(No Model.) 5 Sheets—Sheet 1.

L. GUTMANN.

ELECTRIC RAILWAY SYSTEM.

No. 426,269. Patented Apr. 22, 1890.

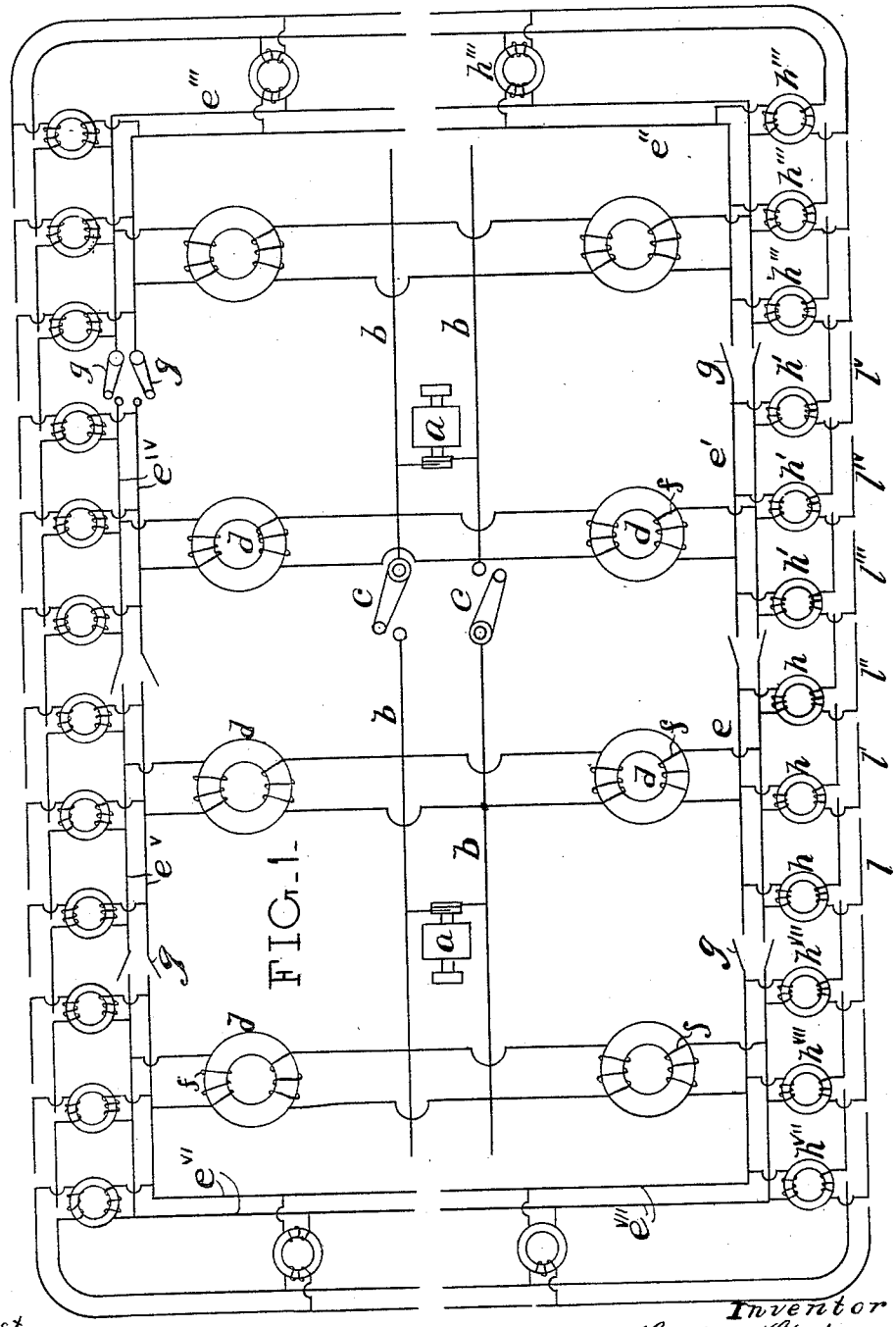

FIG. 1.

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ELECTRIC RAILWAY SYSTEM.

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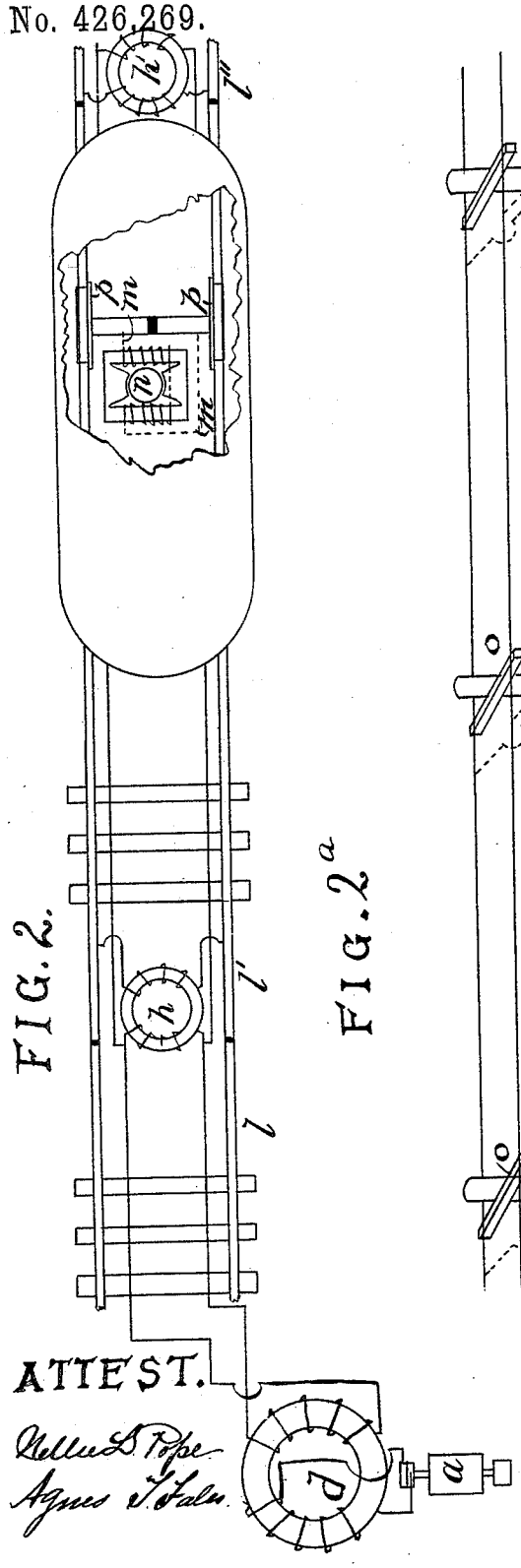

FIG. 2.

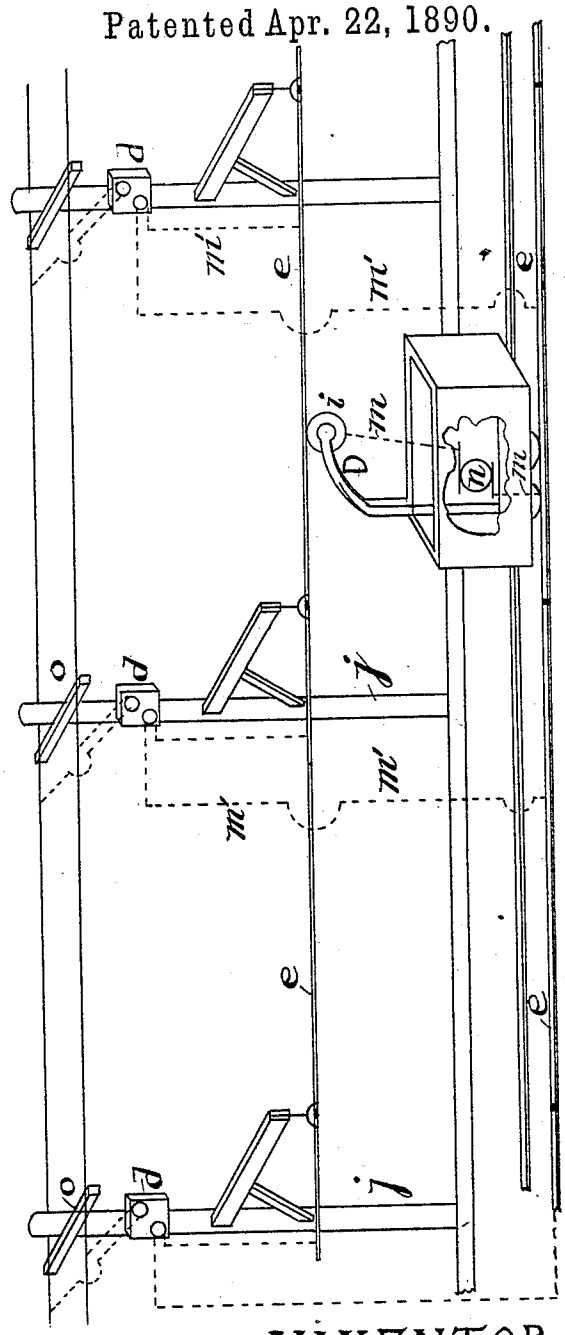

FIG. 2a

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(No Model.) 5 Sheets—Sheet 3.

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ELECTRIC RAILWAY SYSTEM.

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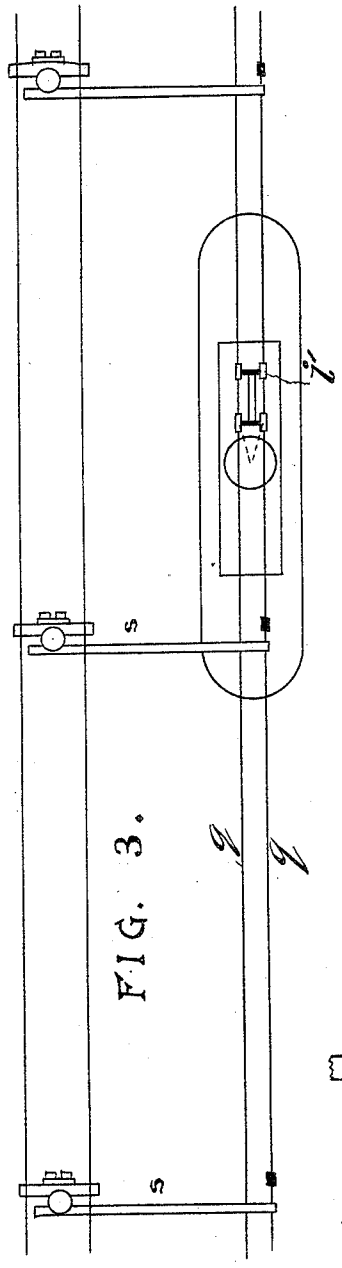

FIG. 3.

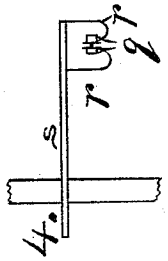

FIG. 4.

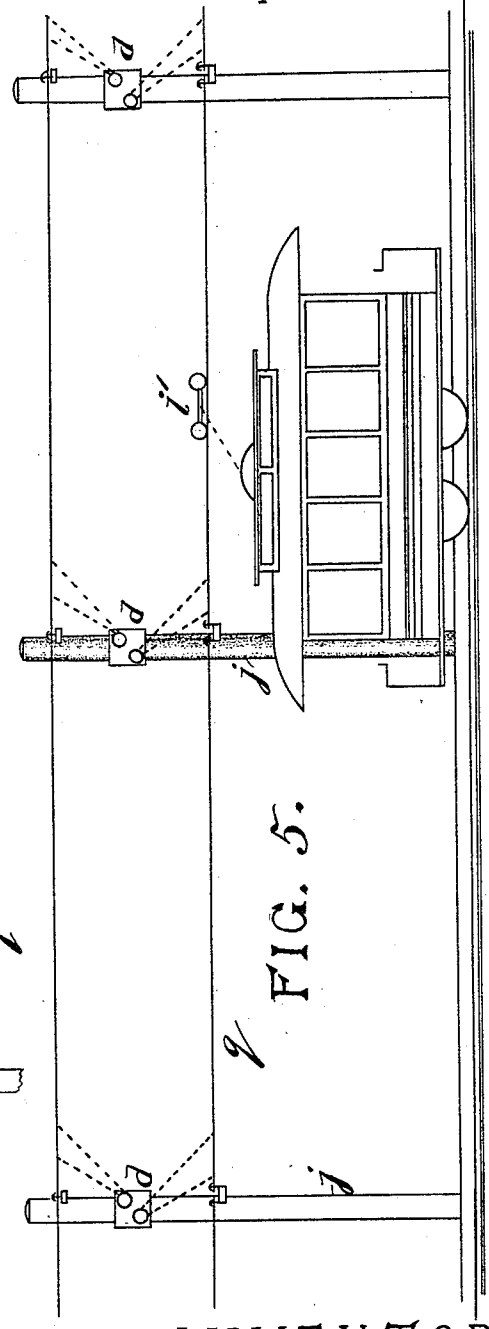

FIG. 5.

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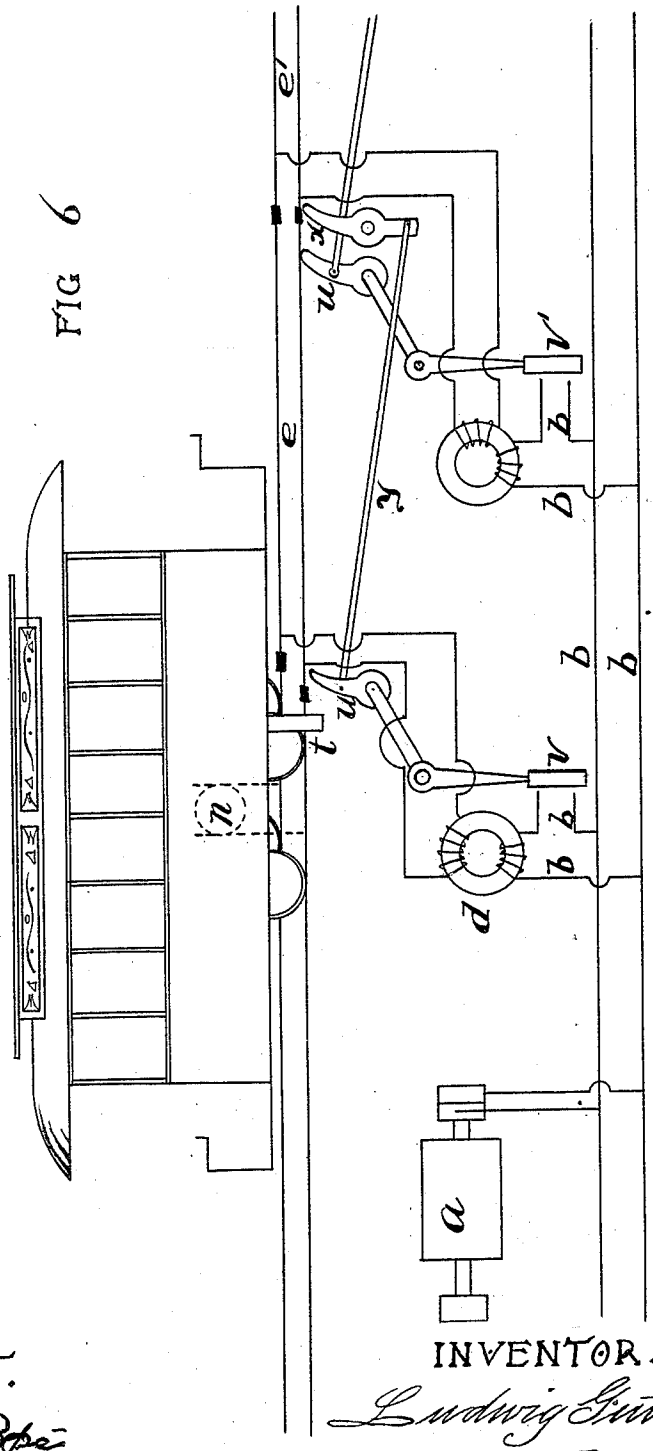
No. 426,269. Patented Apr. 22, 1890.

FIG 6



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(No Model.) 5 Sheets—Sheet 5.

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ELECTRIC RAILWAY SYSTEM.

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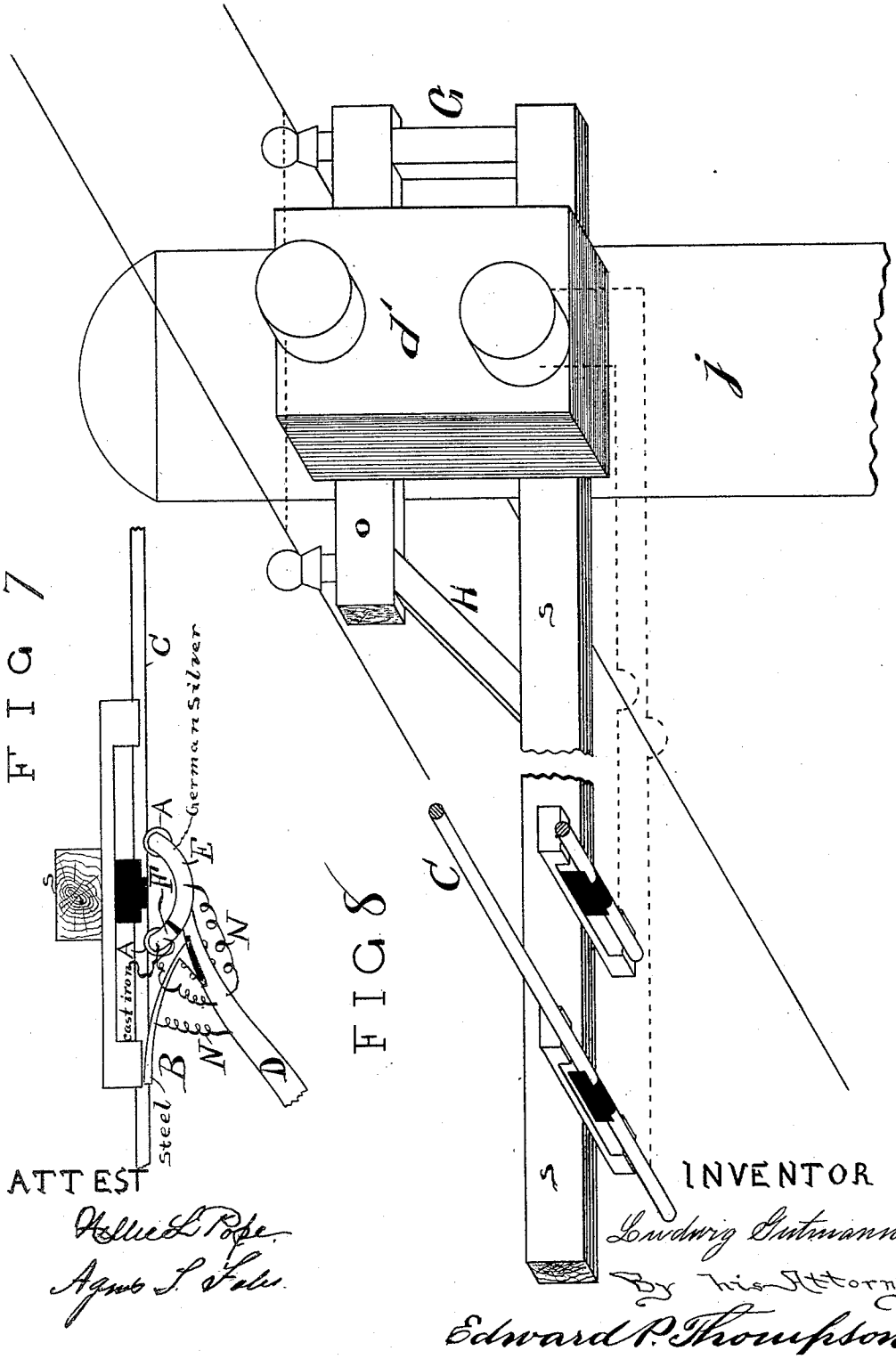

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UNITED STATES PATENT OFFICE.

LUDWIG GUTMANN, OF FORT WAYNE, INDIANA.

ELECTRIC-RAILWAY SYSTEM.

SPECIFICATION forming part of Letters Patent No. 426,269, dated April 22, 1890.

Application filed January 5, 1889. Serial No. 295,525. (No model.)

To all whom it may concern:

Be it known that I, LUDWIG GUTMANN, a subject of the German Emperor, and a resident of Fort Wayne, county of Allen, and State of Indiana, have invented certain new and useful Improvements in Electric-Railway Systems, of which the following is a specification.

My invention relates to an alternating-current system of electric distribution for electric railways; and its object is to convey the current economically over long distances and to avoid leakage and fall of electro-motive force in the work-circuit.

All the details of the invention are set forth in the accompanying drawings, in which Figure 1 is a diagram of the generators, both primary and secondary, and of the circuits. The figure represents a working secondary circuit adapted to impart a current to a motor on a car running from one end of the circuit to the other end—as, for instance, when connecting two distant cities. Fig. 2 is a plan view of a part of the system in which the two rails of the railway-track are made the working secondary circuit. Fig. 2^a is a view in elevation and in perspective of a system in which the one secondary conductor is one of the rails of the track and in which the other secondary working-conductor is over the car in the manner of an overhead conductor. In these two figures, Figs. 2 and 2^a, the car is partly broken away, so as to disclose the motor therein. In Figs. 3 and 5, the latter being a view in elevation and the former in plan, the secondary or working circuit is located entirely above the car and carries a trolley or current-collector. Fig. 4 shows a side view of the suspenders for the conductors of the secondary circuit, the same being so constructed as to allow the passage of the current-collector. Fig. 6 shows an application of circuit-closers to the system, whereby the converters placed along the track are cut out, except when a car is on a particular section. Fig. 7 is a side view of the preferred form of current-collector, the conductor being also shown in contact with the said collector. Fig. 8 is a perspective view of supports of the converter and primary and secondary conductors on an enlarged scale.

The system consists of the combination of one, two, or more independent generators or generating-stations *a a*, producing alternating, pulsating, or intermittent currents of high potential, placed along the line of the railway; primary conductors *b*, connected to the generators, extending from one generating-station to the next or next two, if situated between two stations, and each of the primary conductors *b*, including circuit-closers *c*, so located and constructed as to be able to include one or more generators in circuit with the said conductors, as well as to be able to exchange one generator for the other; converters *d*, connected at intervals to both the poles of the primary circuit; secondary conductors *e e′ e″ e‴*, &c., connected in circuit with the secondary coils *f* of the said converters, respectively; circuit-closers *g* in circuit with the said conductors *e e′ e″ e‴*, &c., the correct position of the same being normally open, as shown in the figure; converters *h*, whose primary coils are connected in multiple arc with one another to the conductor *e*; converters *h*, connected in multiple arc with one another to the conductor *e′*; converters *h″*, connected with their primary coils across the circuit of conductors *e″*, and so on; the converters h^{vii}, connected with their primary coils across the conductors e^{vii}, and tertiary conductors or secondary conductors of the converters *h h′ h″ h‴*, &c., represented in section *l l′ l″ l‴* l^{iv}, &c., each section being in circuit with one of the converters *h′ h″* in sets of one, two, three, or more. It is evident that if the two conductors *l* or *l′* or *l″* are connected, as by a current-collector, a current will be generated, so that if an electric car is started along the said conductors in such a manner that its electric-current collector moves upon the conductors *l l′ l″*, &c., the car will automatically travel along the line, its momentum carrying it past the break, whereby the sections are formed. In a similar manner it is evident that cars could be propelled along the conductors *e e′ e″*, &c. This latter condition is represented in Fig. 2^a, where are shown also the car, the collector *i*, and the converter-supports *j*. The current passes directly from the generator *a* to the converter *d*, and induces a current in the secondary coils and working-conductors connected thereto, one of which

is overhead and the other is the rail itself, and both of which are (or one of them is) respectively divided at intervals into sections.

In Figs. 2 and 2^a the wheels on the sectioned conductor or rail may form part of the current-collector. The dotted lines m show the electrical connections from the one conductor e to the motor n and to the other conductor e'. The dotted lines m' show the connections from the converters d (shown incased) to the conductors e. The primary conductors b are carried on elevated poles or supports j and fastened thereto by means of cross-pieces o. The upper portion, Fig. 2, differs from the lower part, Fig. 2^a, in that the conductors e' consist both of the two rails of the track. The rails are lettered l l', &c., as they represent the same part of the drawings—namely, the secondary conductors of the converters h h', &c., as in Fig. 1. The collector may be a pair of wheels of the car, the same p being insulated from each other and electrically connected to the motor n by electrical conductors, (represented by the dotted lines m.) When the wheels are on the conductors l', as shown, the motor n comes in circuit with the generator, and is in what may conveniently be termed the "tertiary circuit" of the generator a.

In Figs. 3 and 5 the working-circuit, whether secondary or tertiary, is represented by overhead conductors. They are supported by the curved piece r, Fig. 4, suspended from the arms s, and between which the collector is adapted to pass. The collector is represented by the letter i'. Figs. 3 and 5 represent a modification, inasmuch as but one of the working or contact conductors is shown subdivided. (See Fig. 3.) The secondary coils are connected with one end to an uninterrupted or continuous wire, while the second end of each secondary coil is connected to a section of the second working or contact conductor. This method considerably modifies the construction and the cost price. It is evident that this modification is also applicable in the case where one overhead conductor and a rail are used. In this case I prefer to make the rail continuous and the overhead conductor into sections on account of greater facilities to well insulate the latter from grounds. If both rails are used, as in Fig. 2, for the working or contact conductors, it is preferred to have them both divided into sections, as modification would not work economically on account of frequent grounds that would occur.

In Fig. 6 the car is provided with a tripping device t, projecting below the level of the car-track, so as to be adapted to come in contact with and to move and turn the cam u through a small angle, whereby the circuit-closer v will close the primary circuit b of the generator a. The circuit-closer v is attached to the cam u and partakes of its motion. The converter d having its primary circuit closed and the motor n being in circuit with the conductors e, after the above operation occurs the car will be electrically propelled. When the car reaches the other end of the section e, the circuit-closer v' will be operated in a similar manner, and an instant later the projection t will turn the cam-lever x, so that the circuit-closer v will be opened, the rod y being connected to the upper part of cam u above its pivot-joint and also at the opposite end, but to the lower part of cam x below the pivot-joint thereof. In this manner the car automatically closes the primary circuit through the converter corresponding to the section upon which it is at the time and opens the same circuit at or about the time when the car leaves the section.

In Fig. 7 the collector consists of the combination of a pair of wheels A, insulated from each other, and a follower spring-contact B, insulated from the wheels. The wheels and spring are all in contact with the conductor C and with the conducting-rod D. The support of the front wheel, (lettered E,) the support F of the last wheel, and the spring B are of higher and higher resistance, so that the current is cut off gradually as the collector passes along the conductor from one section to the other. By this means the resistance is increased to a maximum gradually, so that as the current becomes broken the sparking is practically *nil*, thereby avoiding the usual wearing out of the collector, and especially of the conductors at the ends of the sections.

In Fig. 8 the arms s, for the support of the working-conductors, are trussed to the arm or cross-piece o, while the converter d' is connected rigidly to both the pieces o and s, which are trussed by the compression-strut G and the tie H. The truss is attached strongly to the pole.

The advantage of cutting out the primary coils of the converters is to avoid the small but important aggregate loss of the energy consumed by the primary coils of the said converters and the loss due to leakage to ground.

The object of bringing the independent circuits within reach of one another to effect by means of circuit-closers g a connection between two following conductors in the secondary circuits of converters d is that the sections, two or more at a time, may be connected by said circuit-closers g, in case of emergency, to one and the same converter, thereby being able to replace a broken converter by the succeeding converter.

It will be noticed that the electric collector is especially long, so as to bridge two consecutive sections. Sometimes the momentum of the car would not carry the collector from one section to the other—as, for instance, if the car should have to stop just at the end of a section. Therefore, to be able to propel a train or car from one city to another distant point the contact-conductors of the independent stations from which the motors are supplied have to be brought into close proximity

to enable the current-collector to connect to the following conductor before the connection with the former is broken.

It will be noticed that the primary as well as the secondary circuits are shown open, both being automatically closed by the car, the former by a tripping device, the latter by the trolley; but it is of course evident that the tripping devices may be used for the secondary as well as the primary circuits.

Having described my invention, what I claim is as follows:

1. In an electric-railway system, the combination of a railway-line, two or more independent generating-stations distributed along the said railway-line, provided with generators for generating currents of alternating, pulsating, or intermittent currents of high pressure, main-line conductors connected to the generators and provided with circuit-closers for interchanging the generators of the different stations to the main-line wires, converters organized in parallel to each other and connected to both the poles of the generators, and contact-conductors mounted upon the train of the railway system and in electrical connection with the secondary coils of the converters, the contact-conductors at the extreme ends of the several central stations to be close enough for the current-collector to bridge over from a conductor supplied by one station to a conductor supplied or energized by another station-generator, the said train being provided with motors the exciting-circuits of which are proportioned to require currents of a potential equal to the pressure in the contact-conductors.

2. In an electric-railway system, the combination of an electric car, conductors divided at intervals into sections, electric connections between the conductors of one section and the electric motor on the said car, an electric converter in circuit with each section as to the secondary coil of said converter, the converters having their primary coils connected to a suitable generator of alternating, pulsating, or intermittent currents, a tripping device upon the said car, a circuit-closer lever located in the path of the said tripping device normally open and in circuit with the converter, the said circuit-closer lever being located at one end of the section, and a second lever also in the path of the said tripping device located at the opposite end of the said section adapted to reverse the first-mentioned circuit-closer lever, the said circuit-closer lever and converter-circuits being repeated at each section, as and for the purpose described.

3. In an electric-railway system, the combination of an electric car in circuit with contact-conductors supplied by primary, secondary, or tertiary generators, a second car in circuit with a second set of contacts, conductors supplied by other primary, secondary, or tertiary generators, a third car in circuit with a third set of contact-conductors supplied by again other primary, secondary, or tertiary generators, two circuit-closers located at the two ends of each section, one of which is a circuit-closing switch, the other a circuit-opening switch for operating the said primary, secondary, or tertiary generators, electric motors mounted on the said cars, and a tripping device attached to the said cars within the path of the said switches, as and for the purpose described.

4. In an electric-railway system, the combination of two contact-conductors, one of them or both being divided at intervals into sections and extending along the railway-line, a circuit-closing switch located at or near one end of each section, and a circuit-opening switch located at or near the second end of each section, electric motors mounted on cars and in traveling contact with the said contact-conductors, and energized by primary, secondary, or tertiary generators, producing alternating electric currents, and a tripping device attached to the car and located in the path of the said circuit-closers, as and for the purpose described.

5. In an electric-railway system, the combination of electric contact-conductors extending along the railway-line, divided at intervals into sections, an electric car provided with a motor, and a collector of the current in traveling contact with the said contact-conductors and permanently connected to the said car and motor, the said collector consisting of the combination of two or more contacts of higher and higher resistance pressing upon or against the said contact-conductors and electrical connections from the said two or more contacts to the said copper conductor.

6. In an electric-railway system, the combination of contact-conductors extending along the railway-track, one of them or both being divided into sections, two other conductors also extending along the track and in circuit with a generator of high-potential, alternating, pulsating, or intermittent currents, electric converters connected with their primary coil normally open to the high-tension circuit, and with their secondary coil also normally open, each to the two contact-conductors or to sections of the said contact-conductors, circuit-closing and circuit-opening switches connected to the open-converter circuits placed at intervals along the railroad-track, and electric cars carrying motors in circuit with the said contact-conductors and provided with a tripping device located in the path of the said circuit closing and opening switches, as and for the purpose described.

In testimony that I claim the foregoing as my invention I have signed my name, in presence of two witnesses, this 24th day of December, 1888.

LUDWIG GUTMANN.

Witnesses:
WILLIAM C. RYAN,
DANIEL RYAN.