(No Model.)

R. M. HUNTER.

ELECTRIC RAILWAY.

No. 430,076. Patented June 10, 1890.

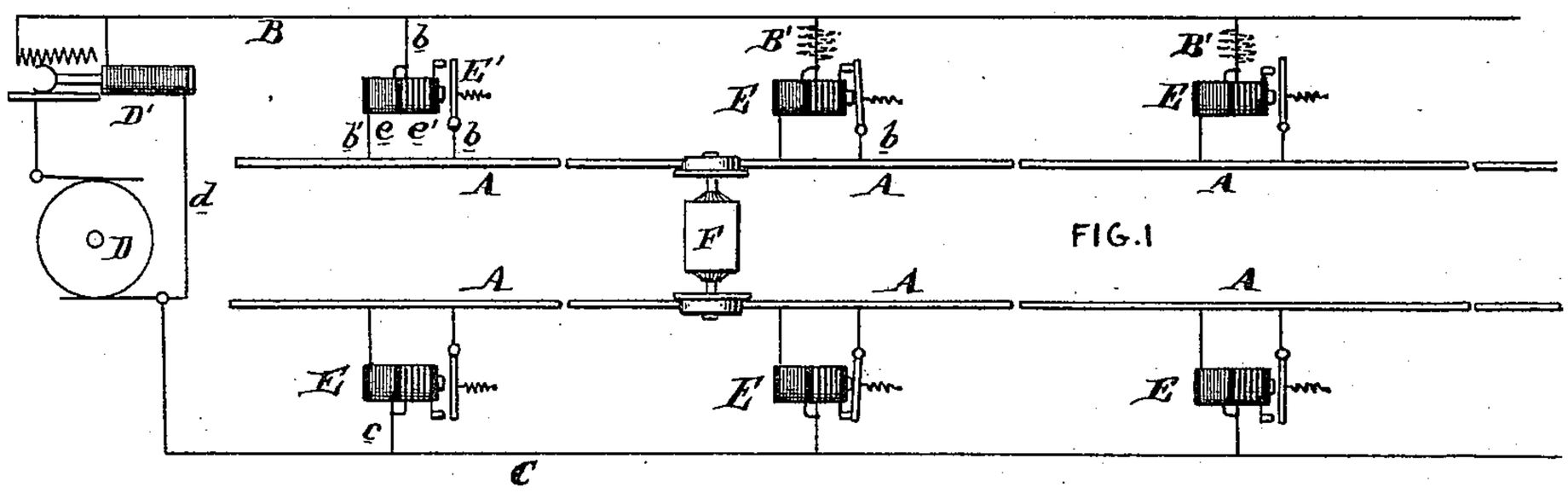


FIG. 1

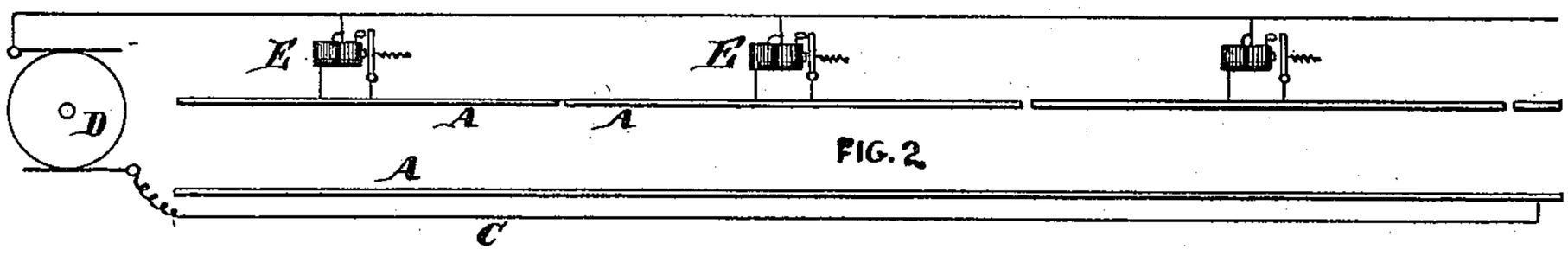


FIG. 2

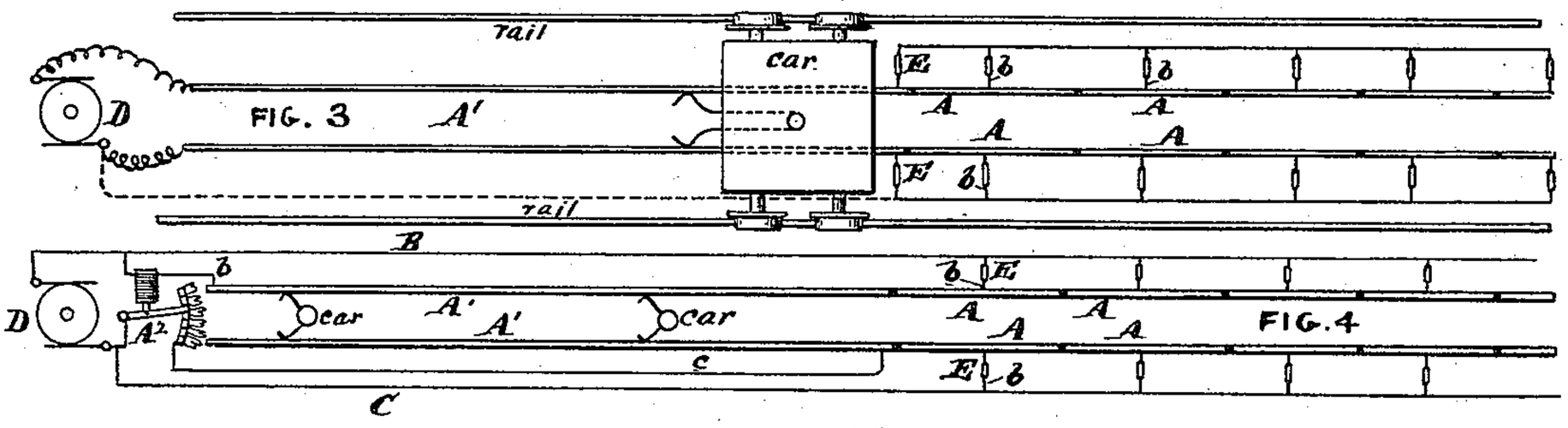


FIG. 3

FIG. 4

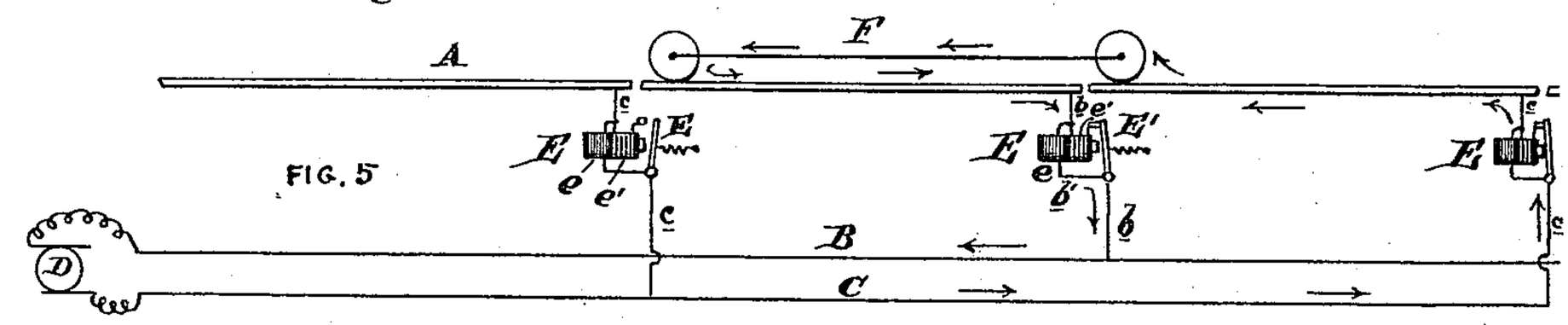


FIG. 5

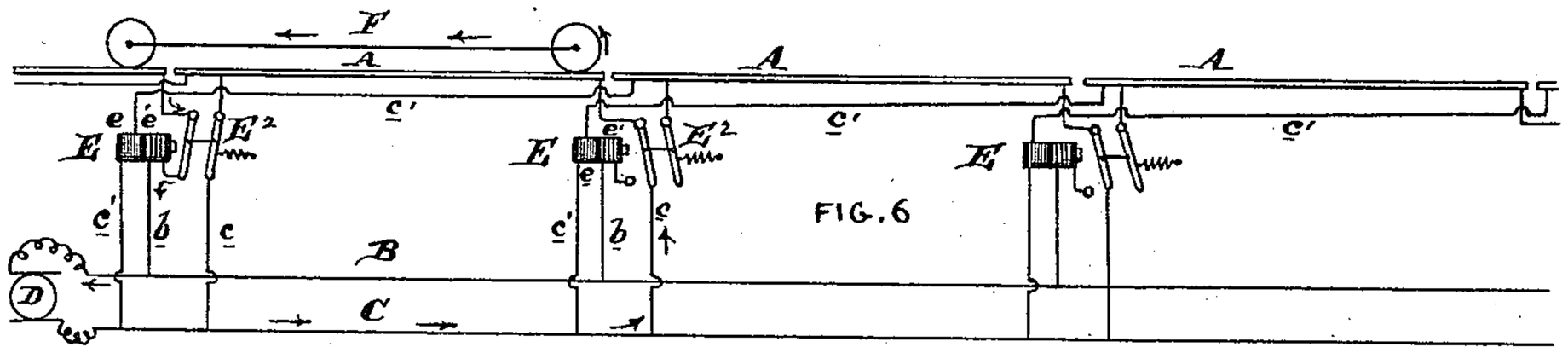
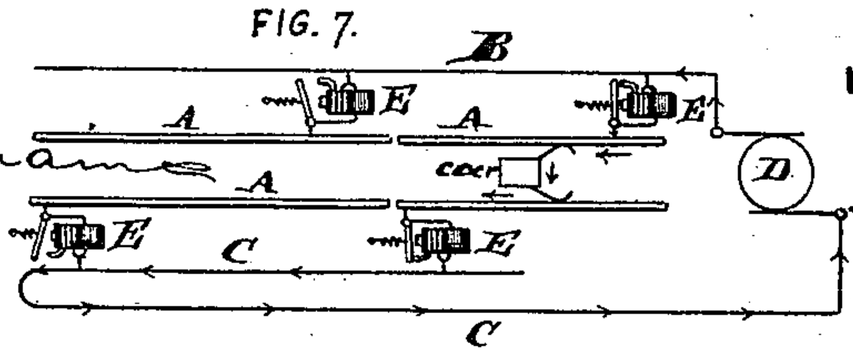


FIG. 6

FIG. 7.



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UNITED STATES PATENT OFFICE.

RUDOLPH M. HUNTER, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE THOMSON-HOUSTON ELECTRIC COMPANY, OF BOSTON, MASSACHUSETTS.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 430,076, dated June 10, 1890.

Original application filed June 21, 1886, Serial No. 205,770. Divided and this application filed June 20, 1889. Serial No. 314,893. (No model.)

To all whom it may concern:

Be it known that I, RUDOLPH M. HUNTER, of the city and county of Philadelphia, and State of Pennsylvania, have invented an Improvement in Electric Railways, of which the following is a specification.

My invention has reference to electric railways; and it consists in certain improvements, which are fully set forth in the following specification, and shown in the accompanying drawings, which form part thereof.

This application (Case 101) is a division of my application, Serial No. 205,770, of June 21, 1886.

In my application filed July 14, 1885, Serial No. 171,625, among several others is described a construction of railway in which the working-conductor sections (be they the rails or separate conductors) are connected to main supply-conductors by branch circuits. In this application I provide the same general construction, but in said branch circuits I locate switches or circuit-breakers, so that the said sections may be connected or disconnected from the supply-conductors as desired, or the said circuit-breakers may be worked automatically by the movements of a train or electrically-propelled vehicle. These circuit-breakers may be electrical or mechanical, the particular construction being immaterial to my invention, which comprehends, broadly, the application of a switch of any description for uniting a working-conductor section with a supply-conductor. The object of such a construction may be either to prevent escape of electricity or injury to animal life. First, in a surface road the working-conductor sections may be formed of the rails or be exposed, and normally there will be little or no current passing over them, hence all danger to animal life is prevented; and, secondly, the supply-conductors may be insulated so as to prevent leakage of electricity, and may be supported upon poles above the ground or in tubes, pipes, or conduits in the ground, and the current from these supply-conductors be conveyed to a working-conductor, (which is naturally more or less exposed to atmospherical influence, dampness, and moisture, which have a tendency to cause leakage;) but the said current is only fed to said working-conductors at the time of the passage of a motor or train over the said conductor-section. By this means I overcome danger and at the same time enable currents to be carried over a long distance of an electric railway without danger of excessive leakage. With this construction of circuits the supply-conductors may be so arranged that the line-resistance is the same for any position of a motor on the line, and is the same for all motors thereon. The application of switches arranged as herein described in an electric railway would be advantageous in locations where the railway passes through damp or swampy grounds, tunnels, and other damp places, and therefore it is evident that a road of this construction might be partly formed of continuous conductors, such as set out in my application, Serial No. 195,742, filed March 19, 1886, and partly of sectional conductors. In practice the yard-sections of those portions of the road in the city, or where several trains would be on the same section of the railway, may be provided with long working-conductors through which all of the current passes, or connected in a separate circuit through which a strong current is caused to pass, and said yard-section may be provided with an independent resistance-changer, which may be worked by hand or automatically.

In my application, serially numbered 202,950, filed May 22, 1886, I describe a system of telpherage wherein a single line of sectional conductors is used to convey the current to and from the train or electromotors, and in my application, Serial No. 204,583, filed June 9, 1886, such a system of sectional working-conductors is shown and claimed in connection with supply-conductors to supply electricity thereto. This invention is also applicable to such a system, to the end that the sectional working-conductors may be practically cut out of the line-circuit to prevent excessive leakage of electricity, due to the exposed condition of said sectional working-conductors. In a system such as this the currents may be fed to the sectional working-conductors and caused to pass always in the same direction, as set

forth in my application filed May 22, 1886, and serially numbered 202,950; or the currents may be caused to flow in opposite directions through the successive working-conductor sections, as set out in my application, Serial No. 204,583, and filed June 9, 1886.

The foregoing gives a general outline of the invention set out in this application, and which is clearly shown in the drawings, and specifically described hereinafter in referring thereto.

In the drawings, Figure 1 is a plan view representing an electric railway embodying my improvements. Figs. 2, 3, 4, 5, and 6 are views illustrating modifications of same; and Fig. 7 is a modification of circuits shown in Fig. 1.

A represents the working-conductors, which are formed in sections in part or in whole, and may be either the rails or separate working-conductors suspended above the surface of the ground or arranged in a conduit. These sections are connected to supply-conductors B and C by branch connections *b*, in which the switches or circuit-breakers E are located.

D is the generator, and supplies electricity to the conductors B and C.

D′ is a resistance-changer or current-regulator, and is adapted to regulate the line-current in accordance with the demand. This regulator is automatic, and has its coil in a shunt-circuit *d*, connecting the two supply-conductors, substantially in the manner set out in my application filed April 28, 1886, Serial No. 200,400. If desired, one line of these conductor-sections A may be continuous, as shown in Fig. 2, and the supply-conductor E directly connected thereto at the end nearest the generator, or more preferably at the end farthest from the generator, as set forth in my application, Serial No. 171,625, filed July 14, 1885, as in that case the resistance to the current for a motor anywhere upon the line would be uniform. If desired, the generator may be connected to one end of the supply-conductor B and to the opposite end of the supply-conductor C, as shown in Fig. 7, which would give an equal resistance for the current when the said working-conductors are both made in sections and coupled up as shown in Fig. 4, the right-hand end of which is supposed to represent a construction such as shown in Fig. 1, though the particular kind of circuit-breakers is immaterial to my invention. The entire line may be made in sections or only a portion thereof where it passes through damp or moist districts, or where the conductors are exposed and pass through thickly-inhabited places. The resistances indicated in dotted lines B′, Fig. 1, may be used in the branch circuits *b* to make the line-resistance uniform for all positions of the motor on the line, as set out in my application, Serial No. 171,625, of July 14, 1885, above referred to. In this construction the resistances would decrease in proportion as they were removed from the generator, and vice versa.

In the construction shown in Fig. 3 the part A′ of the railway is supposed to be of considerable length and is practically without sections and is positively and at all times in circuit with the main line or supply-circuit, and such a part may be used for the greater part of the line; or, if desired, it may be used as a yard or city section and where a large number of trains are passing over it at the same time. In case it is used for the last-mentioned purpose its length would be limited. To make the resistance to the current through all motors on said section A′ uniform, the lower pole of the generator may be connected to the supply-conductor C, as indicated in dotted lines.

The construction shown in Fig. 4 is substantially the same as that shown in Fig. 3, with these provisions for equal resistance of the section or part A′, which in this figure has its own supply-conductors B′ and C′, connecting with opposite ends of the line and provided with an automatic resistance-changer A^2, which may be of the form shown in this figure or constructed like that shown at D′ in Fig. 1.

In the construction shown in Fig. 5 the sections A are arranged for telpherage, and the successive sections are coupled with the supply-conductors of opposite polarity, whereby the current in the successive sections A have opposite polarities. In this construction the car or train of cars are at least equal in length to one of the sections A, and the system in this case would be operated in the manner set out in my application filed June 9, 1886, Serial No. 240,538. This construction would be as if the sections A, connecting with the supply-conductor B of Fig. 1, were interposed between the sections A, connecting with the supply-conductor C.

In the construction shown in Fig. 6 the same general principle as shown in Fig. 5 is followed out, only in this case the switches are arranged somewhat different to enable the current to pass through the telpherage-train always in the same direction, as set out in my application filed May 22, 1886, and the details of construction of these switches will be referred to hereinafter.

If rails are used as the working-conductors, a series of these rails should be positively connected together in a suitable manner to preserve the continuity of the joints and at the same time allow for expansion and contraction of the rails and that point between the sections of rails so arranged that they should be thoroughly insulated; but in the case of conductor-sections made separate from the rails they may be formed of any suitable metal of good conductivity and with facing of copper or bronze. The switches may be made so as to be worked by hand, or they may be automatic in their action or caused to be operated by the passage of a train. It is immaterial to my invention how these switches are constructed; but I prefer that shown as being effective and at the same

time most positive in its action. These switches consist of a high-resistance helix *e* and a low-resistance helix *e'*, of which the high-resistance helix is in a shunt-circuit *b* around the low-resistance magnet, and connecting the supply-conductor with the working-conductor section, and the low-resistance helix is in the branch circuit, which is broken by the armature E' attracted by the helices. Fig. 1 will illustrate the operation of these automatic switches, in which F represents a car closing a circuit between two sections A of different polarity, and in which it will be seen that the circuit-closing levers corresponding to such sections are drawn forward, so as to complete the branch circuits *b*, completing the circuit through the low-resistance helices *e'*. As soon as the motor passes to the next section the switches open and the circuit through the high-resistance helices in the next section will be completed in the motor, and this will attract the armature-closing levers E' and complete the circuits *b'* and *c'* through the low-resistance magnets of this section, as before. It will be noticed that the low-resistance helix will retain the armature E' in a closed condition and form a path for the current so long as the motor is upon its section, and thereby protect the high-resistance helices from becoming burned or destroyed. To obtain a uniform resistance in the line-circuit through the motors for various positions of the motor upon the line, in place of the construction hereinbefore described, resistance B^2 may be interposed in the branch circuits *b* or *c*, or both, as indicated in dotted lines, Fig. 1, and as set out in my application of July 14, 1885. In place of these resistances the helices *e* and *e'* may have their resistances so proportioned as to accomplish this result.

When no train is passing, the circuit-closing levers E' will break the branch circuits *b* and *c*, and the sections will be coupled with a supply-conductor only through the high-resistance helices *e*, which prevent any material current passing to the sections and by leakage to the earth until a motor passes upon a section and thereby prevents any excessive loss by leakage, and there is no great danger due to contact with the conductor-section.

In the construction shown in Fig. 6 we have the high-resistance helices connected with the supply-circuit C and all of the low-resistance helices connected to the supply-circuit B. The switches E' in this instance control the circuit *b* through the low-resistance helix, but is provided with a back contact, which couples its section to the supply-conductor C, so that normally the contact-section receives electricity of one polarity, and when the low-resistance helix is in circuit the section receives electricity of the opposite polarity. This armature E' operates a section-switch E^2, which couples the adjacent section A with the supply-conductor C when the armature E connects its section with a supply-conductor B. The high-resistance helix is in circuit with a section farther down the line, so that an approaching train first completes the circuit through *c'*, and the high-resistance helix, which attracts the armature E', completing the circuit through the low-resistance helix *e'*, and connecting the adjacent section through the lever E^2 with the supply-conductor of opposite polarity, thereby causing the switches to operate on the approach of a train and supply electricity to the motor on said train and cause it to pass always in the same direction.

When no train is on the conductor, all of the switches will be as shown at right-hand side of Fig. 6, and we will have each section A connected through branch *c* with supply-conductor C, and also with same supply-conductor by conductor *x c'* and high-resistance helices *e;* hence no current is passing over sections A. When a train F approaches, however, the circuits change as the switch E, connecting with the sections A, on which the train or motor rests, is actuated, as shown. In this case the current passes from supply-conductor C through *c* to A, through motor F to next section A, through low-resistance helix *e'* and branch *b* to supply-conductor B. In addition to this, current also passes from conductor C through *c'* and helix *e* of switch in next section in advance to section A, then through motor F to next section A, a branch *b*, high-resistance helix *e'*, to supply-conductor B. In this manner the next switch in advance is always actuated before the train or motor reaches it and connects the next preceding section A with the supply-conductor B.

The details may be greatly modified to suit the views of the constructors of the railways, therefore I do not limit myself to the specific construction shown.

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

1. In an electric railway, a working-conductor made in sections insulated from each other, in combination with a supply-conductor, a source of electric supply, circuit-closing devices to connect or disconnect the said sections with the supply-conductor, a traveling electric motor receiving electricity from said working-conductor, and a current-collecting device carried by the motor and making continuous running contact with said working-conductor.

2. In an electric railway, an electrically-propelled vehicle, a working-conductor made in sections insulated from each other, in combination with a supply-conductor, a traveling electric motor receiving electricity from said working-conductor, a current-collecting device carried by the motor and making a continuous running contact with said working-conductor, a source of electric supply, and automatic circuit-closing devices actuated by the passage of a vehicle over said line of working-conductors.

3. In an electric railway, a working-conductor composed of insulated sections, in combination with an electric generator, two supply-conductors, branch conductors connecting the supply-conductors alternately with the successive working-conductor sections, and switches in said branch conductors.

4. In an electric railway, a working-conductor composed of insulated sections, in combination with an electric generator, two supply-conductors, branch conductors connecting the supply-conductors alternately with the successive working-conductor sections, and electrically-actuated switches in said branch conductors.

5. In an electric railway, a working-conductor composed of insulated sections, and an electrically-propelled vehicle, in combination with an electric generator, two supply-conductors, branch conductors connecting the supply-conductors alternately with the successive working-conductor sections, and switches in said branch conductors actuated by the passage of the vehicle from one section of working-conductor to the next.

6. In an electric railway, a working-conductor composed of insulated sections, in combination with an electric generator, two supply-conductors, branch conductors connecting the supply-conductors alternately with the successive working-conductor sections, and an electrically-actuated switch in said branch conductors actuated by the passage of the vehicle from one section of working-conductor to the next.

7. In an electric railway, a working-conductor made in insulated sections, and an electrically-propelled vehicle receiving electricity therefrom, an electric generator, two electric supply-conductors connecting with the two poles of the generator, two branch conductors for each section of working-conductor to connect it with each of the supply-conductors, and switches in said branch conductors whereby the section may be coupled with either supply-conductor.

8. In an electric railway, a working-conductor made in insulated sections, and an electrically-propelled vehicle receiving electricity therefrom, an electric generator, two electric supply-conductors connecting with the two poles of the generator, two branch conductors for each section of working-conductor to connect it with each of the supply-conductors, and electrically-actuated switches in said branch conductors, whereby the section may be automatically coupled with either supply-conductor during the passage of a vehicle over said section.

9. In an electric railway, the working-conductors made in line-sections and a yard-section insulated from each other, in combination with an electric generator directly connected with the yard-section, electric supply-conductors connecting with the generator, and branch conductors connecting the supply-conductors with the line-sections of working-conductors.

10. In an electric railway, the working-conductors made in line-sections and a yard-section insulated from each other, in combination with an electric generator directly connected with the yard-section, electric supply-conductors connecting with the generator, and branch conductors connecting the supply-conductors with the line-sections of working-conductors, and switches in said branch conductors.

11. In an electric railway, the working-conductors made in line-sections and a yard-section insulated from each other, in combination with an electric generator directly connected with the yard-section, electric supply-conductors connecting with the generator, and branch conductors connecting the supply-conductors with the line-sections of working-conductors, and automatic switches in said branch conductors.

12. In an electric railway, the working-conductors made in line-sections and a yard-section insulated from each other, in combination with an electric generator directly connected with the yard-section, a resistance-changer to control the current passing through the yard-section, electric supply-conductors connecting with the generator, and branch conductors connecting the supply-conductors with the line-sections of working-conductors.

13. In an electric railway, the working-conductors made in line-sections and a yard-section insulated from each other, in combination with an electric generator directly connected with the yard-section, an automatic resistance-changer to control the current passing through the yard-section, electric supply-conductors connecting with the generator, and branch conductors connecting the supply-conductors with the line-sections of working-conductors.

14. In an electric railway, the working-conductors made in line-sections and a yard-section insulated from each other, in combination with an electric generator directly connected with the yard-section, a resistance-changer to control the current passing through the yard-section, electric supply-conductors connecting with the generator, branch conductors connecting the supply-conductors with the line-sections of working-conductors, and switches in said branch conductors.

15. In an electric railway, the working-conductors made in line-sections and a yard-section insulated from each other, in combination with an electric generator directly connected with the yard-section, an automatic resistance-changer to control the current passing through the yard-section, electric supply-conductors connecting with the generator, branch conductors connecting the supply-conductors with the line-sections of working-conductors, and switches in said branch conductors.

16. In an electric railway, the working-conductors made in line-sections and a yard-section insulated from each other, in combination with an electric generator directly connected with the yard-section, a resistance-changer to control the current passing through the yard-section, electric supply-conductors connecting with the generator, and branch conductors connecting the supply-conductors with the line-sections of working-conductors, and automatic switches in said branch conductors.

17. In an electric railway, the working-conductors made in line-sections and a yard-section insulated from each other, in combination with an electric generator directly connected with the yard-section, an automatic resistance-changer to control the current passing through the yard-section, electric supply-conductors connecting with the generator, branch conductors connecting the supply-conductors with the line-sections of working-conductors, and automatic switches in said branch conductors.

18. In an electric railway, a yard-section of working-conductors, in combination with line working-conductors, an electric generator, an electrical connection between the generator and line-conductors, and a resistance-circuit connecting the yard-section at different distances from the generator with the generator, whereby the resistance is the same for all positions of a motor on the yard-section.

19. In an electric railway, a yard-section of working-conductors, in combination with line working-conductors, an electric generator, an electrical connection between the generator and line-conductors, a resistance-circuit connecting the yard-section at different distances from the generator with the generator, whereby the resistance is the same for all positions of a motor on the yard-section and a resistance-changer in said yard-section circuit.

20. In an electric railway, a yard-section of working-conductors, in combination with line working-conductors, an electric generator, an electrical connection between the generator and line-conductors, a resistance-circuit connecting the yard-section at different distances from the generator with the generator, whereby the resistance is the same for all positions of a motor on the yard-section, and an automatic resistance-changer in said yard-section circuit.

21. In an electric railway, a yard-section of working-conductors, in combination with line working-conductors, an electric generator, an electrical connection between the generator and line-conductors, and a connection between the two poles of the generator and the opposite ends of the respective yard-conductors, whereby the resistance is the same for all positions of a motor on the yard-sections.

22. In an electric railway, a working-conductor made in sections insulated from each other, in combination with a supply-conductor, a source of electric supply, circuit-closing devices to connect or disconnect the said sections with the supply-conductor, and resistances between the source of electric supply and conductor-sections, whereby the resistances from said source of electric supply to the various sections are equal or substantially equal.

23. The combination, substantially as hereinbefore set forth, of a railroad-track or working-conductor divided into two or more sections insulated from each other and from the earth, a generator of electricity, positive and negative supply-conductors extended from the respective poles of said generator along the line of said railroad, branch conductors uniting the opposite lines of rails or conductors of each insulated section of track or working-conductor with said positive and negative supply-conductors, respectively, circuit-controllers whereby the current for actuating an electrically-moved vehicle is permitted to traverse each of said branches only while said vehicle is passing over the insulated section of track or conductor connected with said branch, and resistances located in said branch tracks, whereby the resistance to the passage of current from the generator to the various sections shall be equal or substantially equal.

24. A railroad-track having its opposite lines of rails or working-conductors electrically insulated from each other, two electric supply-conductors which unite said opposite lines of rails or working-conductors, respectively, with the opposite poles of a generator of electricity, the two poles of the generator being connected, respectively, with opposite ends of the two supply-conductors, and two circuit-controllers, one in each of said conductors, which are simultaneously actuated to admit an operative electric current to said track or to interrupt the same.

25. In an electric railway, a working-conductor composed of insulated sections, in combination with an electric generator, two supply-conductors, branch conductors connecting the supply-conductors alternately with the successive working-conductor sections, electrically-actuated switches in said branch conductors, the said switches consisting of the armature and switch levers, a low-resistance magnet in normally-open circuit, but put into circuit by movement of its armature and switch levers, and a high-resistance magnet acting upon the same armature and in a normally-closed circuit between the supply-conductor and working-conductor section.

In testimony of which invention I have hereunto set my hand.

RUDOLPH M. HUNTER.

Witnesses:

ERNEST HOWARD HUNTER,

S. T. YERKES.