(No Model.) 2 Sheets—Sheet 1.

# G. W. VON SIEMENS.

## ELECTRIC CLOSED CONDUIT SYSTEM FOR RAILWAYS.

No. 509,403. Patented Nov. 28, 1893.

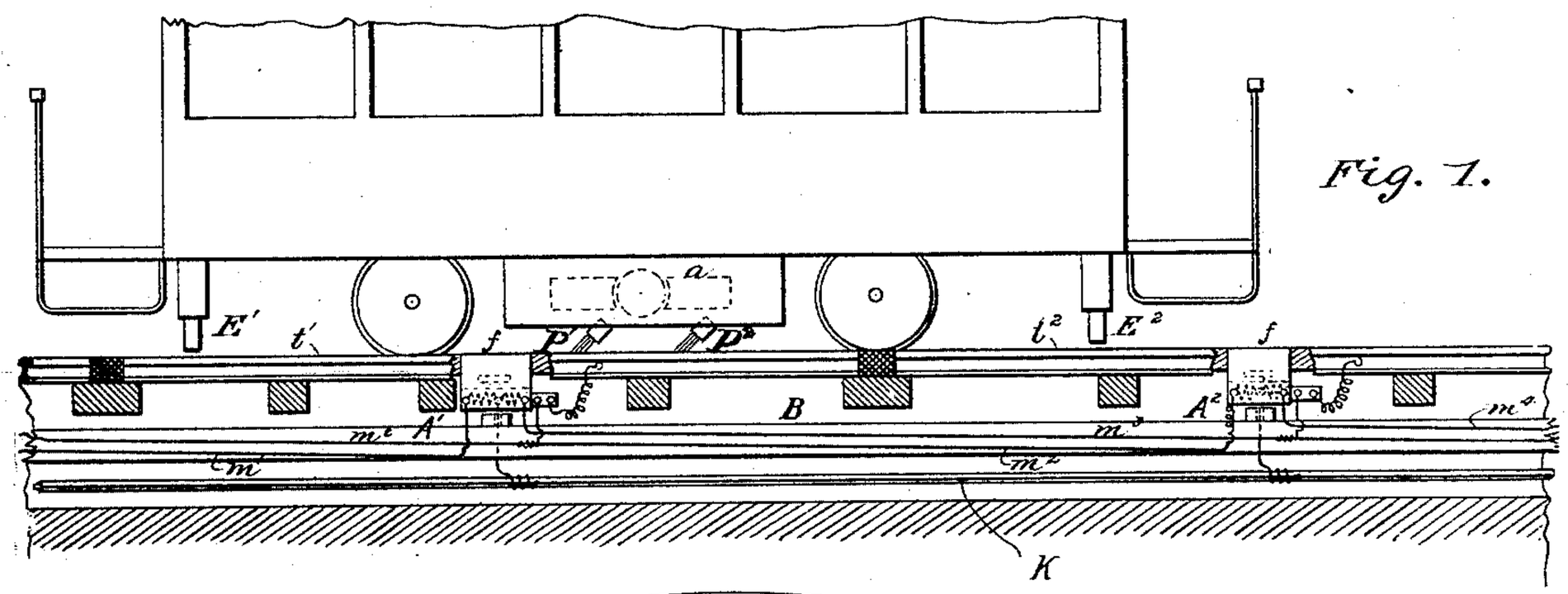


Fig. 1.

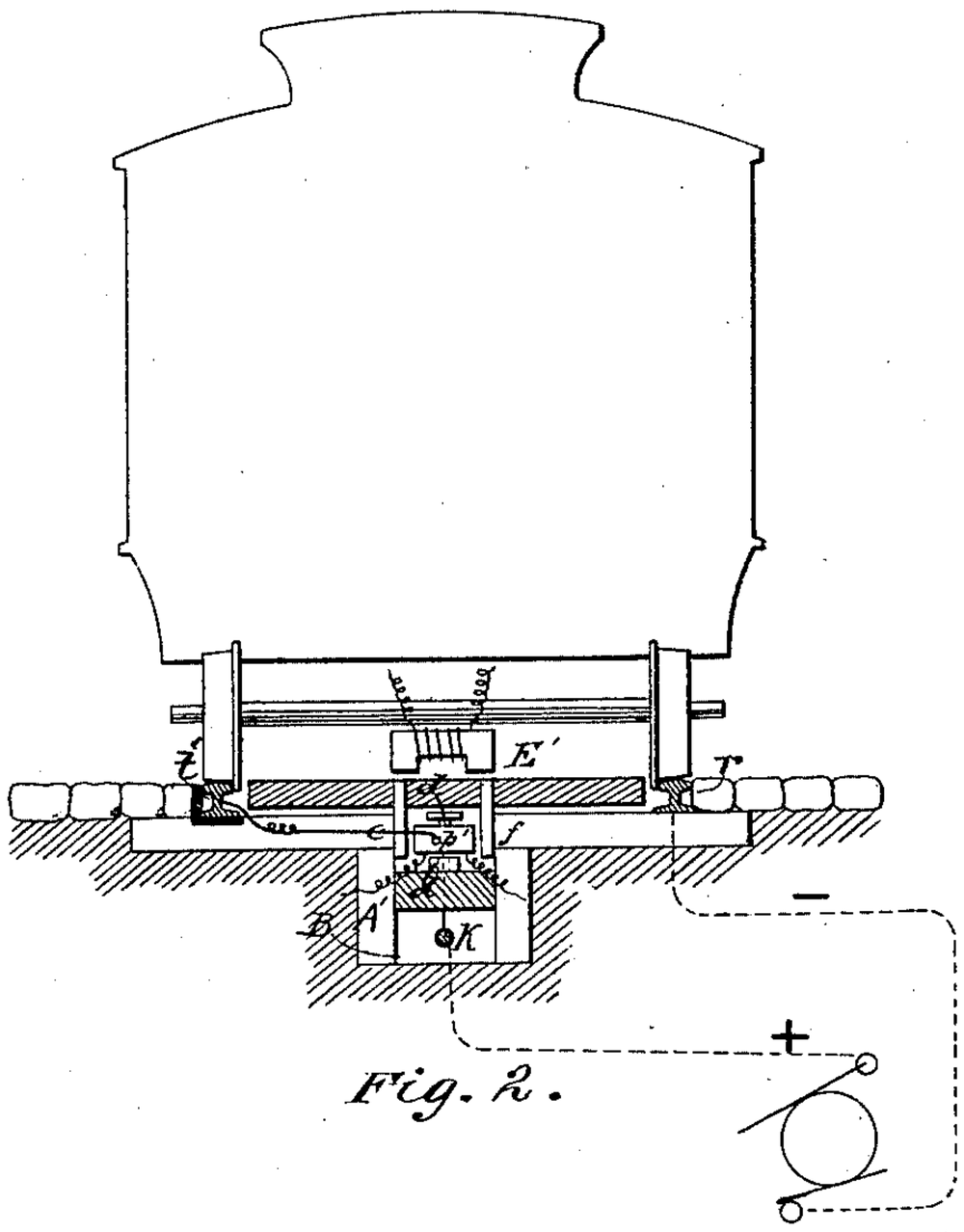


Fig. 2.

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(No Model.) 2 Sheets—Sheet 2.

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## ELECTRIC CLOSED CONDUIT SYSTEM FOR RAILWAYS.

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*Fig: 3*

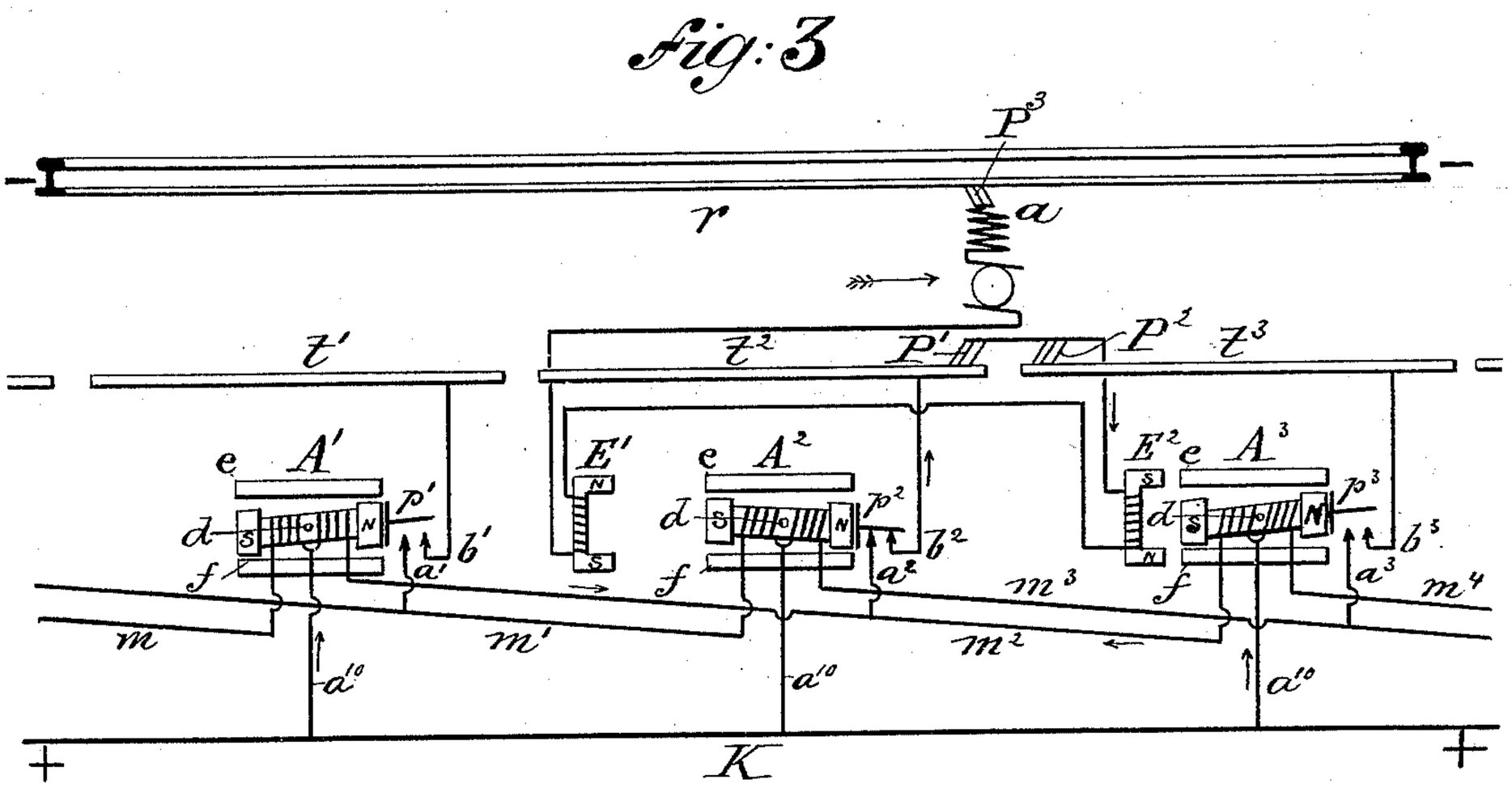
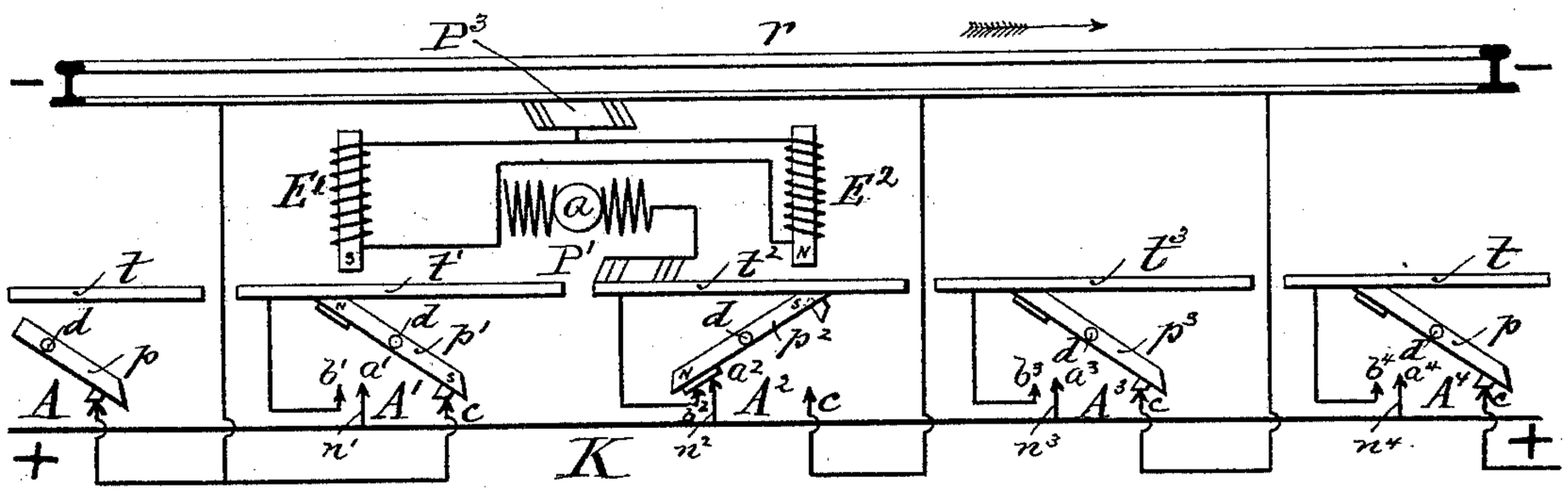



*Fig: 4.*

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# UNITED STATES PATENT OFFICE.

GEORGE WILHELM VON SIEMENS, OF BERLIN, GERMANY, ASSIGNOR TO SIEMENS & HALSKE, OF SAME PLACE.

## ELECTRIC CLOSED-CONDUIT SYSTEM FOR RAILWAYS.

SPECIFICATION forming part of Letters Patent No. 509,403, dated November 28, 1893.

Application filed April 13, 1892. Serial No. 428,970. (No model.) Patented in Germany April 29, 1891, No. 61,477, and July 13, 1893, No. 69,490, and in France December 19, 1891, No. 218,147.

*To all whom it may concern:*

Be it known that I, GEORGE WILHELM VON SIEMENS, a subject of the King of Prussia, residing at the city of Berlin, Prussia, Germany, have invented certain new and useful Improvements in Supplying Current for Electrically-Operated Vehicles or Tramways and Railways, (for which I have obtained Letters Patent in Germany, No. 61,477, dated April 29, 1891, and No. 69,490, dated July 13, 1893, and in France, No. 218,147, dated December 19, 1891;) 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 consists in means for supplying an electric current to moving railway cars from an insulated conductor removed from the trackway, or otherwise situated, in a manner such as to promote perfect insulation of such conductor, avoiding losses which are otherwise liable to result when such conductor is located in proximity to the ground and traveling contact made directly therewith.

In order to enable others skilled in the art to which my invention appertains to understand and use the same, I will proceed to describe one suitable form of apparatus embodying the said invention, explain its operation, and subsequently point out in the appended claims its novel characteristics.

Referring to the accompanying drawings: Figure 1 is a vertical longitudinal section of a roadway showing the position of the apparatus therein; Fig. 2, a cross section of Fig. 1; Fig. 3, a diagram illustrating the preferred arrangement of the electrical connection; and Fig. 4, a diagram illustrating a modification thereof.

Similar characters of reference represent corresponding parts throughout.

K represents the main line or insulated cable or conductor; $t'$, $t^2$, $t^3$, a series of sectional conductors which are connected to the main line K, through the automatic apparatus hereinafter described; and $r$ represents one rail of the railway. As illustrated in Figs. 1 and 2, the sectional conductors $t'$, $t^2$, $t^3$, &c., compose the other rail;—the sections of the same being insulated from one another at the rail joints.

In lieu of utilizing one of the traction rails as a sectional conductor thus described, the conducting sections $t'$, $t^2$, $t^3$, may compose a separate middle rail made up of contact plates insulated from each other. The positive pole of the source of electrical energy is connected to the main line K, and the return rail $r$ connected to the negative pole at such source, or grounded. When a middle rail is used, as above indicated, both traction rails of the road may be used as return current conductors.

The electrical connection of the main line K, with the sectional conductors $t'$, $t^2$, $t^3$, is automatically established or broken during the passage of the car over apparatus $A'$, $A^2$, $A^3$, which are provided with polarized electro-magnets $p'$, $p^2$, $p^3$, bearing switch contacts whereby they are adapted by their normal positions to open the circuit between conductors $a'$, $b'$, or between $a^2$, $b^2$, and to close the said circuit when moved by the car magnet to their active positions. The magnets $p'$, $p^2$, $p^3$ are pivoted or rest in trunnions, at an intermediate portion thereof, so as to tilt into their opposite normal and active positions, indicated for instance at $A'$, $A^2$ respectively. Suitable trunnions are indicated at $d$ in Figs. 2 and 3. Each conductor $b'$, $b^2$, $b^3$, &c., connects with a distinct conducting section $t'$, $t^2$, $t^3$, &c., respectively. Each conductor $a'$, $a^2$, $a^3$ connects by a branch, $m'$ $m^2$ and $m^3$ and tap wires $a^{10}$ at one or more points (two in Fig. 3) with the main line K.

In Fig. 3, each branch conductor $m'$ $m^2$ $m^3$, &c., includes two electro-magnets one on each side of the one controlling said conductor, and a magnetizing coil surrounds each of said magnets $p'$, $p^2$, $p^3$, so that the latter are polarized preparatory to the passage of the car over them in either direction, as the case may be, in the manner which will hereinafter appear.

The intervals between the conductors $t'$, $t^2$, $t^3$ are filled by suitable insulated traction surfaces, as indicated at Fig. 1, and the cars are provided with suitable traveling contact mak-

ing devices $P^3$, bearing on the rail $r$, and P′, $P^2$, on the sectional rail $t'$, $t^2$, $t^3$ respectively, establishing communication between the latter and the respective poles of the electro-motor on the car.

E′, $E^2$ are two electro-magnets located upon the car and included in the car circuit, of which magnets the one $E^2$, ahead in the direction of travel, is so polarized relatively to the electro-magnets $p'$, $p^2$, $p^3$ that the latter, when the said magnet $E^2$ approaches, are compelled to abandon their normal or open positions and connect the contacts $a'$, $b'$, and $a^2$, $b^2$, &c., successively. The second of the electro-magnets E′, on the car, is so polarized relatively to the said electro-magnets $p'$, $p^2$, $p^3$ as to cause their return in succession to their normal positions, such as indicated at A′, $A^3$.

The electro-magnets E′, $E^2$ on the car are included either in the main circuit with the motor $a$, or in a shunt circuit, but are constantly excited.

Electrical connection is established with one section $t'$ before it is broken with another $t^2$, &c., as the car progresses, and in order to maintain continuous electrical connection with the motor on the car, a double contact making device P′, $P^2$ is employed for making traveling contact.

$e$, $f$ represent iron plates which are embedded in the roadway (see Fig. 2), which serve to facilitate the passage of the lines of force of the car magnets E′, $E^2$ to the magnets $p'$, $p^2$, $p^3$, &c. The car magnets E′, $E^2$ are spaced apart at a distance greater than the length of each sectional conductor $t'$, $t^2$, $t^3$ so that the connection $a'$, $b'$, or $a^2$, $b^2$, &c., will be closed by one apparatus $A^2$ before it is broken in another, A′.

In changing the direction of travel of the car, the poles of the magnets E′, $E^2$ must be reversed. The parts underground are placed in a suitable subway B, indicated in Figs. 1 and 2, near the sectional rail $t'$, $t^2$, $t^3$,—the magnets E′, $E^2$ passing in proximity to the plates $e$, $f$. The operation, referring to Fig. 3, is as follows: The car or vehicle is assumed to travel in the direction of the arrow. The car magnet $E^2$ has passed the apparatus $A^2$, throwing the magnet $p^2$ into the position indicated, closing circuit through line K, contacts $a^2$, $b^2$, and conductor $t^2$ to the car. Upon further progress, the car magnet E′ exerts an opposite effect upon the apparatus $A^2$, returning the magnet $p^2$ into its normal position of rest, (such as indicated in the instances of $p'$ or $p^3$,) opening circuit between the line K and the said conductor $t^2$. This occurs after the advancing car magnet $E^2$ has reached the apparatus $A^3$, causing the closure of circuit therethrough in a similar manner into the conductor $t^3$, also corresponding to the time when the double contact making device P′ $P^2$ is in common electrical contact with the two conductors $t^2$, $t^3$. A continuous but localized supply of current is thereby afforded to the car as it passes over the successive sections of the sectional conductor. When the electro-magnet $p^2$ is moved into the position indicated, it connects the two contacts $a^2$, $b^2$ with each other, and the branches of $a^2$, $m^2$, which include magnetizing coils, a portion of each of which is upon the adjacent magnets $p'$, $p^3$, respectively, thus simultaneously polarizing said adjacent magnets to render them operative, preparatory to the advancement of the car in whichever direction it progresses.

Referring to Fig. 4, $p$ $p'$, $p^2$, $p^3$ are permanently polarized magnets pivoted at $d$ to swing in vertical arcs under the rail sections $t$ $t'$, $t^2$, $t^3$. The normal position of rest of said magnets is indicated at $p$ $p'$, $p^3$. Their position of displacement is as indicated at $p^2$. These magnets are permanently polarized and electrically connect directly with the sectional conductors $t$ $t'$, $t^2$, $t^3$, serving themselves as conductors. Below the oscillating magnets $p'$, $p^2$, &c., are located the contacts $a'$ $a^2$, &c., electrically connected to the conductors $n'$ $n^2$, &c., and the contacts $b'$, $b^2$, &c., electrically connected to the sections $t'$, $t^2$, &c., the contacts $a'$ and $b'$ and $a^2$ and $b^2$, being in a position to be connected with each other when the polarized magnets $p'$, $p^2$ are displaced. The magnets E′, $E^2$, upon the car, polarized by circuit, are situated so as to pass in proximity to the conductors $t$ $t'$ $t^2$ $t^3$, &c.,—being thereby brought also into proximity with the permanently polarized magnets $p'$, $p^2$. Supposing the car to advance in the direction of the arrow, Fig. 4, the first magnet $E^2$ repels the normally uplifted end of the movable magnet and attracts the opposite end thereof, bringing it to the position indicated at $p^2$, closing contact through $a^2$, $b^2$,—the circuit passing from the main line K, through the conductor $t^2$, beneath the car, and through the traveling electro-motor to return current conductor $r$, or ground. As the car progresses, and subsequent to the time when the magnet E′ similarly operates on a succeeding oscillatory magnet underground, the magnet $E^2$, reversely polarized, causes the magnet $p^2$ to resume its normal position of rest, breaking circuit through $a$, $b$, cutting conductor $t^2$ out of circuit. The same operation is successively repeated. Each of the polarized magnets $p$ $p'$ $p^2$, &c., is provided, in the illustration, Fig. 4, with a third contact $c$, connected with the return current conductor $r$, for the purpose of returning any electrical energy that may remain stored in the conductors $t'$, $t^2$, &c., after they are cut out of circuit, to the main return conductor.

Having thus described my invention, I claim—

1. In a system of electrical distribution for railways, the combination with a main feeder, and a series of sectional insulated conductors, of a car provided with a traveling contact device; oppositely polarized magnets carried upon the car; a normally open circuit be-

tween the main feeder and each of said sectional conductors; a series of electro-magnets, one for each sectional conductor; and contacts and connections whereby said electro-magnets are, respectively, polarized in advance of the passing over them of the car magnets, substantially as described.

2. In an electric railway system, the combination with a main feeder, of a series of insulated conductors adapted for contact with a contact device on the car, magnetically operated circuit devices for successively cutting said conductors into and out of circuit, magnets for operating said circuit devices, relatively located on the car at a greater distance apart than the distance between the circuit devices, and contacts and connections whereby the magnets of said circuit devices are respectively polarized in advance of the passing over them of the car magnets, substantially as described.

3. In a system of electrical distribution for railways, the combination with a main feeder, a series of sectional conductors, a car carrying an electro-motor and having a contact making device and an electro-magnet, of a series of circuit controlling devices each comprising a polarized electro-magnet, contact points and branch conductors, the latter leading from one contact point of one of said circuit controlling devices to the magnet coil of the circuit controlling device in front of the same, substantially as described.

4. In a system of electrical distribution for railways, the combination of a main feeder, sectional conductors normally out of circuit, a circuit controlling device for each of said sectional conductors, comprising a polarized electro-magnet and contact points with a branch conductor leading from one of said contact points to a sectional conductor, and a divided branch conductor leading to the main feeder from the other of said contact points through the coils of the polarized magnets located, respectively, in advance and in the rear of the first mentioned magnet, substantially as described.

5. In a system of electrical distribution for railways, the combination with an insulated main conductor, of a sectional contact making rail, a double contact-making device upon the car adapted to connect with one rail section before leaving another, a series of magnetically controlled circuit devices for connecting and disconnecting each of said rail sections with the said main conductor, the same being located at uniform distances apart, and two magnets upon the car oppositely polarized, and so polarized relatively to the magnets of the said circuit devices as to open and close the circuits as set forth, the said car-magnets being located at a greater distance apart than the distance between the circuit devices, substantially as described.

In testimony whereof I have affixed my signature in presence of two witnesses.

GEORGE WILHELM V. SIEMENS.

Witnesses:

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W. HAUPT.