No. 690,499. Patented Jan. 7, 1902.

H. P. WELLMAN.

ELECTRIC RAILWAY SYSTEM.

(Application filed Oct. 9, 1896. Renewed June 18, 1900.)

(No Model.) 3 Sheets—Sheet 1.

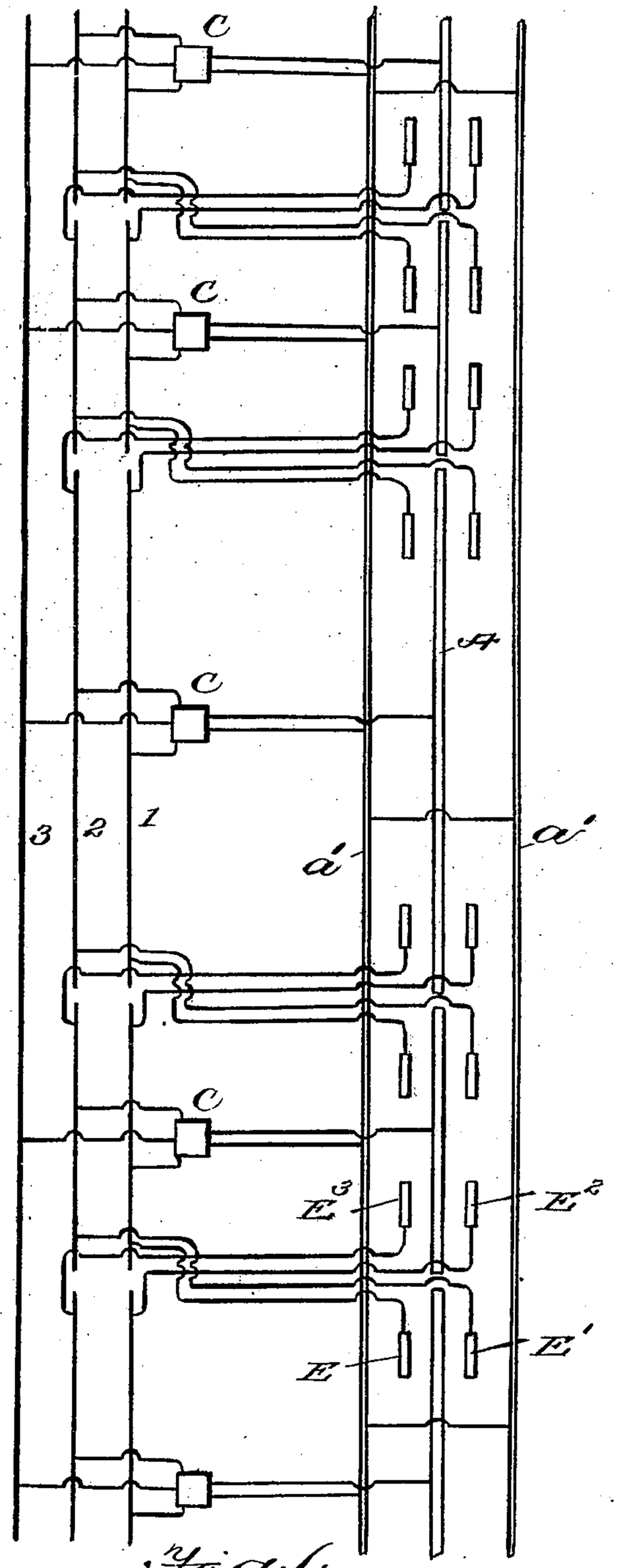

Fig. 1.

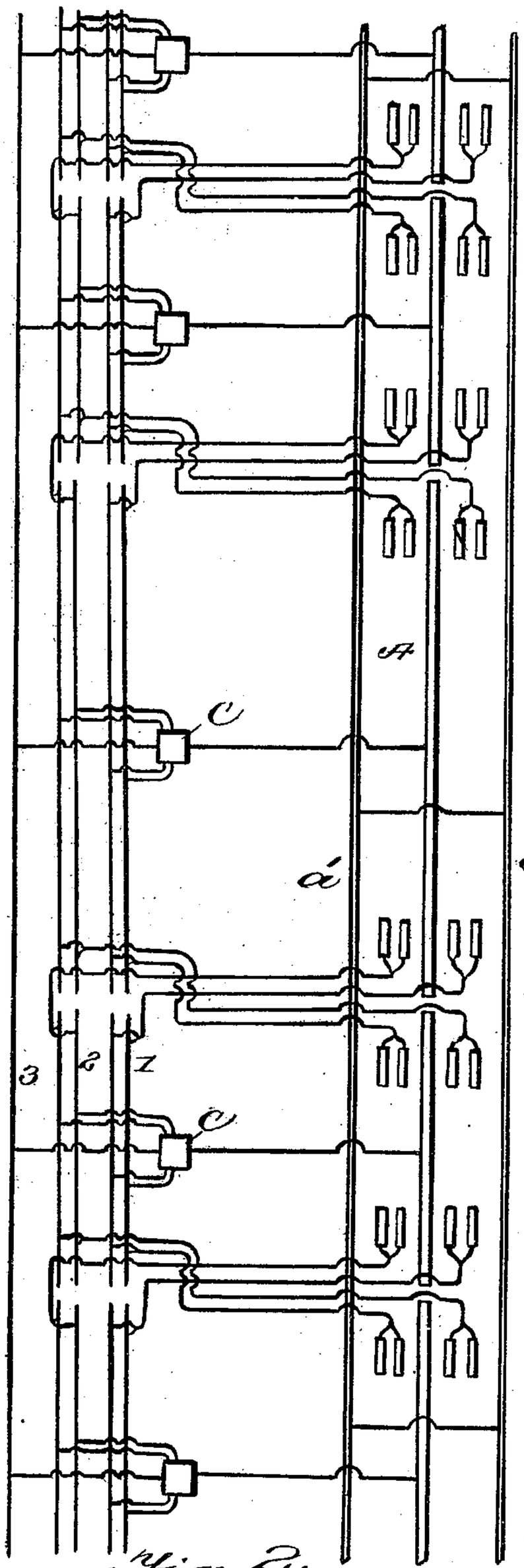

Fig. 2.

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(No Model.) 3 Sheets—Sheet 2.

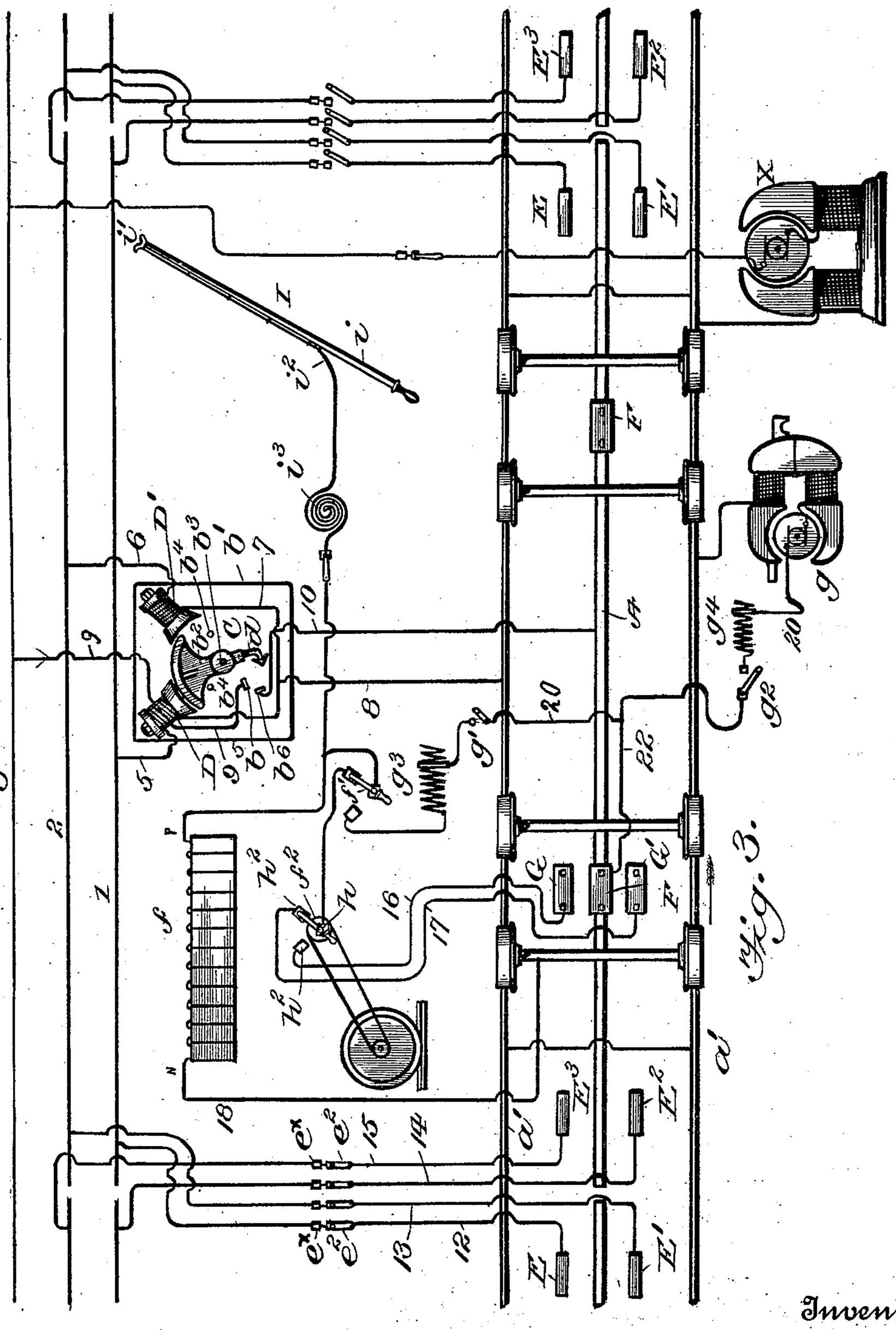

Fig. 3.

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ELECTRIC RAILWAY SYSTEM.

(Application filed Oct. 8, 1896. Renewed June 18, 1900.)

(No Model.) 3 Sheets—Sheet 3.

Fig. 4.

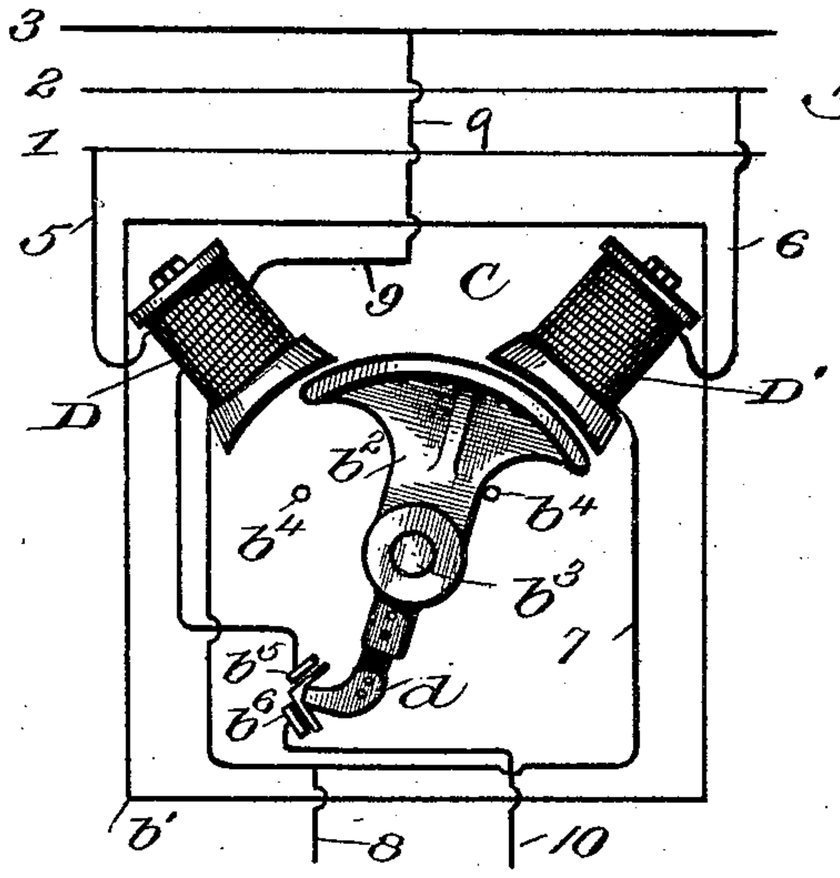
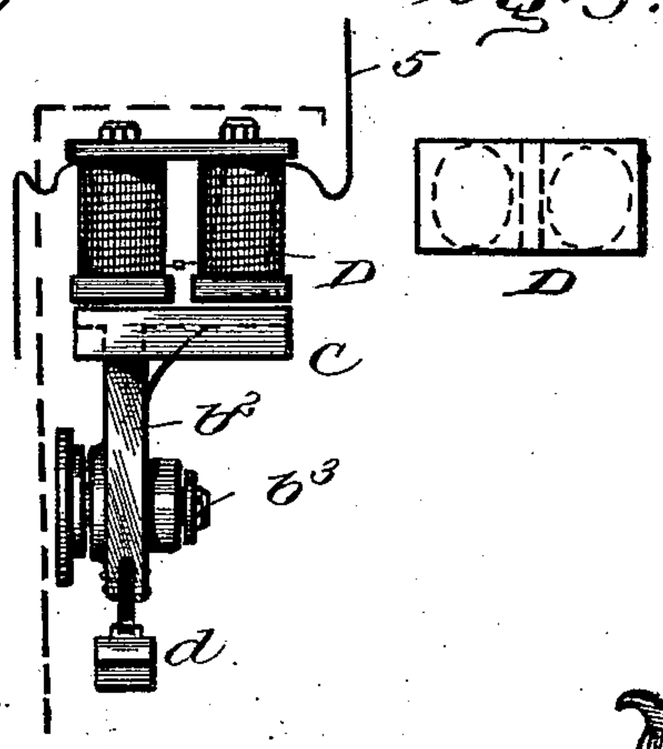


Fig. 5.



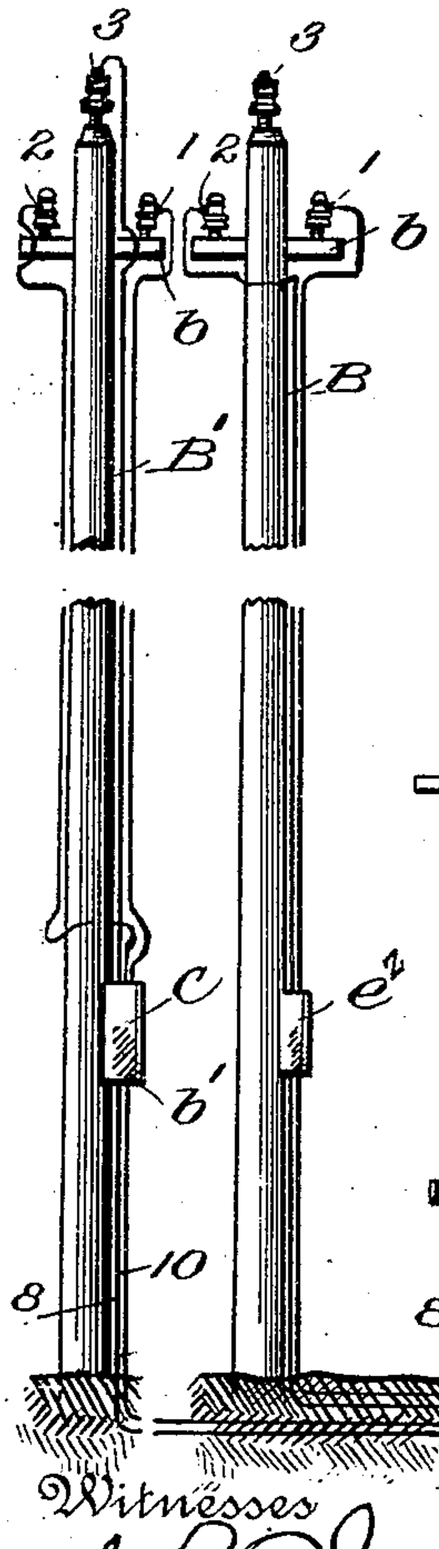


Fig. 7.

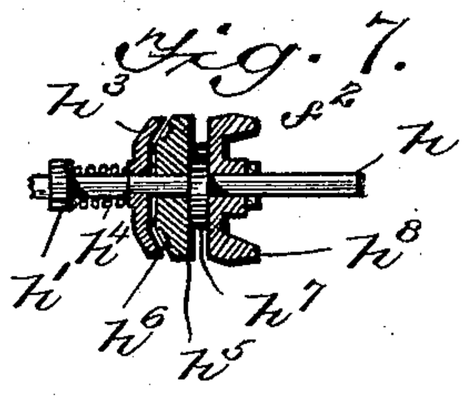


Fig. 8.

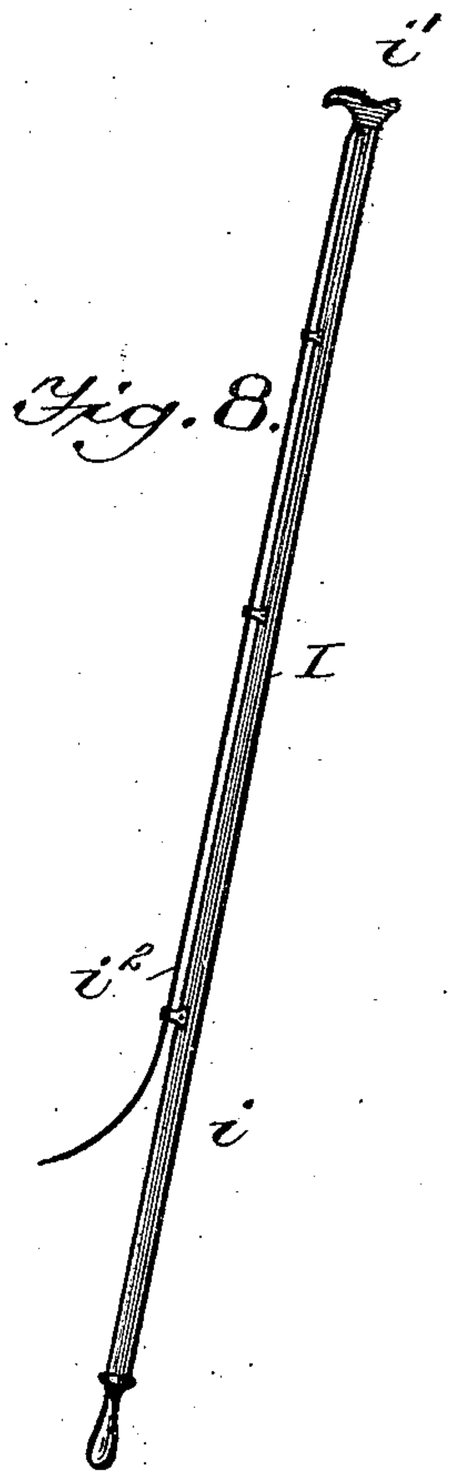


Fig. 6.

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UNITED STATES PATENT OFFICE.

HARLAN P. WELLMAN, OF ASHLAND, KENTUCKY, ASSIGNOR TO THE GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRIC-RAILWAY SYSTEM.

SPECIFICATION forming part of Letters Patent No. 690,499, dated January 7, 1902.

Application filed October 9, 1896. Renewed June 18, 1900. Serial No. 20,764. (No model.)

To all whom it may concern:

Be it known that I, HARLAN P. WELLMAN, of Ashland, in the county of Boyd and State of Kentucky, have invented certain new and useful Improvements in Electric-Railway Systems; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention contemplates certain new and useful improvements in electric railways.

The primary object of the invention is to provide an automatic method of supplying and conveying line or feeder current to a sectional conductor located between the track-rails and in circuit with the motor of a car.

A further object is to provide a simple and highly-efficient system in which an electric current is automatically transmitted through the successive sections of a sectional conductor as the car progresses by means of contact devices carried by the latter and adapted to have a sliding contact or engagement with suitable terminals in circuit with the feed-in wires and said sectional conductor.

A further object is to insure the charging of each conductor-section in advance of the approach of a car and before the latter is in engagement therewith and to also cut out each section as the car passes to the next adjacent section.

A further object is to provide simple and efficient auxiliary means for effecting the charging of each conductor-section in the event of the failure of the primary source to cut the conductor-section into circuit.

The invention will be hereinafter fully set forth, and particularly pointed out in the claims.

In the accompanying drawings, Figure 1 is a diagrammatical view illustrating my improved system. Fig. 2 is a slight modification thereof. Fig. 3 is an enlarged diagrammatical view illustrating the system in connection with batteries, portable contact devices, and trucks of a car. Fig. 4 is an enlarged view of the feed-in switch. Fig. 5 is an edge view of the latter. Fig. 6 is a sectional view illustrating the contact devices and feed-in wires, the automatic battery-switch being shown in two ways, one as viewed at one end and the other diagrammatically. Fig. 7 is a sectional detail view. Fig. 8 is a view of the portable contact device.

Referring to the drawings, A designates my improved sectional conductor, which consists of a series of disconnected plates, each mounted on insulated supports *a*, secured to the ties, said plates being extended longitudinally between the track-rails *a'* on a plane slightly above the tread of the latter. This conductor may be made in sections to conform to the requirements of the road—that is, in isolated sections of the road it may be several miles long or several hundred feet in length, depending entirely upon the condition of the road-bed. In nearing settlements, towns, or cities the sections may be made very short, each section being cut in circuit immediately in advance of the approaching car or train and immediately cut out again after the motor-car has passed to the next succeeding section.

1 and 2 indicate two bare or uninsulated wires running parallel with and corresponding in length to each conductor-section. These wires are strung from cross-arms *b* of poles B. A third wire 3 is strung by poles B and B' and leads from the generator X. This wire should be thoroughly insulated from the ground.

C designates the feed-in switch, one being provided for each conductor-section and located about midway of the ends thereof—that is, it is secured on one of the poles B', located as stated. Each switch is inclosed in a waterproof box *b'*, mounted at a suitable point on pole B'. It comprises an armature b^2, partly balanced and mounted on a pivot b^3. This armature works on what I term an "electromagnetic gravity principle"—that is, the upper end of the armature is heavier than the lower end thereof, so that when said armature is moved under the influence of either one of the magnets the movement will be completed by the action of gravity upon said weighted upper end. There are two separate double magnets D D' for operating the armature, which latter has its upper end adjacent to the pole-pieces of said magnets curved on a radius from its pivoted center. The lower ends of the cores of these magnets are elon-

gated and curved on the same radius as the upper end of the armature, which latter does not contact therewith, a small clearance being left between the opposed faces. Stops b^4 limit the movement of this armature. The magnet D is connected by a wire 5 with bare wire 1, while the magnet D′ is connected by a wire 6 with wire 2. The two magnets are connected by a wire 7, from which leads a ground-wire 8. From supply-wire 3 leads a feed-in wire 9, having a terminal b^5, while to a corresponding adjacent terminal b^6 is connected a wire 10, which leads to one of the sections of conductor A, forming the continuation of the feed-in wire 9. The armature b^2 at its lower end carries a circuit-closer d, which is shown as being of arrow-head shape and is designed to fit between the terminals b^5 b^6 when the armature is attracted by the magnet D′. In this way the current is transmitted to the sectional conductor.

From the above it will be seen that one terminal of the coil of each of the double magnets is connected to the bare wires 1 and 2, while the other terminals are connected to the ground. The current circulating through magnet D′ pulls the armature b^2 over to that side and then closes the main feeder-circuit switch at b^5 b^6, and thus cuts the current into the conductor A, while current circulating in the magnet D draws the armature to that side and cuts out the current of the sectional conductor.

E, E′, E², and E³ designate contact-terminals located between the track-rails on either side of the sectional conductor. Each terminal consists of a plate e, mounted on insulated supports e'. Two terminal-plates are placed near the end of each section, making four terminals within each section. In Fig. 3 one section of the conductor is shown complete, while the adjacent terminals of the adjoining sections are also indicated. To the terminal E is connected wire 12, which leads to bare wire 1 of the complete section, while terminal E′ is connected by a wire 13 to wire 2. The wire 14 of terminal E² connects with wire 1 of the adjoining section and terminal E³ by wire 15 to the wire 2 of said section. These terminal-wires are extended beneath the ground, being suitably insulated, and up posts B. They are passed through waterproof boxes e^3 on said posts, said boxes inclosing fuses $e^\times$ and switches e^2 for each of said wires. It should be noted that means must be provided to prevent both magnets D and D′ of the same section from being simultaneously energized. This will be described hereinafter.

In connection with this system either single or double truck motor-cars may be used. If a single-truck, only one contact-brush F should be used for engaging conductor A; but if a double-truck, one brush is mounted on each truck; but only on one truck are the terminal contact-brushes G G′ arranged. These contact-brushes F G G′ are yieldingly mounted in any suitable manner on the car-truck, (see Fig. 6,) the brush F being located directly above the sectional conductor A, so as to have sliding contact therewith, while the brushes G G′ are on either side of brush F, so that they will have sliding contact with the terminals E E′ E² E³. These latter brushes are maintained at sufficient height above the level of the track-rails to make positive sliding contact with the terminals, and yet not low enough to make contact with the rails when passing switches, crossings, &c. Both of these brushes G G′ are connected by wires 16 and 17 with the positive pole of a storage battery f, located within or on the car by a two-point switch so arranged and connected that one or the other may be made alive with the current; but in no event must both of these brushes be alive with current at the same time. This may be accomplished by an automatic switch f^2, operated by the car-axle and controlled by the direction in which the car travels. The negative wire 18 of the storage battery f is connected to one of the car-axles, using track-return. The cells of this battery need to be only of small capacity for operating magnets of the feed-in switch, or they may be of large capacity and capable of operating motor g, located on the car and connected thereto by a wire 20, having switches g' g^2 and resistance g^3. These cells can be charged direct from the operating-currents through the medium of brush F and wires 20 and 22, the circuit being closed through a switch f' and switch g'. When it is desired to so charge the cells, the switch-arm f' is moved to contact with the terminal of wire 20 and the current is allowed to pass direct to the battery. Thus the automatic switch f^2 and the brushes G G′ are cut out of circuit with the battery while the latter is being charged. When the cells have become properly charged, the switch-arms f' and g' are again shunted, the former closing the circuit from said battery to the brushes G G′ and the latter opening the circuit from said battery to the motor. In other words, when charging the storage battery no current can be supplied to the contact-brushes G G′, and when the switch-arm f' is shifted to direct the current to switch f^2 all connections with the main car power-circuit and contact-brush are cut off and the storage battery cannot be charged. If it is desired to charge the battery from the main current, a suitable resistance, as g^4, must be used, and it is essential that the coils of the magnets D D′ be wound with sufficient resistance to withstand such current, and the main working potential or voltage of the storage-battery cells must equal the main line or feeder working potential. Thus the storage-battery cells could be kept permanently connected in multiple with the main motor operating and charging current, the magnets D D′ being operated by either the current from the storage battery or the main line of feeder-current, or by both, as most convenient. It is better to disconnect

the positive terminal of the storage battery (after the latter is fully charged) from the main working and operating currents and then use the battery alone for operating the magnets of the feed-in switch. This would not injure the cells or drain off their charge in the event of a current being turned into the car-motor when there was no working potential or current in the conductor A. This trouble could be provided for by having the storage-cells of sufficient capacity to operate the car-motor in the event of temporary delays in the supply of the main operating-current, or with the magnet-coils wound for low resistance the number of cells will necessarily be proportioned to supply an operating-current of low voltage. Hence when charging the battery of low potential by means of the main operating or feeder current it would necessarily have to be accomplished through a resistance and then entirely disconnected from the main operating or feeder-supply current, which can be done by hand-switch f' before connecting and operating the magnets, thus avoiding danger of burning out the coils of said magnets.

The means of preventing the magnets D and D′ of the same section from being simultaneously energized is as follows: The automatic two-point switch f^2 comprises a shaft h, suitably supported by the car-frame, an arm h' on said shaft designed to engage either contact h^2 of wires 16 17, a friction-disk h^3, free to move longitudinally on said shaft, a spring h^4, bearing against said disk, a second disk h^5, having friction-rollers h^6, against which disk h^3 bears, a collar h^7 on said shaft, and a sprocket-wheel h^8, with which engages a chain h^9, leading from one of the car-axles. Hence the position of the switch-arm h' is controlled by the direction in which the car travels. This automatic switch avoids all danger of putting in circuit the wrong brush G G′, as might occur with the hand-switch being neglected by motormen.

In practice but one contact-brush G or G′ is alive with current, and this is always the one to the right looking in the direction in which the car is traveling. Assuming the latter to be going as indicated by the arrow, Fig. 3, the brush G′ when it contacts with the terminal E′ closes the circuit through wire 13 and bare wire 2, which charging magnet D′ causes the armature of the feed-in switch to turn on its pivot and throw the closer d into engagement with the terminals b^5 b^6, instantly charging the sectional conductor, and as the brush F comes into contactherewith the current is through wire 22 conveyed to the motor. As the car passes to the next succeeding section the brush G′ upon contacting with terminal E^2 will throw the current into magnet D through the agency of wire 14 and bare wire 1, thus cutting out the current from the conductor-section, the armature being again moved on its pivot removing the closer end thereof from engagement with the contacts b^5 b^6. By reason of the described location of the several terminal-plates adjacent to the ends of the conductor-sections each of said sections is charged before the car or train reaches it and is cut out of circuit as soon as the car passes therefrom onto the next conductor-section, which, the same as above described, has been cut in by contact of the brush G′ with the terminal E′ near the end of the section described as having been previously charged. Now should the direction of travel of the car be reversed the automatic switch will instantly throw the switch-arm into engagement with wire 16, thus cutting out brush G′ and charging brush G, so that the latter will effect the operation of the feed-in switch through the agency of terminal E^3, wire 15, and bare wire 2, while the circuit will be cut out by said brush engaging terminal E, wire 12, and bare wire 1. On long sections of the sectional conductor these terminals for the brushes should be placed about one car length from the ends and on short sections correspondingly near the ends thereof. As the described operations of the feed-in switch are performed before the motor-car enters upon a live section of the conductor and after the car leaves the latter, there can be no arcing at the contacts of the feed-in switch. It will be seen that through the agency of these terminals and the contacting brushes the battery-current is conveyed to the feed-in switch, whereby the latter will cut in or out the current of the sectional conductor as required in service. At road-crossings in isolated districts the sectional conductor A may simply be omitted or taken out for a distance equal to the convenient width of crossing, and a conduit-insulated cable placed under ground, thereby connecting the ends of the sectional conductor, or the road-crossing may be left clear of the sectional conductor and contact-terminals may be placed at the ends of the sectional conductor, as usual, on each side of the road-crossing, the same as at any of the other several divisions or sections thereof. Then, too, the conductor may be disconnected or cut in at all switches, crossings, and turn-outs without in any way affecting the economical working or operation of the system. The latter is universally adapted to any of the requirements to be met in electric-railway operations. All wires connecting the terminals and sectional conductor with the bare or uninsulated wires strung on the poles should be either conduit-insulated or specially treated with some approved insulating compound. As before stated, the feed-in switch is located intermediate the ends of each conductor-section. Hence the bare wires will be of equal resistance in acting on the feed-in switch and thoroughly balance the system.

In the event of a motor-car passing over one of the terminals and through incorrect adjustment of the brush G or G′ did not have proper contact therewith the conductor-sec-

tion located ahead of the car would not be cut in circuit, but would remain dead, and the car would necessarily have to stop, not being supplied with current for the motor. For just such emergencies I provide each motor-car with a portable contact device I. It consists of a rod *i*, having a terminal hook *i'*, to which is attached a flexible wire i^2, which leads down said rod and its excess is wound into a reel i^3. The other end of this wire is permanently connected to the positive pole of the storage battery. In order to cut the dead section of the conductor into circuit, the motorman touches the hooked end of rod *i* against one of the bare wires 1 or 2—that is, the one for operating the feed-in switch—thereby turning the main feeder-current into the sectional conductor.

It is obvious that by doubling the number of sectional bare wires 1 and 2, (see Fig. 2,) doubling the number of contact-brushes and the terminal plates, and doubling all connecting wires a system will be produced having a complete metallic circuit for operating the feed-in switch. This would do away with the necessity of the grounded wire and would require that the portable contact device be provided with two hooks and two cables or wires, the reason of which is obvious.

While I have shown and described all the essential features of my invention and a preferred form for carrying out the latter, yet it will be understood that I do not restrict myself in this particular, for many changes may be made without departing from the scope of the invention—as, for instance, the feed-in switch and bare wires might be specially provided for at depots or terminal points and the number of contact-terminals may be varied. It is not deemed necessary to specify all changes that might be made and the effect thereof, as they are all contemplated in the idea of operating the feed-in switch of each sectional conductor through the agency of a storage battery and brushes contacting with terminal plates, charging each conductor-section in advance of and before the motor-car reaches it, and switching off the feeder-current after the motor-car has passed each conductor-section.

I claim as my invention—

1. The combination with a motor-car having an auxiliary current-generator, and two contact-brushes in circuit therewith, of an automatic two-point switch controlled by the direction in which the car is moving, whereby the current can be cut into either one of said brushes, as and for the purpose set forth.

2. The combination with a motor-car having an auxiliary current-generator, and a conductor composed of a series of disconnected sections, of contacts carried by said car for closing the circuits, and an automatic switch carried by said car and controlled by the direction in which the car is moving, whereby the current can be cut into either one of said contacts, as and for the purpose stated.

3. The combination with a motor-car having an auxiliary current-generator and two contact-brushes capable of being thrown in circuit therewith, of an automatic two-point switch intermediate said brushes and said generator, and connections between said switch and a rotary member of said car, whereby said switch will be controlled by the direction of travel of said car, substantially as set forth.

4. The combination with a motor-car having an auxiliary current-generator, and two contact-brushes in circuit therewith, of an automatic two-point switch comprising a shaft, a switch-arm for engaging either one of two contacts, spring-pressed disks on said shaft and a wheel engaged by a belt driven by the car-axle, substantially as set forth.

5. The combination with a sectional conductor, a feed-in switch, connection between the latter and said conductor, and terminal plates also in circuit with said feed-in switch, of a motor-car carrying a motor, a brush or brushes in circuit therewith designed to have sliding contact with said sectional conductor, brushes for engaging said terminals, a storage battery, connections between the latter and said latter brushes, and a two-point switch for controlling the current to one of said brushes at a time, substantially as set forth.

6. An electric-railway system comprising a sectional conductor, a feed-in switch adapted to control the admission of current thereto, uninsulated wires paralleling said sectional conductor, means for electrically charging said wires, whereby said switches may be operated, and a circuit-closing device adapted to cut the current into said uninsulated wires in the event of their not being charged by said means, substantially as set forth.

7. An electric-railway system comprising a sectional conductor, a feed-in switch adapted to control the admission of current thereto, a main supply-wire, uninsulated wires paralleling said former wire and said sectional conductor, means for electrically charging said wires, whereby said switches may be operated, and a circuit-closing device adapted to cut the current into said uninsulated wires in the event of their not being charged by said means, substantially as set forth.

8. An electric-railway system comprising a sectional conductor, a feed-in switch adapted to control the admission of current thereto, a continuous main supply-wire, uninsulated sectional wires paralleling said sectional conductor and corresponding in length thereto, means for electrically charging one of said wires before a car reaches said section and charging a second wire after the car leaves the latter, whereby said conductor-section will be cut in and cut out of circuit, and a circuit-closing device adapted to cut the current into said uninsulated wires in the event of their not being charged by said means, substantially as set forth.

9. An electric-railway system comprising a

sectional conductor, uninsulated sectional wires corresponding thereto, means for electrically charging said wires, a circuit-closing device adapted to cut the current into said uninsulated wires in the event of their not being charged by said means, magnets in circuit with said wires, a feed-in wire adapted to supply said sectional conductor with electricity, said feed-in wire having contact-plates, and a pivoted armature controlled by said magnets and adapted to close the circuit between said contact-plates, substantially as set forth.

10. An electric-railway system comprising a conductor composed of a series of disconnected sections, means for charging each section, and a motor-car, or the like, movable adjacent to said conductor and carrying contacts for automatically closing the circuits, whereby the current can be cut into and out of each section, and a device carried by said car adapted to effect the closing of said circuits in the event of failure of said contacts, said device being normally disengaged from the conductor-sections.

11. An electric-railway system comprising a conductor composed of a series of disconnected sections, means for charging said sections successively and cutting out each section after charging the next forward section, and a motor-car, or the like, movable adjacent to said conductor and carrying contacts for automatically closing the circuits, whereby the current can be cut into one section at a time and cut out therefrom after the next section is charged, and a device independent of said contacts for automatically closing the circuits, said device being adapted to effect the closing of said circuits in the event of failure of said contacts, substantially as set forth.

12. An electric-railway system comprising a sectional conductor between the track-rails, a feed-in switch for each conductor-section, a main supply-wire, uninsulated sectional wires paralleling each conductor-section and having contact-terminals also between said track-rails, said sectional wires being connected to said feed-in switch, means carried by a car movable on said track-rails for charging said sectional wires upon contacting with said terminals, whereby said feed-in switch will be operated to cut in and cut out the electric current to said sectional conductor, and a circuit-closing device adapted to cut the current into said uninsulated wires in the event of their not being charged by said means, substantially as set forth.

13. An electric-railway system comprising a sectional conductor, a main supply-wire, uninsulated sectional wires corresponding to each conductor-section having terminals adjacent to the ends of each conductor-section, a feed-in switch for each conductor-section to which said sectional wires are connected, said feed-in switch being connected to said conductor-section, and a car having a motor, a contact brush or brushes for engaging said sectional conductor, electrically-charged contact-brushes for engaging said terminals, and an electrically-charged contact device adapted to cut the current into said uninsulated wires in the event of their not being charged by said brushes and said terminals, substantially as set forth.

14. An electric-railway system comprising a sectional conductor, a main supply-wire, uninsulated sectional wires corresponding to each conductor-section having terminals adjacent to the ends of each conductor-section, a feed-in switch for each conductor-section to which said sectional wires are connected, said feed-in switch being connected to said conductor-section, and a car having a storage battery one pole of which is in constant circuit with a brush carried by said car and designed to have sliding contact with one of said terminals of the sectional wires, a brush carried by said car having sliding contact with said conductor-section and in circuit with a motor on said car, and a contact device also in circuit with said battery and adapted to cut the current into said uninsulated wires in the event of their not being charged by said brushes and said terminals, substantially as set forth.

15. An electric-railway system comprising a sectional conductor located in juxtaposition to the track-rails and in parallelism therewith, a feed-in switch for each conductor-section, uninsulated sectional wires corresponding to said conductor-sections in circuit with said feed-in switch, terminal plates for said sectional wires also in juxtaposition to said track-rails, a car having a storage battery, a brush or brushes for engaging said terminals and operating said feed-in switch, a brush for contacting with said conductor-section, a motor in circuit with said brush, and a contact device adapted to cut the current into said uninsulated wires in the event of their not being charged by said contact brushes and terminals, substantially as set forth.

16. An electric-railway system comprising a conductor composed of a series of disconnected sections mounted between the rails of a track, a feed-in switch, a main supply-wire, uninsulated sectional wires paralleling said sectional conductors and connected to said switch, said sectional wires having terminal contact-plates adjacent to said conductor, and a motor-car carrying electrically-charged brushes for engaging said terminals and closing a circuit for charging the sections of said conductor in their order, and an electrically-charged contact device adapted to cut the current into said uninsulated wires in the event of the circuit not being closed by said brushes and said terminals, substantially as set forth.

17. The combination with a sectional conductor, and wires paralleling the same, of a motor-car carrying brushes and a storage battery in circuit with one of said brushes, another of said brushes being in circuit with

the motor and engaging said conductor, a portable device designed to be placed in engagement with one of said wires, and a wire leading therefrom to said storage battery, substantially as set forth.

18. The feed-in switch having two magnets, an armature carrying a circuit-closer, the pivot-point of said armature being on a line below and centrally between said magnets, and the feed-in wire having contact-plates designed to be engaged by said circuit-closer, said armature being adapted to swing below and not contact with either of said magnets, substantially as and for the purpose set forth.

19. The combination with a sectional conductor, of the main supply-wire, the sectional wires paralleling the same, a feed-in switch located centrally of these conductor-sections and to which said sectional wires are connected, the feed-in wire having contact-plates and leading from said feed-in switch to said conductor-sections, said feed-in switch having two spaced-apart magnets, and an armature pivotally mounted below and centrally between said magnets and carrying a circuit-closer for engaging said contact-plates, said armature being adapted to swing beneath and not contact with either of said magnets, substantially as set forth.

20. The feed-in switch herein described comprising two magnets each curved at one end, an armature pivoted below said magnets and having its upper end heavier than its lower end and curved on the same radius as said magnets, and pins for limiting the movement of said armature, substantially as set forth.

21. The feed-in switch herein described comprising two magnets having their cores curved and elongated at their lower ends, means for operating said magnets successively, a feed-in wire adjacent to said magnets having contact-plates, and a pivotally-mounted armature curved at its upper end on the same radius with the ends of said cores but not contacting therewith, and a circuit-closer carried by said armature designed to engage said contact-plates, substantially as set forth.

22. In an electric railway, the combination with the feeder, of power-conductor sections, current-collecting means, means coöperating with the current-collecting means for energizing said sections as the car progresses, and means independent of the current-collecting means for energizing said sections when said coöperating means is inoperative.

23. In an electric railway, the combination with the feeder, of power-conductor sections, means along the way coöperating with current-collecting means on the car for energizing said sections as the car progresses, and an independent contact device on the car cooperating with said means along the way, for energizing said sections when said means on the car is inoperative.

24. In an electric railway, the combination with the feeder, of power-conductor sections, electromagnetically-operated switches for connecting the latter with the former, traveling contacts carried by the car for collecting current from the power-conductor and energizing said switches, and an independent contact carried by the car and adapted to make contact with a conductor-section to energize said switches independently of said traveling contacts.

25. In an electric railway, the combination with the feeder, of power-conductor sections, electromagnetically-operated switches for connecting the latter with the former, road-conductors through which the switches are energized, means carried by the car for engaging the power and road conductors, and an independent contact carried by the car and adapted to engage a road-conductor to energize said switches when said means is inoperative.

26. In an electric railway, the combination with the feeder, of power-conductor sections, electromagnetically-operated switches for connecting the latter with the former, road-conductors through which the switches are energized, current-collecting means carried by the car for engaging the power and road conductors, a storage battery on the car, and a contact on the car connected with the battery, and independent of said collecting means, for energizing said switches when they cannot be energized through the road-conductors.

27. In an electric railway, the combination with the feeder, of power-conductor sections, electromagnetic switches for connecting the latter with the former, an independent source of current, a collector carried by the car, and an independent contact device carried by the car, connected with the source, and adapted to make contact outside of the car to complete energizing-circuits for the switches.

28. In an electric railway, the combination, with the feeder, of a sectional power-conductor, switches connecting each of the latter with the former, electromagnets for opening and closing said switches, means for energizing said magnets when the car is moving in one direction, independent means for energizing the magnets when the car is moving in the opposite direction, only one of which means is operative at one time, and means whereby one or the other of said means is automatically made operative, according to the direction in which the car is moving.

29. In an electric railway, the combination with the feeder, of a sectional power-conductor, switches for connecting the sections thereof with the feeder, electromagnets for opening and closing said switches, means for energizing said magnets when the car is moving in one direction, means for energizing the magnets when the car is moving in the opposite direction, and a switch operated from the car-axle, to make said means operative as the car moves in one direction or the other.

30. In an electric railway, the combination

with the feeder, of a sectional power-conductor, switches for connecting the sections of said conductor with the feeder, electromagnets for opening and closing said switches, road-contacts connected with said magnets, a contact carried by the car for engaging with road-contacts to complete a circuit and operate the switches when the car is moving in one direction, a second contact on the car for engaging with road-contacts to complete a circuit and operate the switches when the car is moving in the opposite direction, and means for preventing the closing and opening magnets from being energized simultaneously.

31. In an electric railway, the combination with the feeder, of a sectional power-conductor, a collector on the car for engaging said conductor, a switch adapted to connect a section of said conductor with the feeder, an electromagnet adapted to close the switch, an electromagnet adapted to open the switch, means operating when the car is moved in one direction, for energizing the first magnet before the conductor-section controlled by the switch is engaged by the collector and for energizing the second magnet after the collector has left said section, independent means operating when the car is moved in the opposite direction, for energizing the first magnet before the conductor-section is engaged by the collector and for energizing the second magnet after the collector has left said section, and automatically-controlled means for causing one of said means to be operative when the car is moving in one direction, and for causing the other of said means to be operative when the car is moving in the opposite direction.

32. In an electric railway, the combination with the feeder, of power-conductor sections, switches for connecting the latter with the former, electromagnets for closing said switches, electromagnets for opening said switches, means whereby each of the former magnets is energized just before a car enters upon the section which such magnet controls, means whereby each of the latter magnets is energized just after the car has departed from the section which said magnet controls, and means for making one of said means operative in each direction of travel of the car.

33. An electric switch which comprises a magnet-armature serving as a circuit-closer, said armature being pivoted at its lower end and concentrically curved at its upper end, and an electromagnet conforming with the curvature of the armature and arranged to pull the same over the center of gravity.

34. An electric switch which comprises a magnet-armature serving as a circuit-closer, said armature being pivoted at its lower end and concentrically curved at its upper end, and electromagnets each conforming with the curvature of the armature and arranged to pull the same in opposite directions over the center of gravity.

35. In an electric railway, the combination with the feeder, of conductor-sections located in the roadway, switches for connecting the conductor-sections with the feeder, electromagnets for actuating the switches, and overhead sectional conductors by which the circuits to said electromagnets are established.

36. In an electric railway, the combination with the feeder, of a sectional power-conductor, electromagnetic switches for connecting the sections of the latter with the feeder, and a switch for energizing said magnets, which is controlled by the direction of motion of the car.

37. In an electric railway, the combination with the feeder, of a sectional power-conductor, switches for connecting the sections thereof with the feeder, an electromagnet for closing the switch, an electromagnet for opening the switch, and a switch controlled by the movement of the car for energizing the magnets alternately which control one switch.

38. In an electric railway, the combination with the feeder, of conductor-sections, electromagnetic switches, collectors carried by the car for engaging said conductor-sections, and a branch from each magnet-circuit, which branch includes a contact along the roadway which is independent of said conductor-sections, at which contact a circuit can be completed to include an independent source of current with the switch-magnet.

39. In a contact system for electric railways having sectional conductors, the combination with a station-generator and a current feeder or main extending therefrom over the route, of switching-magnets, circuit connections for operatively connecting said current feeder or main with certain sectional conductors, an independent source of current, and a manually-operated contact connected with said source and adapted to make contact with certain other sectional conductors, to complete circuits through the switching-magnets.

40. In a contact system for electric railways having sectional conductors, the combination with a main or feeder, of switching-magnets and circuit connections for operatively connecting said feeder with the sectional conductors, and a manually-operated device making contact at a point along the line of way, to close a circuit through a switching-magnet, and thereby connect the feeder with a sectional conductor.

41. A contact system for electric railways having sectional rails or conductors arranged in the road-bed, a station-generator and a current feeder or main extending therefrom over the route, switching-magnets and circuit connections for operatively connecting said current feeder or main with the sectional rails or conductors, in combination with an exposed conductor so arranged that circuit may be effected from an independent source of current to and through a switching-magnet.

42. In an electric railway, the combination

with the feeder, of conductor-sections, electromagnetic switches, the coils of which are energized successively as the car progresses, to close the switch connecting the feeder with the sections; an independent source of current connected to the track through the car-wheels, and exposed contacts connected to the circuits of the switch-magnets, whereby the circuits can be established from said independent source through the switch-magnet.

43. In an electric railway, the combination with the feeder, of conductor-sections, electromagnetic switches supplied in normal operation with current suitable for connecting the feeder-sections with the feeder, and a circuit-closing device or switch manually operative along the way to cause the feeder to be connected with a conductor-section.

44. In an electric railway, the combination with the feeder and return, of power-conductor sections, electromagnetic switches for connecting the latter with the feeder, a collector, means for closing said switches while sufficient current is flowing through the collector, and the following means adapted to be utilized when said means is inoperative, which consists of an auxiliary source of current on the car, a conductor along the way connected with the switch-coils, and a contact carried by the car connected with said source and adapted to engage with said conductor along the way.

45. In an electric railway, the combination with the feeder, of conductor-sections, electromagnetic switches for connecting the latter with the former, and a circuit including an independent source of current and the switch-magnet, in which circuit is an exposed contact outside the car, at which contact the circuit can be completed.

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

HARLAN P. WELLMAN.

Witnesses:
W. C. RICHARDSON,
C. W. MEAD.