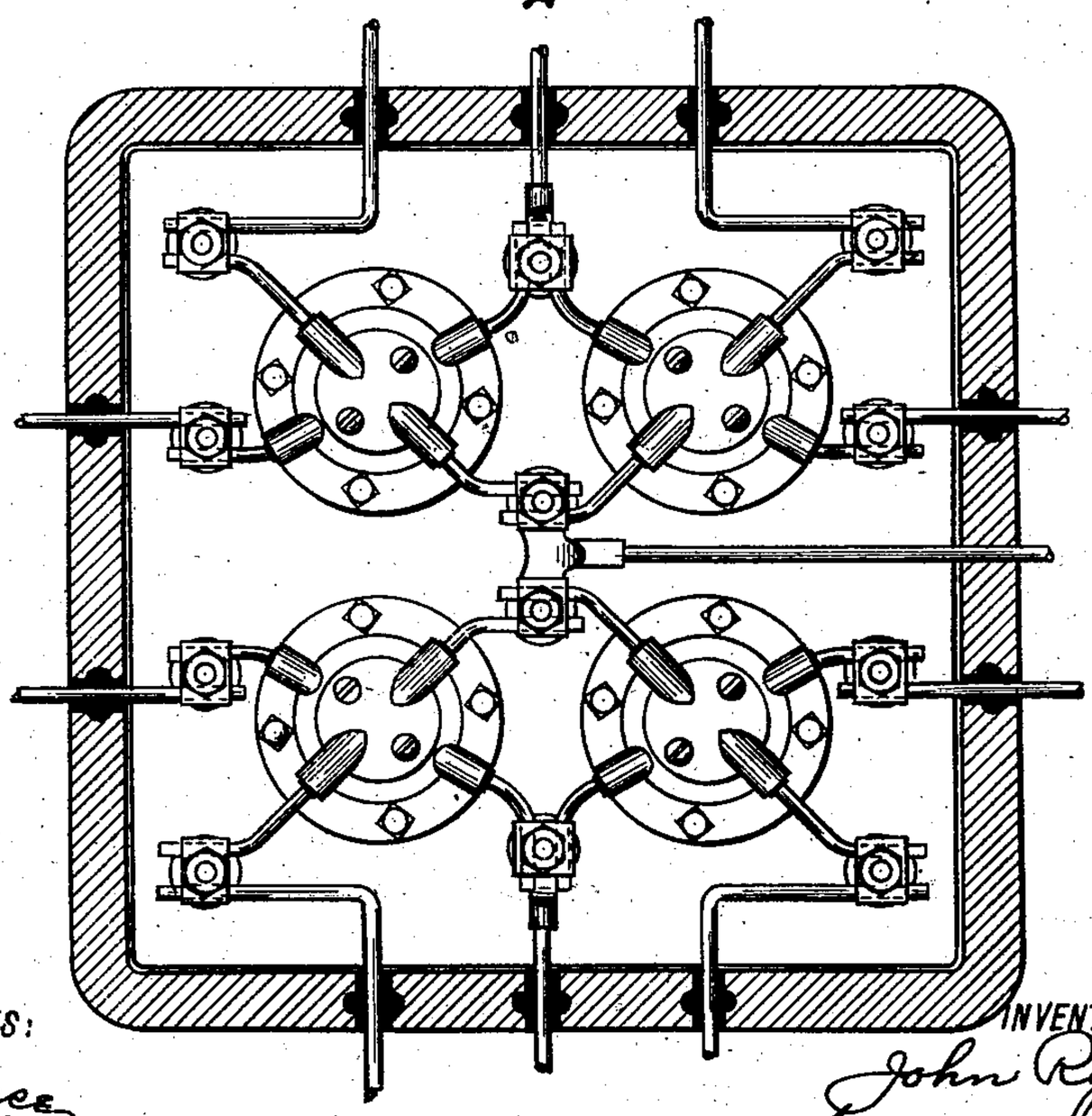


Fig. 4.

Fig. 5.



WITNESSES:

H. C. Chase

F. E. Arthur,

INVENTOR

John Ryan

BY

Smith & Bruce

ATTORNEYS.

UNITED STATES PATENT OFFICE.

JOHN RYAN, OF WATERTOWN, NEW YORK, ASSIGNOR TO JOHN D. RYAN, OF WATERTOWN, NEW YORK.

ELECTRIC-RAILWAY SYSTEM.

SPECIFICATION forming part of Letters Patent No. 694,425, dated March 4, 1902.

Application filed October 8, 1900. Serial No. 32,428. (No model.)

To all whom it may concern:

Be it known that I, JOHN RYAN, of Watertown, in the county of Jefferson, in the State of New York, have invented new and useful Improvements in Electric-Railway Systems, of which the following, taken in connection with the accompanying drawings, is a full, clear, and exact description.

This invention relates to improvements in electric-railway systems, and particularly to that class in which a current of electric energy is taken from a point beneath the car or other vehicle and transmitted to the motors or other parts of the car and in which the power-circuit is broken beyond the limits of the car.

The primary objects of this invention are, first, to dispense with all overhead conductors or structures; second, to reduce to a minimum the liability of short circuits or dangerous currents beyond the limits of the car, and, third, to provide means controlled by the operator of the car for insuring the maintenance of the power-current through the motors or other parts of the car.

To this end the invention consists in the construction, combination, and arrangement of the component parts of an electric-railway system, as hereinafter fully described, and pointed out in the claims.

In describing this invention reference is had to the accompanying drawing, forming a part of this specification, in which like reference characters indicate corresponding parts in all the views.

Figure 1 is a diagrammatic view of a portion of an electric-railway system embodying my invention. Fig. 2 is a top plan of one of the switch-boxes partly broken away for disclosing the interior parts. Figs. 3 and 4 are sectional views taken, respectively, on lines 3 3 and 4 4, Fig. 2; and Fig. 5 is a top plan, partly in section, of a modified form of switch-box as used for double-track rails, showing a means of connecting a multiplicity of the solenoid-switches.

In Fig. 1 are represented diagrammatically the essential elements of my invention, in which A represents a suitable track consisting of ordinary rails *a a'*. B B' are sectional conductors arranged substantially parallel with the track A, and C is a feed-wire connected to a source of electric energy (not illustrated) and to one of the sectional conductors for supplying power-current to the several sections of said sectional conductor. D represents a car or other vehicle movable along the rails *a a'* and sectional conductors B B', and E E are suitable switches for controlling the passage of the power-current from the feed-wire to the sectional conductors and to the car.

The rails *a a'* are of any desired construction for supporting and guiding the car D, said rails forming conductors for the return-current from the car in the usual manner to the dynamo or other source of electric energy. The sectional conductors B B' may also be of any desired construction, the conductor B being arranged substantially midway between the rails *a a'* and parallel therewith and consists of a plurality of metallic sections arranged end to end and insulated from each other. In order that the conductors B B' may be positively insulated from the rails *a a'* and absolutely prevent the liability of short circuits, I preferably embed the same in suitable insulating material, as cement. (Not necessary to herein illustrate or describe.) The conductor B' is preferably arranged at the outside of the rails *a a'* and in proximity thereto in order to prevent short circuits between the sections and conductors and to carry off any leakage therefrom, and consists of a series of metallic sections arranged end to end and insulated from each other in substantially the same manner as the sections of the conductor B. The metallic sections of each of the conductors B B' are substantially identical in form and length and are so arranged relatively to each other that their ends terminate in substantially the same transverse planes, the surface of said sectional conductors being exposed for receiving any desired form of contact-pieces provided on the car for the purpose of transmitting the power or other electric current to and from the car D and the sectional conductors B B', it being understood that any leak or short circuit between the conductors B and B' will be taken up by the ground-rail *a'*.

The feed-wire C may be located in any desired position relative to the track A, but is preferably arranged in a suitable subsurface

conduit of insulating material and connected in the usual manner to a source of electric energy, as a dynamo, (not illustrated,) and to the sectional conductor B for supplying power-current to the several metallic sections of said conductor B.

Although the above-described feed-wire is particularly serviceable for use in my improved railway system, it is evident that any other well-known equivalent may be used in place of the feed-wire, if desired. This conductor C is connected in such manner to each of the metallic sections of the conductor B that when the contact between the contact-pieces of the car and the metallic sections of the sectional conductor B is broken the circuit between said metallic sections of the conductor B and the conductor C is broken or open, thereby cutting out the power-current from such sections of the conductor B as are not in electrical contact with the contact-pieces of the car. These sectional conductors are usually of such length that at no time does the live-power current extend beyond the limits of the car, thus insuring absolute safety from injury by means of the power or other electric current.

The means for electrically connecting the conductor C to one of the metallic sections of the conductor B preferably consists, as seen in Fig. 1, of a branch conductor 1, terminals 2 and 3, automatically-actuated means 4 for connecting the terminals, and a conductor 5, connecting the terminal 3 to one of the metallic sections of the rail B. The branch conductor 1 connects the main conductor C to the terminal 2, and it is thus apparent that when the terminals 2 and 3 are connected by the means 4 the power-current passes from the main conductor C through the branch conductor 1, terminals 2 and 3, connecting means 4, and conductor 5 to the metallic section of the sectional conductor B. In like manner all of the metallic sections of the conductor B are connected to the main conductor C.

The car D may be of any desired construction provided with one or more motors *d*, which are mechanically connected in the usual manner to the running-gear of the car for propelling the same. The power-current is transmitted from the metallic sections of the sectional conductor B to the motor or motors of the car and is regulated by suitable controllers of any desired construction provided on each end of the car.

The means for electrically connecting the motors of the car with the metallic sections of the conductor B consists of a contact-piece 6 and a conductor 7, having one end connected to the contact-piece and its other end connected by conductors 8 to the terminals 9 of suitable controllers F F′. The terminals 9 usually consist of segments of conductive material formed on the movable member of the controller and movable into and out of contact with a series of contact-points which are electrically connected to a conductor 10, said conductor being connected by a conductor 11 to a field-winding, as 12, which in turn is connected to a brush 13 of the motor *d*. The other brush of the motor *d* is connected by suitable means to the sectional rail or conductor B′, which in turn is connected to one of the rails, as *a′*, of the track A for the purpose of returning the power-current to the source of electric energy, as the dynamo previously mentioned. The means for connecting said other brush of the motor *d* to the sectional conductor B′ consists, as shown in Fig. 1, of conductors 14, 15, and 16 and contact-pieces 17.

The connections between the conductor B′ and the rails *a a′* consist of a conductor 18, a solenoid 19, and a conductor 20. The conductors 18 connect one of the metallic sections of the sectional conductor B′ to one end of the solenoidal coil 19, and the conductor 20 connects the other end of said coil with one of the rails, as *a′*.

By referring to the foregoing description and the accompanying drawing it will be readily understood that the power-current in passing from the main wire C to the motors of the car passes along the conductor 1, terminals 2 and 3, connecting means 4, conductor 5, one of the sections of the conductor B, contact-piece 6, conductors 7 and 8, member 9, conductor 10, conductor 11, field-coil 12, and the brush 13 to the motor *d*. The power-current then passes from the motor *d* along the conductors 14 15 16 and contact-pieces 17, through the metallic section of the conductor B′, the conductor 18, coil 19, conductor 20 to the rail *a′*, and thence back to the dynamo.

The terminals 2 and 3, connecting means 4, and coil 19 form essential parts of the solenoidal switch E, presently described, and serve the purpose of making and breaking the power-circuit as the car D is moved along the metallic sections of the sectional conductors B B′.

The controllers F F′ are provided with contact-pieces *f′*, connected to the end of the conductors 10 of greatest resistance and adapted to be still engaged by contact-pieces *g*, provided upon the members *f*, as said members are moved out of contact with the several points of the controller for maintaining a closed circuit through the solenoid-coils when the motors are deënergized.

As previously stated, the means connecting the terminals 2 and 3 is controlled by the operator on the car, and during the passage of the car along the sectional conductors B B′ said means is forced into contact with the terminals 2 and 3 by means of the power-current passing through the coils 19 of the solenoidal switch E. It is evident, therefore, that so long as the power-current exists in the main conductor C the solenoid-switch will be automatically actuated and the power-current transmitted from the main conductor to the motors of the car.

In order that the switch E may be under the direct control of the operator of the car,

in case of breakages or loss of current from the main conductor C, I provide said car with a suitable source of electric energy, as a storage battery G, and electrically connect the same in such manner as to force the connecting means 4 into contact with the terminals 2 and 3 for the purpose of regaining the power-current when recovered in the conductor C. This means for connecting the battery G to the switch E consists of a conductor g', a double-pole-changing switch H, having terminals h h', a conductor g'', and an additional conductor 1. The conductor g' is connected to one pole of the battery G and to the terminal h of the switch H. The switch H is moved to the position shown by dotted lines, Fig. 1, one of the poles being in contact with the terminal h and with the conductor 1, which conductor is in turn connected to the wire 14. The other pole of the switch H connects the terminal h' with the line g'', which in turn is connected to the opposite pole of the battery G. The terminal h' is connected by a conductor i to the axle of one of the wheels J, which are normally in contact with the rails of the track A.

It will be evident from the foregoing description that the battery-current passes from one pole of the battery along the conductor g', through one pole of the switch H to the conduit I, and thence to the conduit 14, which conducts the current by the conduits 15 and 16 to the sectional rail B'. The current then passes through the coil 19 and conductor 20 to one of the rails, as a', and is conducted from said rail through the axle or other conducting means to the wheel J, and is thereby conducted to the opposite pole of the battery G through the conductor i to the other pole of the switch H and the conductor g''. This circuit being completed from the battery G operates the switch E and connects the power-current to the motors of the car.

It is well known to those skilled in this art that it is frequently necessary to recharge a storage battery, and for this purpose I provide upon the car suitable switches m, n, and o. The switch m is preferably mounted upon the member f, is insulated therefrom, and is movable into and out of contact with terminals 25 and 26. The switch n is provided on the member f of the controller F' and is movable into and out of contact with a terminal 27. The terminals 25 and 27 are connected to each other by a suitable conductor 28. The switch o is movable into and out of contact with a terminal o', connected to the conductor g, and is connected thereto when desired to recharge the battery G, as shown by dotted lines, Fig. 1. The terminal 26 is connected to the switch o by a suitable conductor 29 and a resistance-coil p. When desired to recharge the battery G, the switch o is moved to the position indicated by dotted lines, Fig. 1, the switch H is moved to the position indicated by full lines in said figure, and the switches m and n are moved into contact with the terminals 25 26 and terminal 27. The power-current then passes from the main conductor C to the conductor 1 through the switch 4, conductor 5, contact-pieces 6, conductors 7 and 8, member 9 of the controller F', the conductor 28, contact-piece m of the controller F, through the line 29 and switch o to one pole of the battery. The current then passes from the battery through one pole of the switch H along the conductors 1 and 14, 15, and 16 and contact-pieces 17, through the sectional conductor B', wire 17, coil 19, and the conductor 20 to the rail a'. After this operation the switch o is returned to its normal position. (Indicated by full lines, Fig. 1.) The switches m and n and contact-pieces f' are so relatively arranged to the contact-points of the controller that when the controllers are being thrown open from any operative position the contact-points g are still electrically connected to the contact-pieces f' for the purpose of retaining sufficient current to energize the coils 19 and hold the switches E in their operative position. When the switches m and n are in contact with the terminals 25, 26, and 27, the contact-points g g' are out of engagement with the contact-pieces f', thereby entirely cutting out the motors from the power-circuit.

The switches E are usually arranged in pairs and supported in a suitable metallic casing e, having a removable cover e' and an insulating-support E'. The object of arranging the switches in pairs is for the purpose of inclosing the same in a single casing, which may be arranged in proximity to the contiguous ends of adjacent sections of the sectional conductors B B'. As seen in Figs. 2, 3, and 4, this switch consists of a coil 19, movable core 30, and the means 4 for connecting the terminals 2 and 3 to each other. The coil 19 is wound upon a metallic spool 31, provided with a central aperture 32 for receiving the core 30. The means 4 for connecting the terminals 2 and 3 preferably consists of a body of mercury or similar material resting in a cup-shaped support 33, said support being formed of insulating material and secured to the core 30 of the solenoid 19.

The switch E is supported in a metallic casing 34, provided with a removable cap 35, and a bushing 36, formed of insulating material, for supporting the terminals 2 and 3. The casing 34 is preferably formed cylindrical and is provided with a contracted chamber 37 at its lower end and with passages 38, leading from said lower chamber to the interior of the casing 34. This chamber 34 and subchamber 37 are usually filled with oil or similar material, which extends to a point above the mouth of the cup 33 and being of less specific gravity than the mercury is permitted to flow over the top of the cup and float upon the surface of the mercury. The advantages of thus filling the chamber with oil will be readily apparent to those skilled in the art, and it is thought unnecessary to herein further describe its various uses.

The core 30 of the solenoid-switch E is formed of magnetizable material and is provided with a stop-shoulder, as a flange 40, which preferably engages the lower face of the spool 31, for limiting the upward movement of the core when the coil 19 is energized. The core 30 is so relatively arranged to the solenoidal coil 19 that when the core has reached the limit of its upward movement the upper end of said core is still in a plane beneath the uppermost helix of the coil 19 in order to maintain a positive magnetic tension upon the core by means of the solenoid.

It will be readily understood by those skilled in the art that forming the inclosing case 34 of the switch E of iron reduces the reluctance to the magnetic lines of force and greatly adds to the efficiency and power of the current passing through the solenoidal coil 19.

The inclosing case *e* is usually supported in proximity to the sectional conductors B B′ and is provided with grooves 44, extending downwardly from the top faces of its side and end walls for receiving suitable flanges 45, formed upon the cap or cover *e′*. The casing *e* is preferably embedded in suitable insulating material, as cement, the cap *e′* being exposed and removable for permitting access to the interior of the case *e* when desired.

It will be evident from the foregoing description and the accompanying drawing that when the switches *m* and *n* of the controllers F F′ are engaged with their respective terminals 25 26 and the terminal 27 the power-circuit is shunted from the motors through the line 28, thereby forming an independent circuit having the solenoidal switches in electrical connection therewith. These switches *m* and *n* are actuated by the movable members of the controllers and are so arranged relatively to the controllers that when said movable members are actuated to open one of the circuits they also serve to simultaneously close the other circuit, thereby maintaining a continuous flow of the power-current to the controllers of the car and through the solenoids in electrical connection therewith.

The operation of my invention will now be readily understood upon reference to the foregoing description and the accompanying drawing, and it will be noted that, if desired, the sectional conductors B B′ may be substituted by any suitable equivalent—as, for instance, the metallic sections of these conductors may consist of mere contact points or buttons, and the contact-pieces 6 and 17, carried by the car, may be correspondingly lengthened or otherwise formed or arranged to effect the desired result. It will be further noted that although the drawings show an ordinary rheostat-controller for the power-current it is evident that any form of controller may be employed and that the detail construction and arrangement of the various switches, electric connections, and other parts of my invention may be considerably varied without departing from the spirit thereof. Therefore I do not limit myself to such precise constructions, arrangements, and combinations as are herein shown and described, and instead of connecting the switches E as shown in Figs. 2, 3, and 4 for a single-track system I may employ the means shown in Fig. 5 when desired to use these switches in connection with a double-track system.

Having thus fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In an electric-railway system, a main conductor for the power-current, a track having one or both of its rails adapted to form a conductor for the return power-current, a sectional conductor interposed between the rails of the track, a second sectional conductor arranged at the opposite side of the return-current rail, normally open connections between the main power-conductor and the sections of the first sectional conductor, a switch for closing said connection, and an additional connection between the return-current rail and the second sectional conductor, said additional connection being connected in the power-circuit and provided with means for electrically operating the switch.

2. An electric switch comprising separated terminals, a solenoid connected in an electric circuit, a core movable within the solenoid, and a support formed of insulating material and provided with a metallic fluid for electrically connecting said terminals, said support being actuated by the core and returned by its own gravity.

3. An electric switch comprising separated terminals, a solenoid, a core movable within the solenoid, means for limiting the movement of the core, and a cup-shaped support formed of insulating material secured to the core and provided with a metallic fluid for electrically connecting said terminals when the solenoid is energized, said core being movable by gravity for disconnecting said terminals when the solenoid is deënergized.

4. An electric switch comprising separated terminals of an electric circuit, an electric coil, a core of magnetizable material movable within the coil, a support connected to the core and provided with means for electrically connecting the terminals, a shell surrounding the coil, and a lubricant within the shell and extending above the contact-points of the terminals.

5. An electric switch comprising separated terminals of an electric circuit, an electric coil, a metallic core movable within the coil and provided with means insulated from the core for electrically connecting said terminals, and means for limiting the movement of the core for preventing the core from assuming its neutral position as the coil is energized.

6. An electric switch comprising separated terminals of an electric circuit, an electric

coil, a core movable within the coil, a support secured to the core and formed of insulating material, a metallic fluid carried by the support for electrically connecting said terminals, in combination with a metallic shell inclosing the switch, and provided with a subchamber alined with the core and passages connecting said subchamber with the interior of the shell, and a lubricant fluid supported within the shell and extending above the contact-points of the terminals.

7. The combination with a shell having its lower end formed with a subchamber and passages connecting said chamber with the interior of the shell and its upper end provided with a removable cap having a detachable bushing formed of insulating material, separated terminals of an electric circuit supported by said bushing and projecting into the shell, a hollow spool formed of non-magnetizable material supported within the shell above said chamber, an electric coil wound upon the spool, a magnetizable core movable within the spool and having its lower end provided with a flange movable in said chamber and adapted to engage the lower face of the spool, said core being formed of less length than the length of the coil, a support secured to the core and formed of insulating material, and a metallic fluid carried by the support for electrically connecting the terminals when the coil is energized, said core being movable by gravity into the chamber for disconnecting said terminals when the coil is deënergized, and a lubricant within the shell and chamber and extending above the contact-points of the terminals.

8. In an electric-railway system, the combination with main and return conductors, sectional conductors arranged on opposite sides of one of the return-conductors, a plurality of switches, electric connections between the sections of one of the sectional conductors and the switches and connected to the main conductor, and additional electric connections between the other sectional conductor and the return-conductor, said additional conductors being provided with means connected to each other for simultaneously actuating the switches.

9. An electric-railway system comprising a main conductor and sectional conductors, a switch connected in circuit between the main conductor and the sectional conductors, a motor-actuated vehicle, means provided on the vehicle and adapted to be connected in the power-circuit for transmitting the power-current to and from the motors of the vehicle and for maintaining the power-current through the switch when the motor is stopped, and a source of electric energy provided on the vehicle for operating said switches independently of the motor-circuit.

10. A controller for electric-motor circuits comprising a resistance-coil having a plurality of contact-points of variable resistance, a contact-bar arranged substantially parallel with the contact-points and connected to the point of greatest resistance, and an arm having contact-pieces electrically connected to each other for simultaneously engaging the contact-points and bar.

11. The combination with main and sectional conductors of an electric-railway system, of an electrically-operated switch between said conductors, a vehicle provided with a motor, a contact-plate electrically connected to a series of contact-points in the power-circuit, and a movable member electrically connected to the sectional conductor of the power-circuit and provided with contact-pieces adapted to engage the contact-plate and said points independently of each other and to maintain the power-circuit through the switch when the motor is deënergized.

12. In an electric-railway system, the combination of sectional conductors for the main and return current of a power-circuit, of an electrically-operated switch connected in the power-circuit, a vehicle having a motor and contact-pieces electrically connected in the power-circuit, a contact-plate, and contact-points electrically connected to each other and to the power-circuit, and a movable member electrically connected in the power-circuit and normally in contact with the plate and points and adapted to contact with the plate independently of said points and to shunt the power-current through the switch when the motor is deënergized.

13. A controller comprising separated terminals of an electric circuit, a contact-plate electrically connected to one of the terminals and to a series of contact-points, a movable member electrically connected to the other terminal and movable into and out of contact with said plate and points, in combination with a normally open independent circuit, means provided on the movable member and insulated therefrom for closing the circuit.

14. In an electric-railway system of the class described, the combination with a motor-circuit, controllers for making and breaking said circuit, an additional circuit independent of the motor-circuit, and means actuated by the controllers for closing the independent circuit simultaneously with the opening of the motor-circuit.

15. In an electric-railway system of the class described, the combination with a motor-circuit, an additional circuit independent of the motor-circuit, of an electrically-operated switch connected in said circuits, and a controller provided with means for simultaneously opening one circuit and closing the other for the purpose set forth.

16. In an electric-railway system of the class described, the combination with a motor-circuit, an additional circuit independent of the motor-circuit, of an electrically-operated switch connected in said circuits, a controller provided with means for simultaneously opening one circuit and closing the other for the purpose set forth, a battery con-

nected in the independent circuit, and a second switch for shunting the power-current through the battery.

17. In an electric-railway system of the class described, the combination with a motor-circuit, an additional circuit independent of the motor-circuit, of an electrically-operated switch connected in said circuits, a controller provided with means for simultaneously opening one circuit and closing the other for the purpose set forth, a battery connected in the independent circuit, a second switch for shunting the power current through the battery, and a resistance-coil between one of the controllers and the second switch.

18. A controller comprising separated terminals of an electric circuit, a third terminal adapted to be connected in said circuit, and a movable member electrically connected to one of the former terminals and movable into and out of contact with the other of said former terminals, said movable member being adapted to contact with the third terminal simultaneously with its breaking contact with the other of the former terminals for the purpose described.

19. A controller comprising separated terminals of an electric circuit, a contact-plate electrically connected to one of the terminals and to a series of contact-points, a movable member electrically connected to the other terminal and movable into and out of contact with said plate and points, said plate and contact-points being so relatively arranged that the movable member may be in contact with the plate when out of contact with the points for the purpose described.

20. An electric-railway system comprising a main circuit and a battery-circuit, sectional conductors or contacts and switches connected in said circuits, contacts on the car for closing the circuits through the sectional conductors and switches, controllers for regulating the power-current to the motor, said controllers being arranged to maintain the power-current through the switches when the motors are deënergized, and a circuit-changing switch connected in both circuits for the purpose of operating the switches by either the power or battery circuit.

21. In an electric-railway system, a motor or power circuit, a battery-circuit independent of the motor, a shunt-circuit independent of the battery-circuit and motor and adapted to be connected in the power-circuit, a solenoid-switch having its coil connected in the battery and shunt circuits, a controller for the power-circuit and provided with means for closing the shunt-circuit before the power-circuit is cut out, and a circuit-changing switch for alternately closing the shunt and battery circuit through said solenoid-coil.

22. In an electric-railway system, a motor or power circuit, a battery-circuit independent of the motor, a shunt-circuit independent of the battery-circuit and motor and adapted to be connected in the power-circuit, a solenoid-switch having its coil connected in the battery and shunt circuits, a controller for the power-circuit and provided with means for closing the shunt-circuit before the power-circuit is cut out, and a circuit-changing switch for alternately closing the shunt and battery circuit through said solenoid-coil and an additional switch arranged to break the shunt-circuit through said solenoid-coil and to close the power-circuit through the battery for recharging the same.

In witness whereof I have hereunto set my hand this 29th day of September, 1900.

JOHN RYAN.

Witnesses:
A. GOODALE,
E. L. CLAIRMONT.