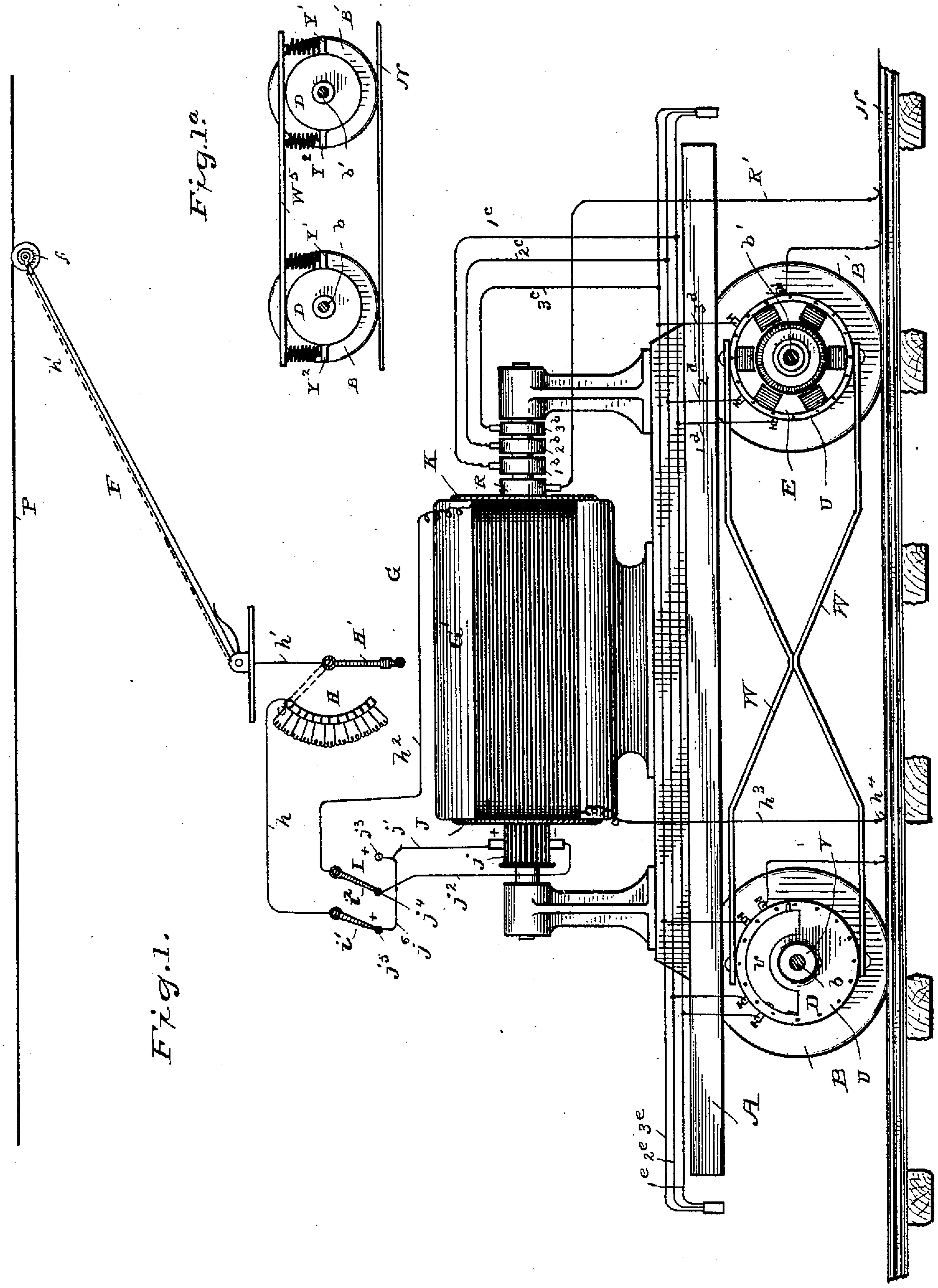
(No Model.)

3 Sheets—Sheet 1.

C. J. VAN DEPOELE.

ELECTRIC RAILWAY SYSTEM.

No. 434,684. Patented Aug. 19, 1890.



Witnesses
H. A. Lamb
C. S. Sturtevant

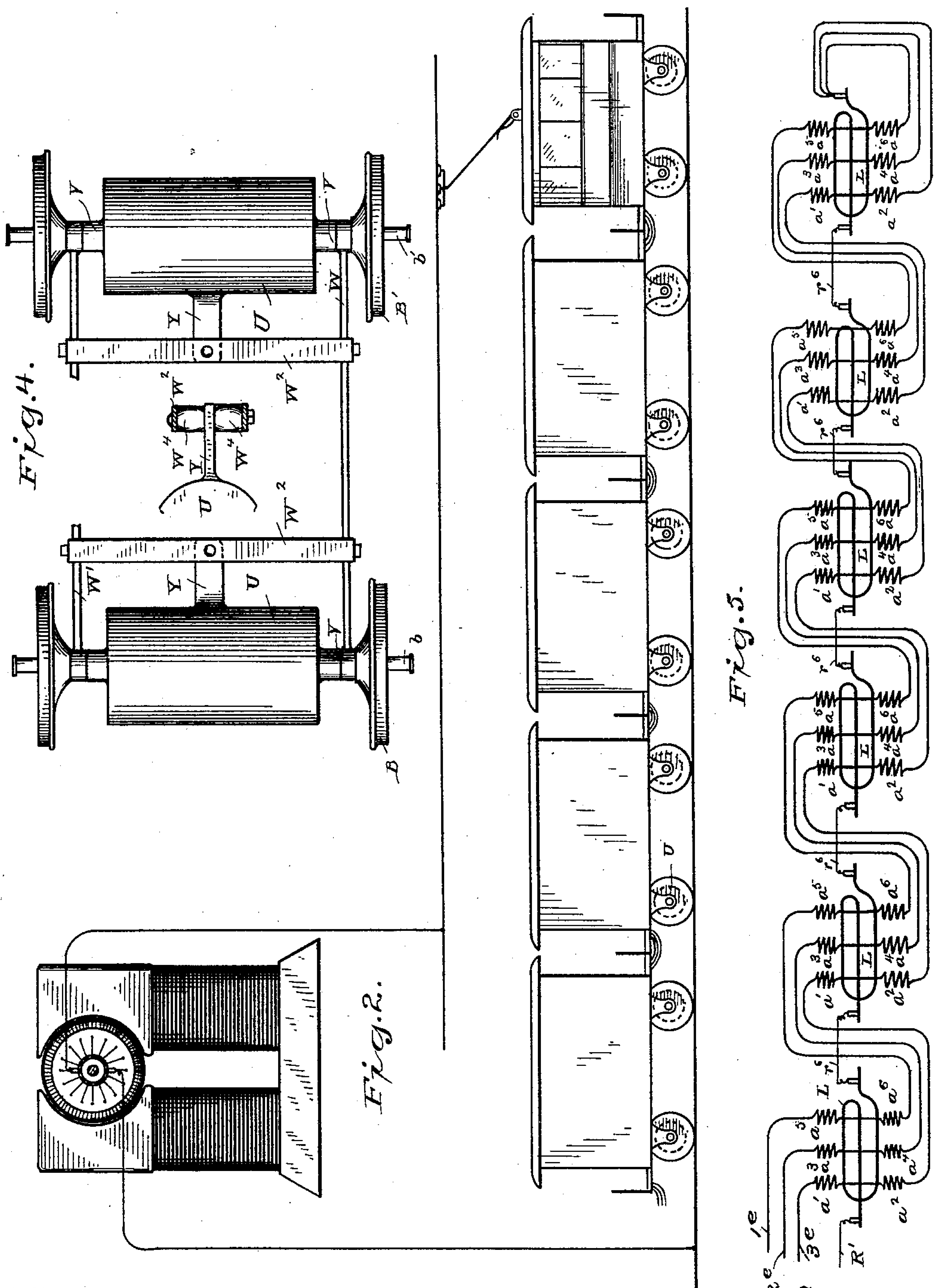
Inventor
Charles J. Van Depoele
By his Attorney
Frankland Jannus

(No Model.) 3 Sheets—Sheet 2.

C. J. VAN DEPOELE.

ELECTRIC RAILWAY SYSTEM.

No. 434,684. Patented Aug. 19, 1890.



Witnesses
H. A. Lamb
C. S. Sturtevant.

Inventor
Charles J. Van Depoele
By his Attorney
Frankland Jannus.

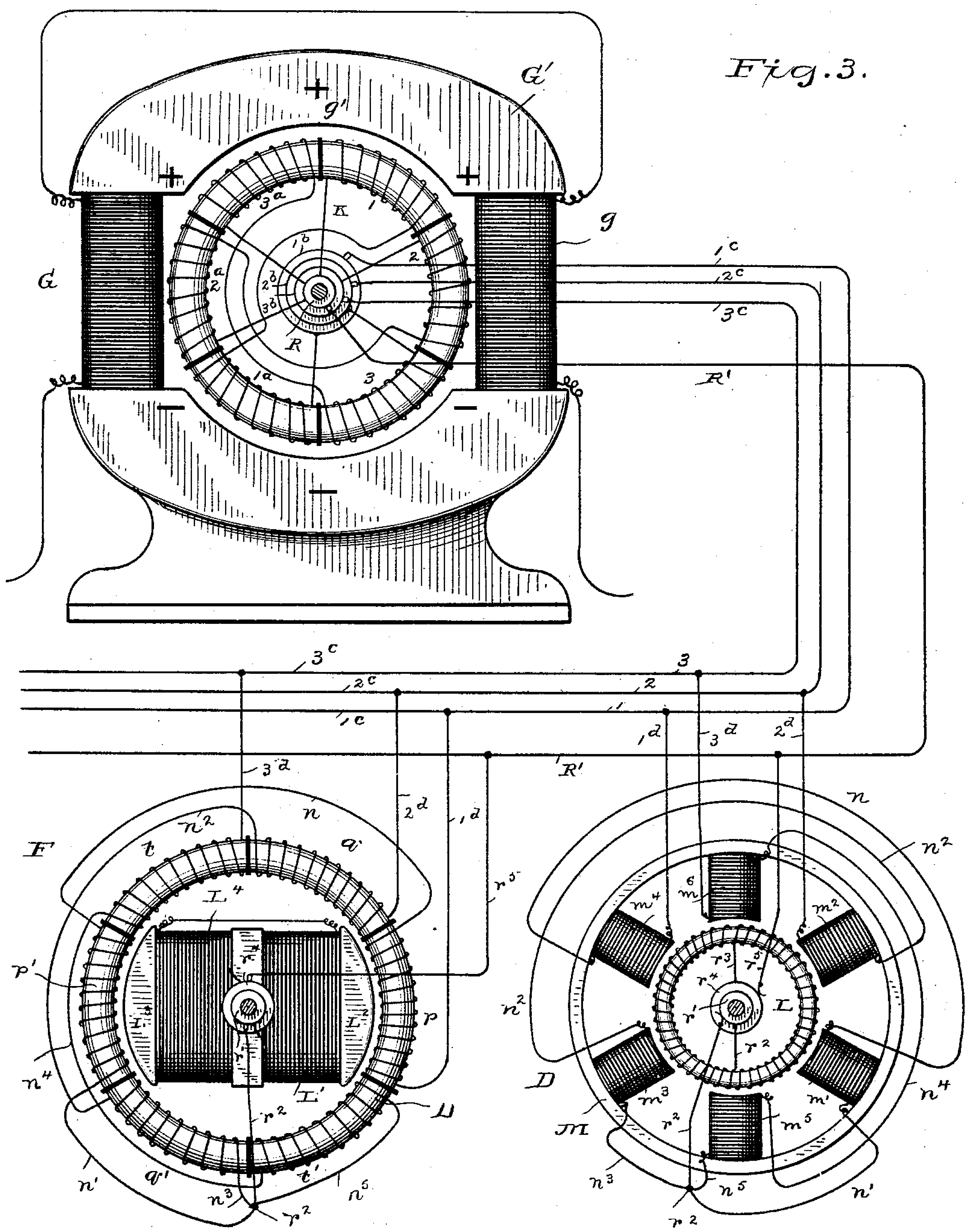
(No Model.) 3 Sheets—Sheet 3.

C. J. VAN DEPOELE.

ELECTRIC RAILWAY SYSTEM.

No. 434,684. Patented Aug. 19, 1890.

Fig. 3.



Witnesses

H. A. Lamb

C. S. Sturtevant.

Inventor

Charles J. Van Depoele

By his Attorney

Frankland Jannus.

UNITED STATES PATENT OFFICE.

CHARLES J. VAN DEPOELE, OF LYNN, MASSACHUSETTS.

ELECTRIC-RAILWAY SYSTEM.

SPECIFICATION forming part of Letters Patent No. 434,684, dated August 19, 1890.

Application filed August 12, 1889. Serial No. 320,456. (No model.)

To all whom it may concern:

Be it known that I, CHARLES J. VAN DEPOELE, a citizen of the United States, residing at Lynn, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Electric-Railway Systems, of which the following is a description, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon.

My invention relates to improvements in electric-railway systems, and it includes means for transmitting the motive current direct from the source of supply by exposed working-conductors extending along the line of the railway. The supply-current is collected from the exposed working-conductors by contact devices carried by one or more of the moving vehicles. According to my present invention the current supplied to the working-conductors is of a tension that can be economically transmitted along the entire line of conductors without wasteful loss. The tension necessary to so transmit current will depend of course upon the size of the conductor and its length. In order to utilize such current to the fullest possible extent and to minimize the danger of short-circuiting and other injuries possible to the motors from the use of high-tension supply-currents, I reduce the potential thereof to any desired degree before permitting the same to enter the motor-circuits.

In a previous application, Serial No. 302,287, filed March 7, 1889, I have shown, described, and claimed a system in which high-tension current was taken from an auxiliary circuit, then transformed or converted to a current of the desired potential much lower than that of the supply, and then transmitted to exposed working-conductors arranged along the line of the railway, from which said conductors the current was collected by the traveling motor. With the present invention, however, the secondary set of supply-conductors is entirely dispensed with, the supply being transmitted over the only conductors arranged adjacent to the railway, and the tension-reducing devices placed upon the moving vehicle or vehicles. The invention also includes a local circuit for the converter, comprising a system of conductors extending throughout a train composed of a plurality of cars, all or any desired number of which being motor-cars and supplied with current from the local circuit fed by the traveling converter. By this means it will be apparent that a train may be made up of any desired length and provided with efficient propelling-power in the shape of electric motors placed upon any desired number of the cars, the motor-cars being at the same time utilized for the ordinary work of the train in carrying passengers or freight. All the motors being connected in similar relation, it will be evident that the entire complement of motors can be controlled from a single point—viz., the converter or the source from which the current is supplied to the train-circuit. As stated, I propose to employ a sufficient number of motors upon each train to efficiently operate the same. This, of course, will necessitate greater converter capacity under some conditions than under others. I therefore provide the principal motor-car with a converter or group of converters so constructed and arranged that they may be connected to produce the desired currents, according to the number of motors it is desired to operate in a single train-circuit. Obviously, if all the current for the motors of an entire train is to be collected by a single device, which would be the most convenient, one ordinary trolley-wheel might afford an insufficient contact-surface for the purpose. According, therefore, to the present invention, I employ a number of trolley-wheels arranged tandem, or, what in many cases I find to be more efficient, one or more rubbing-shoes, which make an elongated and very effective contact with the main supply conductor or conductors.

The invention is not limited to the special devices hereinafter shown, described, and claimed, although I find them particularly well adapted to the purpose. In addition to what is herein shown and described, the system includes a continuous-current tension-reducing device or motor-generator carried upon a traveling vehicle and supplying current to a local train-circuit, and a number of ordinary continuous-current motors located upon one or more of the cars composing the train, all of the said motors receiving current from the said train-circuit, whether in multiple arc or in series, the entire number of motors by which the train is propelled being under such circumstances controllable from a single point—viz., the device by which the motor-generator is operated. With continuous currents in all the circuits some particular means will be required for reversing the motors; but this branch of the subject will be treated in a separate application.

The accompanying drawings illustrate an organization embodying the invention, which will be hereinafter described, and referred to in the appended claims.

In said drawings, Figure 1 is a view in elevation, partly in diagram, showing a motor-car provided with converter, motors, and current collecting and controlling devices arranged according to my invention. Fig. 1[a] is a detail view showing an elastic connection between the motors and the truck-frame. Fig. 2 is also a view in diagram showing the relative arrangement of different parts of the system as a whole. Fig. 3 is a diagrammatic view showing the arrangement of the circuits and connections of the converter and two of the motors. Fig. 4 is an enlarged plan view illustrating the general appearance of the motors and inclosing-casings when in operative position. Fig. 5 is a diagrammatic view of another arrangement of the train-circuit.

As indicated in the drawings, A is the bed or floor of a motor-car, said car being sustained by wheels B B′, adapted to move upon suitable tracks N.

D E represent electric motors, which are suitably sustained in operative relation to the axles *b b′* of the said carrying-wheels, and to which the armature-shafts of said motors are geared or attached.

P represents a suspended bare working-conductor forming one side of the supply-circuit, the track-rails N in the present instance being utilized to convey the return-current.

A suitable traveling contact device, as here shown, an upward pressure contact-arm F, is sustained upon the motor-car in any convenient manner or position, and carries at its outer free extremity a contact device. (Shown in Fig. 1 as a grooved wheel *f*, and in Fig. 2 as a triple contact-shoe engaging and making a continuous traveling contact with the said supply-conductor.)

G is a converter or motor-generator for converting the high-tension supply-current into a succession of currents which follow each other and are transmitted to the motor-circuits for operating the same to propel the motor car or cars.

H is an adjustable resistance in the main supply-circuit, and is connected to a circuit-changing switch I, leading to the converter G. By means of the adjustable resistance H the quantity of current flowing into the converter-circuit may be controlled, and the two-way switch I serves to reverse the action of the converter and motor by changing the direction of the flow of the main or primary current thereof in the motor-armature with relation to the field-magnets.

The converter G may be constructed in a variety of ways. As here shown, the converter consists of an annular exterior field-magnet G′, composed of a number of magnetizing-coils *g*, placed upon an iron core having north and south polar extensions *g′* and energized by the coils *g*, as indicated in diagram in Fig. 3. Within the annular field-magnet so formed are mounted upon a central shaft two armatures J K, both adapted to be rotated within said field-magnet, but both entirely distinct each from the other. The armature J may be of the well-known Gramme type, and is provided with a commutator *j*, provided with positive and negative commutator-brushes connected, respectively, to the conductors j j^2, extending to the switch I, which, as seen, is provided with three terminals j^3 j^4 j^5. If the terminals j^3 j^5 both represent the same polarity, as would be the case when they are joined by a spanning-conductor j^6, as shown, and if the middle terminal is connected to the negative commutator-brush by conductor j^2 by the negative polarity, a two-way switch, such as here shown, having levers i' i^2, will serve to change the direction of the flow of current in the armature J while leaving the field-magnet circuit undisturbed, and by so doing reverse the direction of rotation of the armature at will. One of the switch-levers, as i', is connected with the extreme end of the resistance or rheostat H by conductor *h*. A switch-lever H′ is pivotally mounted in operative relation to the rheostat H, and is connected to the conductor h', extending along the trolley-arm F to the contact device or trolley *f*.

The motor-generator G herein shown differs from the motor-generator shown, described, and claimed in my prior application, Serial No. 312,612, filed May 29, 1889, chiefly in the number and nature of the coils upon the generator-armature. The field-magnets of the motor-generator may be connected with the commutator-brushes in any desired relation. As here shown, they are connected in series with the armature. However the said circuits may be connected, a current regulating or controlling device must be provided for determining the speed of the motor-armature, and with it the output of the generating portion of the apparatus and the speed of the entire system of motors.

As shown, the circuits of the motor-generator are as follows: From resistance H, by conductor *h*, through switch-lever i', conductors j^6 j', positive commutator-brush into armature, out of armature by negative commutator-brush, thence by conductor j^2 to switch-lever i^2, thence by conductor h^2 to and into the field-magnet coils *g*, issuing from said field-magnet coils, by conductor h^3, which is connected to the return-circuit in any manner found most convenient. In the present instance the track-rails are employed as a return-circuit, and when this is the case the return-conductor h^3 is connected thereto through the wheels and axles of the car, or by means of a separate rubbing-block or metalic brush h^4, provided for the purpose. Where it is desired to employ a complete metallic circuit, whether suspended or underground—that is, a double-conductor system—the return-conductor h^3 is connected to the contact device engaging the return-conductor. The second armature K of the motor-generator, being rotated in the field of force by the motor-armature J, will generate and emit any desired species of currents according to the nature of its winding. In the present instance the said armature is arranged to feed into three different circuits in succession and a single return-conductor is provided and arranged to be common to all the circuits and to carry all the return-currents in succession.

In Fig. 3 I have shown diagrammatically the relative electrical construction of the generator-armature K, and of a form of motor which I find it convenient to employ in connection with the present system. The armature K is wound in three divisions comprising six coils 1 1^a 2 2^a 3 3^a, and the said six coils are connected by their outer terminals to three insulated annular contact surfaces or rings 1^b 2^b 3^b. All the inner terminals of said coils are connected to a central ring r, constituting the common return. Suitable contact-brushes being placed upon the contact-rings, three separate successive current impulses in one direction and three in the other will be collected at each complete revolution of the said armature.

Two slightly-different forms of motor, both suitable for use with my improved system, are also seen in Fig. 3, said motors comprising six-pole field-magnets and two-pole armatures. The six poles of the field-magnet are so connected with the three circuit-wires extending from the generator-armature that they will be energized oppositely in pairs, and in succession—that is to say, the motor will have three sets of poles on opposite sides of the armature which will be energized consecutively. This is effected by carrying the conductors 1^c 2^c 3^c, extending from the rings 1^b 2^b 3^b of the generator-armature and connecting the same by suitable branch conductors leading therefrom to opposite pairs of field-magnet coils, the inner ends of said branch conductors being all connected through brushes to collector-rings r' upon the armature-shafts of the motor D F. The rings r' thus constitute one side of the common return-circuit between the multiple circuits of the generator and the coils of the field-magnets of the motor which correspond thereto. The armatures L L' of the motors are provided with a continuous winding l, which is provided with connections at opposite equidistant points by conductors r^2 r^3. The conductor r^2 is connected to ring r' and the return-current from each pair of the field-magnet coils passes therethrough in succession. The currents entering the armatures L L' through conductors r^2 divide and flow through the armature-conductors 1 in multiple arc issuing by conductor r^3, and passing thence to ring r^4, and from there by branch r^5 into the main common return R', connected to the ring R, representing all the inner terminals of the generator-armature.

As seen in Fig. 3, the motor D is provided with six field-magnet cores sustained by an exterior magnetic shell or support M. The magnetic cores referred to project radially inward into operative relation to the periphery of the armature L, and the said cores are wound with suitable magnetizing-conductors connected in pairs with the several supply-conductors. Current flows from conductor 1^c through branch 1^d to magnet m, thence by conductor n to magnet m', thence by conductor n' to the common return r^2. The second pair of magnets receive their current from main conductor 2^c, through branch 2^d, to magnet m^2, flowing thence by conductor n^2 to magnet m^3, and thence by conductor n^3 to the common return r^2. The third pair of magnets is similarly energized by the currents flowing in the conductor 3^c, currents flowing thence by branch 3^d to magnet m^4, thence by conductor n^4 to magnet n^5, and thence by conductor n^5 to the common return r^2.

The motor F differs slightly from that just described in having an annular field-magnet divided into six sections instead of the six separate field-magnets connected in pairs, as shown in connection with motor D. The armature is also of a different type, being what is known as a "Siemens H." The connections, however, are to the same effect as in the motor D. The motor F is illustrated particulaly to show that the invention is not limited to a single form of motor; and it will be understood that any device capable of operation in connection with the system herein described may be used in connection therewith.

In the motor F the armature L' is provided with opposite polar extensions L^2 L^3, the intervening iron core being wound with suitable conductor L^4. Contact-rings r' r^4 are provided, as in the armature L, and the opposite ends of the coils L^4 are connected by suitable conductors, whereby the armature-coils form a single circuit producing poles of opposite name at the opposite extremities of said armature. The armature L' is rotatively mounted within an annular field-magnet comprising a core P, wound with magnetizing-conductor divided into six sections p p' q q' t t', said sections being energized by magnetizing-conductors wound thereon, said conductors being connected substantially as described with reference to the motor D, to wit: From main conductor 1^c, through branch 1^d, to section p, thence by conductor n, to section

p', thence by conductor n' to the return r^2. The second set being connected by conductor 2^d with the main conductor 2^c, said conductor 2^d extending to section q, thence by conductor n^2 to section q', thence by conductor n^3 to the return r^2. The third set of field-magnet coils is connected to the main supply-conductor 3^c by conductor 3^d, current passing from section t, by conductor n^4, to section t', thence by conductor n^5 to the return r^2. Thus it will be seen that the multiple currents flowing in the conductors 1^c 2^c 3^c energize the arms L L' with a polarity corresponding to that of their field-magnet poles, and that the field-magnet poles are successively energized to coact to establish and maintain continous rotary movement of the armature in a direction depending upon the direction of rotation of the generator-armature, and consequently the order in which the currents flow in the motor-circuits.

While I have described the motor-armature as of the drum type, it will be understood that any type of armature can be used with good results; and although in this case only a two-pole armature is shown it will be apparent that any number of poles may be provided, either in the armature or in the field-magnets, or in both, provided they are so disposed that their action will be successive and progressive.

As seen in Fig. 1, the return-conductors r^5, extending from the motors D E, are connected to the track through the wheels B B', as is also a return-conductor R', connected to the generating-armature. This, however, is merely for economy and is not essential, since the said conductors might be led in conjunction with two other conductors of the local circuit, forming a complete metallic circuit.

As seen in Fig. 1, the conductors 1^c 2^c 3^c are connected directly to circuit-conductors 1^e 2^e 3^e, which may be assembled together for convenience, and are carried throughout the train and suitably coupled between the cars, where more than one car is in use, said conductors forming a local train-circuit, which, being short, will be of small resistance, and into which the entire output of the generating-armature is delivered. Any desired number of motors up to the capacity of the tension-reducing devices can be employed upon a single train and receive current from the said local train-circuit, being connected thereto by branch conductors 1^d 2^d 3^d, and suitable return extending from each motor.

By the use of what I term "commutatorless motors" special attention to each motor is rendered unnecessary, and I find it possible to operate motors at a long distance from the operator and for considerable periods of time without any attention whatever. The delicate and sensitive parts comprised in the commutator and brushes of a continuous-current motor are, with the system herein set forth, entirely dispensed with. Furthermore, by arranging the current supply and transmission devices substantially as herein set forth, or in any equivalent manner, all the motors of a train, whatever their number, are all in the same circuit, either multiple arc or series, as desired, and are therefore readily and effectively controlled in their every movement from a single point—viz., from the circuit and current controlling devices in the circuit of the motor-armature.

The invention is not limited to the employment of a single overhead conductor with a line of rails for the return side of the circuit, since I may employ a complete double suspended conductor system—such, for example, as shown and described in my patent dated August 13, 1889, No. 409,156.

As seen in Figs. 1 and 4, and indicated in dotted lines in Fig. 2, the armatures of the motors may be mounted directly upon the axles of the wheels of the vehicles to be propelled and the field-magnets be sustained within exterior iron casings U, carried by sleeved extensions V, also mounted upon the said axles. The casings U should be rigidly connected to prevent their rotation, as by rods W. Doors v are also provided in the ends of the casings U to permit inspection of and attention to the current-distributing devices.

The means shown in Fig. 1 for preventing the rotation of the field-magnets of the motors show them as being held in absolutely stationary positions. It may under some circumstances, however, be found desirable to permit some rotary movement of the casings containing the said field-magnets. This object may be attained in many way. For example, as seen in Fig. 4, longitudinal beams or bars W' are connected to the axles and extend longitudinally between them. To the longitudinal frames W W' transverse frames or supports W^2 W^2 are secured, and the motor-casings U are each provided with an extension or nose Y, connected by suitable buffer-springs W^4 with the transverse frames W^2. With this construction the exterior casing of the motors is supported concentrically upon the axles to be driven, and is permitted to have some rotary motion both in stopping and starting, according to the strength of the buffer-springs between the noses Y and the transverse supports.

In Fig. 1^a another form of spring attachment is seen. As here shown, the motor-casings U are provided with noses Y' Y^2 on opposite sides. A strong longitudinal bar W^5 is placed across the tops of both motor-casings, and the noses are connected to said longitudinal beam by a strong spiral or other spring Z. Being therefore, so far as their rotary movement is concerned, entirely spring-suspended, it will be obvious that the rotative effect of the casings will act to compress one spring and extend the other, and vice versa, thus cushioning the strain from that cause.

In Fig. 5 I have shown a train-circuit including six motors connected in series. a' a^2

a^3 and a^4 a^5 a^6 represent the opposite pairs of field-magnets, substantially as hereinbefore described, and all six sets of said field-magnets are connected in series with the train-circuit conductors 1^e 2^e 3^e. The armatures of these motors are indicated at L. The three conductors of the train-circuit 1^e 2^e 3^e are united at the rear end of the train and all connected by suitable contact-brush with one terminal of the first armature L, issuing thence from the other terminal of said armature and being connected by conductor r^6 with the next armature, and so on throughout the entire series, issuing from the rear terminal of the last armature, where the circuit is connected to the conductor R′, which represents the return-circuit of the generator. It will be understood, however, that I do not limit myself to any particular method of connecting the motors of the train-circuit, and have shown those hereinbefore referred to by way of illustration only.

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

1. An electric-railway system comprising a source of current of relatively high potential and supply-conductors carrying said current and extending along the line of way, a moving vehicle provided with a motor-generator, means for connecting the continuous-current-supply circuit and the motor-generator, a multiplex local circuit moving with the vehicle and successively receiving currents of reduced tension, and one or more motors for propelling the motor and supplied with current from the said local circuits.

2. An electric-railway system comprising a source of relatively high-potential current extending along the line of way, a moving vehicle provided with current-collecting devices, and a motor-generator, a divided local circuit moving with the vehicle and supplied with currents of reduced tension, and one or more motors propelling said vehicle and supplied with current from said local circuit.

3. An electric-railway system comprising an exposed supply-circuit extending along the line of way, a moving vehicle provided with current-dividing devices, means for establishing connection between the supply-circuit and the current-dividing devices, a local circuit comprising a plurality of conductors moving with the vehicle and each separately supplied with current, and one or more multiple current-motors connected with the supply-circuit and arranged and connected to propel the vehicle.

4. An electric-railway system comprising a suitable source of continuous current, supply-conductors extending along the line of travel, a motor car or cars provided with contact devices for establishing connection with the supply-conductors, a converter upon the motor-car and circuits, moving with the converter and supplied therefrom, and connections extending from the said converter-circuits to the motor or motors for supplying motive current thereto.

5. An electric-railway system comprising an exposed supply-circuit extending along the line of way, a moving vehicle provided with tension-reducing and current-dividing devices, and means for establishing connection between the supply-circuit and the current and the circuits of the said moving vehicle, a local circuit comprising a plurality of conductors moving with the vehicle and each supplied separately with current from the said current-dividing devices, and one or more multiple current-motors connected with the supply-circuit and arranged and connected to propel the vehicle.

6. An electric-railway system comprising a continuous-current supply along the line of way, a motor-generator energized thereby and carried by the train, said motor-generator producing a number of independent consecutive currents and suitable circuit-conductors for conveying the consecutive currents to the motors on the train, and means for reversing the order of the said successive currents, and thereby reversing the direction of rotation of the motors.

7. An electric-railway-train system comprising a continuous-current supply along the line of way, a motor-generator energized thereby and carried by one of the cars of the train, said motor-generator producing a number of independent successive current impulses, multiple current-motors and independent conductors supplying currents to the several circuits thereof, and means for regulating the speed of the motor-generator.

8. In an electric-railway motor, the combination, with axles to be driven, of armatures mounted thereon and adapted to rotate the same, an annular field-magnet system exterior thereto, an exterior metallic casing for each motor sustaining the field-magnet system and sleeved upon the axle, a rigid frame extending between the motors, and yielding connections between the exterior casings of the motors and the said frame, whereby a limited rotary movement of the casings is permitted.

In testimony whereof I hereto affix my signature in presence of two witnesses.

CHARLES J. VAN DEPOELE.

Witnesses:

JOHN W. GIBBONEY,

CHARLES L. OECHSNER.