No. 765,653. PATENTED JULY 19, 1904.

W. GRUNOW, Jr.

ELECTRICAL SWITCH OPERATED BY ELECTROMAGNETS.

APPLICATION FILED FEB. 7, 1902. RENEWED NOV. 27, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

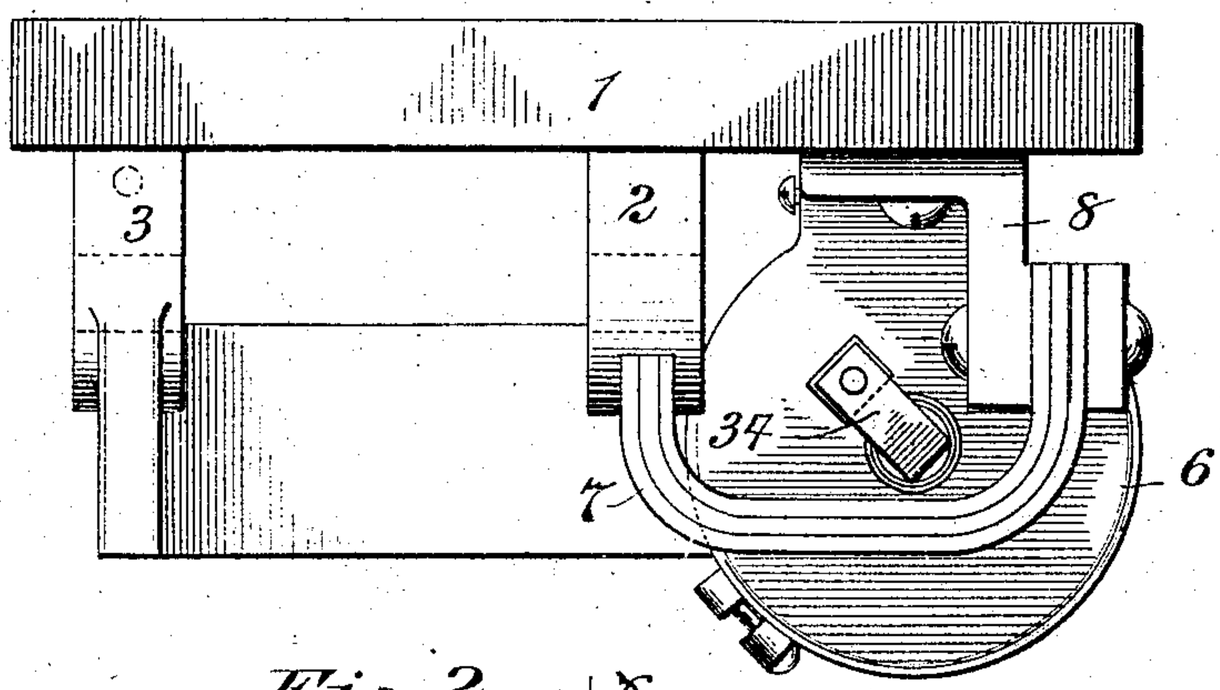

Fig. 2.

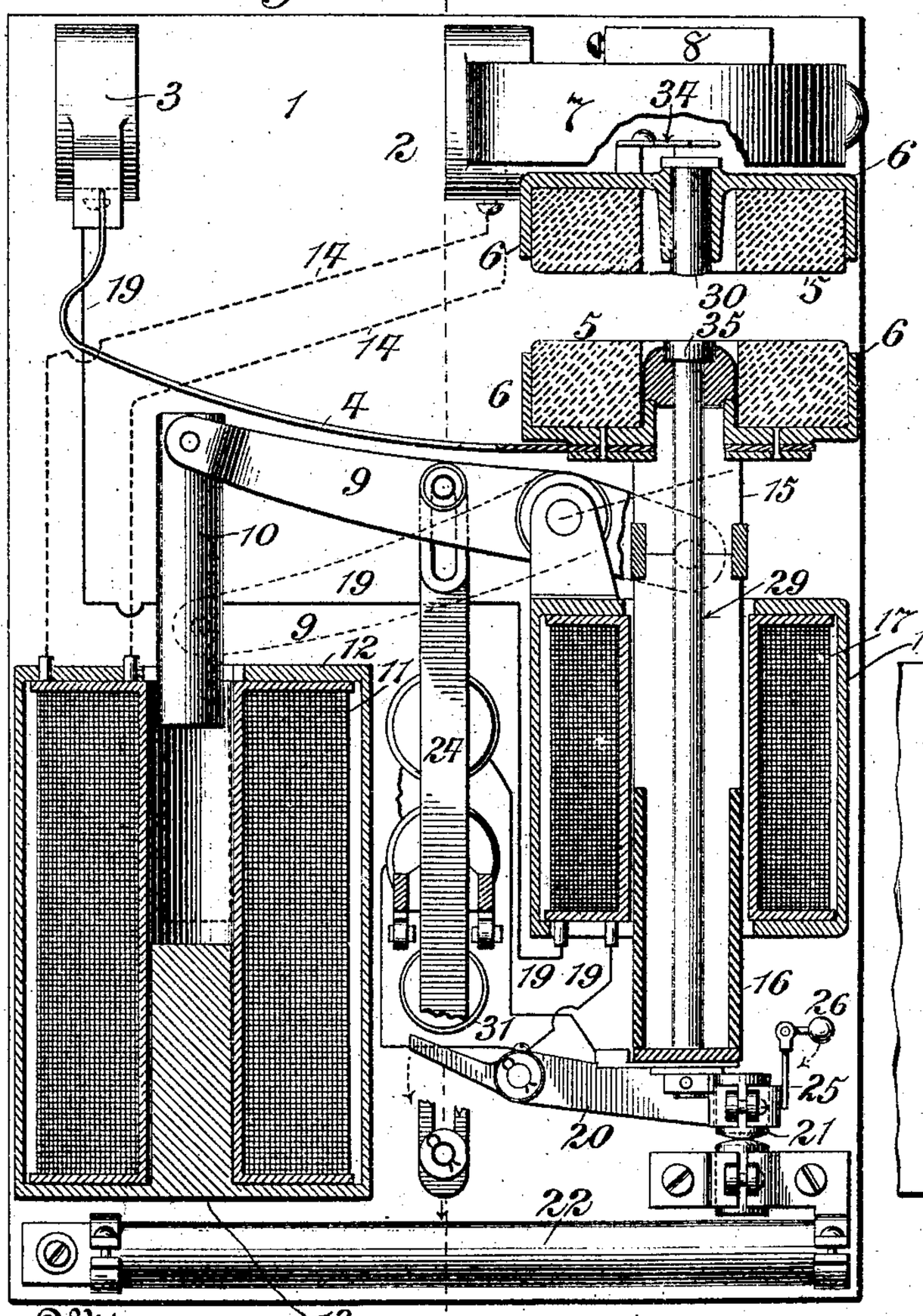

Fig. 3.

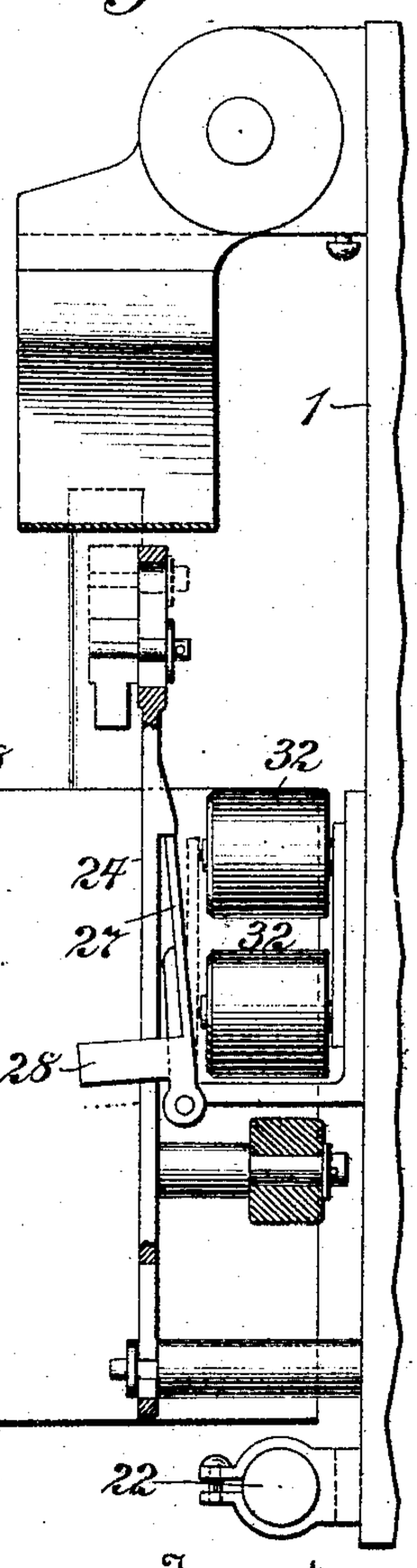

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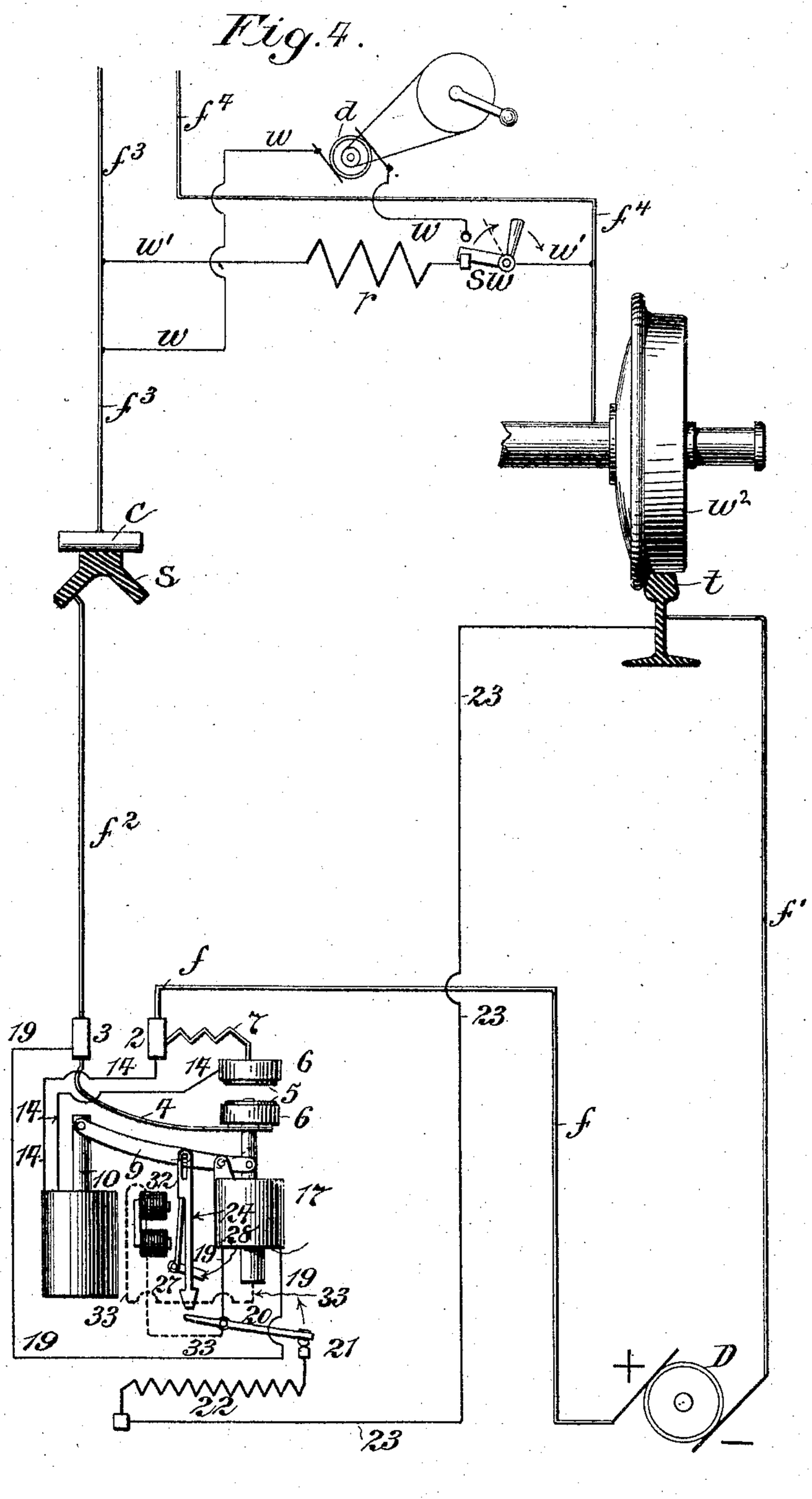
Fig. 4.



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UNITED STATES PATENT OFFICE.

WILLIAM GRUNOW, JR., OF BRIDGEPORT, CONNECTICUT.

ELECTRICAL SWITCH OPERATED BY ELECTROMAGNETS.

SPECIFICATION forming part of Letters Patent No. 765,653, dated July 19, 1904.

Application filed February 7, 1902. Renewed November 27, 1903. Serial No. 182,910. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM GRUNOW, Jr., a citizen of the United States, residing at Bridgeport, in the county of Fairfield and State of Connecticut, have made a new and useful Invention in Electrical Switches Operated by Electromagnets, of which the following is a specification.

My invention is directed particularly to improvements in switches for effecting the manipulation of currents of great quantity and high potential difference—such, for instance, as are used in connection with electric railways and power systems generally utilizing electricity; and it has for its objects, first, to provide a switch which will effectually close and interrupt the circuit without damaging arcing and also without "chattering;" second, to provide a switch in which the closing of the circuit is effected by or through the agency of a grounded circuit which is interrupted a definite time after the working circuit has been closed and in such manner that the working current is not interfered with in its functions or permitted in any way to damage the apparatus; third, to provide means on board of a moving car whereby the switches of a sectional-third-rail system may be primarily closed by an independent or local source of electrical energy carried by each car or train when the current has been interrupted for any particular third rail over which the car may be traveling and to combine therewith means for enabling the working current to automatically effect the same result successively as the car passes over the route; fourth, to provide a switch having the especial details of construction described, and illustrated in the accompanying drawings.

Referring now to the drawings for a full and clear understanding of the invention, such as will enable others skilled in the art to construct and use the same and to practice the methods accomplished by such use, Figure 1 is a plan view of the novel switching apparatus as seen looking at Fig. 2 from the top toward the bottom of the drawing. Fig. 2 is a side elevational view of the switch as seen looking at Fig. 1 from the bottom toward the top of the drawing, the operating-solenoids, the working-current terminals, and certain of the connected parts being shown in sectional view. Fig. 3 is a sectional view taken through Fig. 2 on the line x x and as seen looking thereat from right to left, the principal operating-solenoid, however, not being visible in this view. Fig. 4 is a diagrammatic view illustrating the switch as operatively connected to a power-house generator, a sectional third rail or conductor, and one of the tram-rails, diagrammatic circuit connections between the sectional conductor, the means for primarily closing the working circuit to any sectional conductor, and the circuit connections therefrom to and through one of the wheels of a car to earth being also shown.

With the electromagnetically-controlled switches for sectional systems of electric railways such as have heretofore been devised much annoyance has resulted from damaging arcing at the working contacts or terminals and from what is known in the art as "chattering" between said contacts or terminals, owing to the fact that as a rule such switches are operated by electromagnets or solenoids of the double-coil type—that is to say, a primary or high-resistance coil is utilized to cause a solenoid-core carrying the movable terminal to primarily effect the closure of the circuit, after which the terminals are held in permanent contact with each other by the working current flowing directly through a low-resistance coil which acts upon the same solenoid-core, the ampere-turns of the coil being in series relation with the working current to the motor or other translating device designed to utilize such current. My invention is designed to overcome this objectionable feature, and to this end I provide a solenoid or electromagnet which primarily acts upon a solenoid-core operatively connected with the movable terminal in such manner that the working circuit is first closed by the action of this solenoid, and when thus closed a multiple arc or branch circuit from the working circuit is closed through a low-resistance solenoid acting upon a balanced lever connected with the movable terminal, which lever is proportionately so fulcrumed as to effectually hold the terminals in working contact with

each other, after which the first-named circuit is broken by a releasing device, a definite time interval occurring between the time that the working circuit is first closed and the circuit-closing circuit is interrupted, thus causing the operation of the apparatus to be effected through a series of successive steps, which avoid or prevent both arcing and chattering.

Referring now to the drawings in detail, in all of which like letters and numerals of reference represent like parts wherever used, D represents a power-house generator operatively connected by current feeders or mains f and f' to metallic terminals 2 in switch-boxes and one of the tram-rails t.

s is a sectional third rail, and f^2 a branch feeder running to a second metallic terminal 3 in the switch-box.

c is a current-collector or trolley carried by a moving car, one of the wheels w^2 of which is shown resting upon the tram-rail t.

f^3 f^4 are the motor-feeders running from the current-collector or trolley to the usual controller and motor. (Not shown.)

d is a local source of electrical energy, as a magneto-machine carried by each car and operatively connected by a conductor w to one of the motor-feeders f^3 on one side and adapted to be connected on the other side to a switch sw, the pivotal part of which is connected in turn by a conductor w' to the negative motor-feeder f^4 and to earth through the car-wheel w^2.

r is a resistance located in the shunt-circuit w' between the motor-feeders f^3 and f^4 and adapted to be connected in circuit with the switch sw. In other words, the local source of electrical energy d and the resistance r are adapted to be connected at will by the switch sw in multiple with the propelling-motor carried by the car.

Referring now to the switching apparatus proper, (shown in enlarged views in Figs. 1, 2, and 3,) 5 5 represent carbon terminals, both of which are secured in conducting-cups 6, the upper one being the fixed terminal electrically connected with the metallic terminal 2 by an angle-arm 8 and conductor 7 of relatively low resistance.

1 is an insulating base-board, to which the two metallic terminals 2 and 3 and all of the operative parts of the switch are secured.

4 is a flexible conductor connected to the metallic terminal 3 and to the lower surface of the metallic cup 6, which secures the lower movable carbon terminal 5, said cup and carbon terminal being supported by an insulating sleeve or pin 15, to the lower end of which is secured a solenoid-core 16, all of said parts being pivotally supported by a proportional lever 9, fulcrumed, as shown, above an iron-clad operating-solenoid 17, 18 being the iron-clad structure. To the free end of the proportional lever 9 is secured a solenoid-core 10, adapted to move vertically into the magnetic field of a second iron-clad solenoid 11, 12 representing the iron-clad portion thereof.

14 is a branch or shunt circuit of relatively large current-carrying capacity operatively connected to the coils of the solenoid 11, which coils, it will be understood, are of relatively low resistance and bear a definite or fixed proportion to the low-resistance conductor 7. In other words, the low-resistance coil 11 is in shunt-circuit to the conductor 7 and adapted to utilize a part of the working current for holding the terminals 5 5 in working relation with each other.

19 is a conductor running from the metallic terminal 3 to the relatively high resistance solenoid 17 and thence to the pivotal point of a switching-lever 20, one end of which is located in the path of a tripping device 24, the other end thereof making electrical contact by carbon contacts 21 21 with a resistance pencil or coil 22, operatively connected by a branch conductor 23, running to earth at the tram-rail t.

25 is a pivoted arc-interrupting device of well-known form, provided with a weight 26, adapted to extinguish the arc between the carbon contacts 21 when the pivoted lever 20 is actuated by the tripping device 24. This arc-interrupting device consists of an insulating-plate of mica or other equivalent material 25, which is held normally out of the path of the movable carbon contact 21 when in its lower position. When, however, the circuit is interrupted between the carbon contacts 21, the insulating-plate 25 of the pivoted arc-interrupting device is forced between the electrodes by the weight 26 as the movable contact ascends, thereby interrupting the arc in a manner well understood by those skilled in the art, such devices being in general use in connection with snap-switches and in places generally where abnormal arcs occur. The tripping device 24 is slotted, as shown, at its upper end and guided in its vertical movement by a pin secured to the proportional lever 9, said tripping device being normally held in its upper position by an armature-lever 27, provided with a weighted arm 28.

32 is a releasing-electromagnet included in a branch circuit 33, running from the lever 20 to the lower end of a conducting-rod 29, located in the axis of the insulating-sleeve 15 and having a conducting-head 35 at its upper end effectually insulated from the carbon block 5 of the movable terminal and adapted to make electrical contact when said terminal is moved upward with a sliding conducting-pin 30, resting by its own weight in an opening through the upper cup 6, 34 being a spring for yieldingly receiving the upper end of said pin, the function of this pin being to prevent any possibility of unevenness of contact between the carbon terminals 5 as they wear away.

The operation is as follows: Suppose that the sectional third rail or conductor *s* is for the time being disconnected from the current-feeder *f*. The switch *sw* on board the car is turned in the direction of the arrows until its free end closes the circuit for the local source of electrical energy *d*. This is set in motion either by hand, compressed air, or in any preferred manner, or a secondary or primary battery may be substituted therefor, if preferred, and a current is established by the conductor *w* through the motor-feeder f^3, current-collector or trolley *c*, sectional third rail *s*, branch feeder f^2, metallic terminal 3 in the switch-box, conductor 19, high-resistance solenoid 17, lever 20, carbon contacts 21, resistance 22, branch conductor 23, tram-rail *t*, car-wheel w^2, motor-feeder f^4, conductor w' to the switch. This causes the solenoid-core 16 to be elevated until the terminals 5 5 are brought into contact with each other. At this instant the working current is closed from the power-house dynamo D by the feeder *f*, metallic terminal 2, conductor 7, carbon terminals 5 5, flexible conductor 4, metallic terminal 3, branch feeder f^2, sectional third rail *s*, current-collector *c*, motor-feeder f^3, the controller and motor on board the car to the negative motor-feeder f^4, by the car-wheel w^2 to the tram-rail *t*, and negative feeder f' to the starting-point. At the same time a multiple or branch circuit is closed through the conductor 14 and low-resistance coils of the solenoid 11, causing the solenoid 10 to maintain the terminals 5 5 in firm contact with each other under the influence of the proportional lever 9. A branch circuit is also closed from the current-feeder *f*, conductor 7, cup 6, sliding pin 30, head 35, rod 29, conductor 33, releasing-electromagnet 32 to the pivoted lever 20, carbon contacts 21, resistance-pencil 22, branch conductor 23 to the tram-rail *t* and to the negative pole of the generator. This energizes the releasing-magnet 32, causing its armature-lever 27 to be drawn forward, and thus release the tripping device 24, so that it falls by its own weight with its lower end coming into mechanical contact with the short arm of the circuit-breaking lever 20, thus interrupting the circuit at the contacts 21 and ultimately allowing the arc-interrupting device 25 to pass between said carbon contacts. These successive steps of closing the circuit through the releasing-magnet and allowing the tripping device to descend by its own weight consume a definite interval of time, so that the working circuit is first closed effectually before these steps are culminated, thereby assuring the fact that the working current will be fully established between the terminals before any disturbance is put upon the device which brought about or effected such closure. Consequently there is no arcing under any condition of usage between the terminals 5, nor is there any chattering of the terminals. After the circuit is thus established through the controller and motor on board the car the switch *sw* is turned in a reverse direction, so as to include the resistance *r* in the shunt-conductor w', so that as the car advances and the current-collector passes from one sectional third rail to another a branch of the working current flows through the resistance and the operating-electromagnets 17. By preference the current-collector or trolley *c* should be of sufficient length, or there should be two or more of these collectors or trolleys separated from each other by definite intervals, so as to insure the absolute movement of the solenoid-cores until the terminals are brought into working contact with each other.

When the current-collector or trolley leaves the third rail *s* and enters upon the next adjacent third rail, the working current is of course interrupted, so that now the weight of the parts, including the lower or movable terminal 5, cup 6, rod 35, and solenoid-core 16, causes the proportional lever 9 to be tilted about its fulcrum, thus lifting the tripping device 24 into its upper position, as shown in Fig. 4, so that it will be locked by the locking armature-lever 27.

By the expression "proportional" or "proportioned" lever (indicated by the numeral 9 in the drawings and referred to in the specification and claims) I wish to be understood as meaning a lever having a long and a short arm so proportioned that a delicacy of operation is effected whereby the terminals are held together by the action of the solenoid 11 upon its core 10 with the greatest nicety, such an arrangement making it possible to secure a certainty of action whereby the terminals are always maintained in contact with each other when working current is flowing through the branch feeder f^2, running to its corresponding sectional conductor or third rail *s*.

I do not limit my invention to the especial details of construction disclosed in the accompanying drawings and hereinbefore described, as obviously many of said details might be materially departed from and still come within the scope of my claims hereinafter made. I believe it is broadly new with me to devise an electromagnetically-controlled switch in which arcing and chattering are prevented by introducing an element of time in the operation between the time of the closure of the working circuit and the breaking of the closing-circuit to such an extent as to insure absolute working contact, and my claims are generic as to this feature. I believe it is also broadly new with me to utilize a multiple-arc branch of the working current for maintaining the working circuit closed after such closure is effected, and my claims are generic as to this feature.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. In a system of electrical energy an electromagnetic circuit-closing switch embracing a fixed and a movable terminal and an electromagnet for causing the movable terminal to move into contact with the fixed terminal; in combination with a second electromagnet the coils of which are in shunt relation to the working circuit and the armature or core thereof operatively connected to the movable terminal, substantially as described.

2. In a system of electrical energy a switch embracing a fixed and a movable terminal; a conductor of relatively low resistance connected to the movable terminal and in series relation with the source of current-supply; in combination with means for bringing the movable terminal into contact with the fixed terminal; together with an electromagnet or solenoid having its coils connected in shunt relation with the aforesaid resistance, the movable part of the electromagnet or solenoid being operatively connected with the movable terminal and the latter electrically connected to a translating device, substantially as described.

3. In a system of electrical energy a source of current-supply, a conductor of relatively low resistance connected in series therewith; a fixed conducting-terminal connected to said low resistance; a movable terminal normally disconnected from said fixed terminal and electrically connected to a translating device; in combination with an electromagnet or solenoid having its movable part operatively connected to the movable terminal and its coils included in circuit with a source of current-supply; together with a second electromagnet or solenoid the movable part of which is operatively connected with the movable terminal and its coils located in shunt relation to the aforesaid resistance, substantially as described.

4. An electromagnetic switch embracing a fixed terminal operatively connected with a source of current-supply including a conductor of relatively low resistance and a movable terminal operatively connected with the movable part of an electromagnet or solenoid included in a high-resistance circuit; in combination with a second electromagnet or solenoid having its movable part operatively connected with the movable terminal and its coils located in shunt relation to the aforesaid resistance; together with a circuit-interrupting device included in circuit with the coils of the first-named magnet and a tripping device adapted to automatically interrupt the high-resistance circuit after the working circuit has been closed for a definite interval of time, substantially as described.

5. An electromagnetic switch embracing a fixed and a movable terminal, the movable terminal being operatively connected with the movable part of an electromagnet or solenoid, the coils of which are included in a relatively high resistance circuit, including also a circuit-interrupting device; in combination with a second electromagnet or solenoid operatively connected with the movable terminal and having its coils in shunt relation to the working circuit; together with a third electromagnet or solenoid having its coils included in a normally open circuit embracing the fixed and movable terminals; a gravity-actuated tripping device held in its upper position by the armature of the last-named magnet and all so interconnected that the first-named magnet causes the circuit to be closed between the electrodes, and the second magnet holds the circuit thus closed; while the third magnet releases the tripping device and causes the circuit of the first magnet to be permanently interrupted after a definite interval of time, substantially as described.

6. An electromagnetic switch embracing a fixed and a movable terminal and a circuit-closing magnet having its movable part operatively connected to the movable terminal; together with a second electromagnet or solenoid having its movable part connected to the movable terminal by a proportioned lever and its coils in shunt relation to the working circuit, substantially as described.

7. An electromagnetic switch embracing a fixed and a movable terminal; a circuit-closing magnet having its movable part operatively connected to the movable terminal; a second electromagnet having its movable part operatively connected to the movable terminal, and an automatic circuit-breaking device adapted to break the circuit of the first-named magnet after the working circuit has been closed for a definite interval of time, substantially as described.

8. An electrically-propelled car provided with a pair of motor-feeders including the propelling-motor; a local source of electrical energy and a resistance connected in independent branch circuits to one of the motor-feeders; in combination with a switch adapted to connect either the local source of current-supply or the resistance to said feeders in multiple with the propelling-motor.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM GRUNOW, JR.

Witnesses:
C. J. KINTNER,
M. F. KEATING.