(No Model.) 3 Sheets—Sheet 1.

C. J. VAN DEPOELE.

ELECTRIC RAILWAY.

No. 403,801. Patented May 21 1889.

Fig. 2.

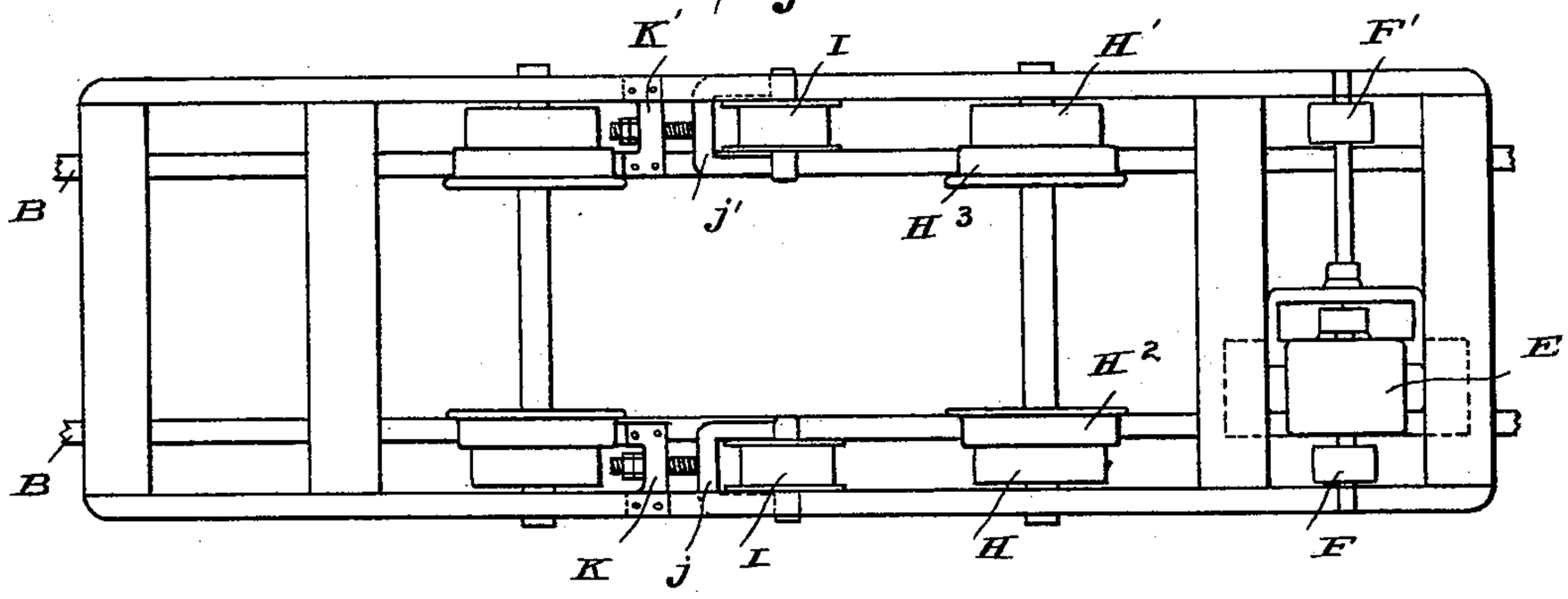
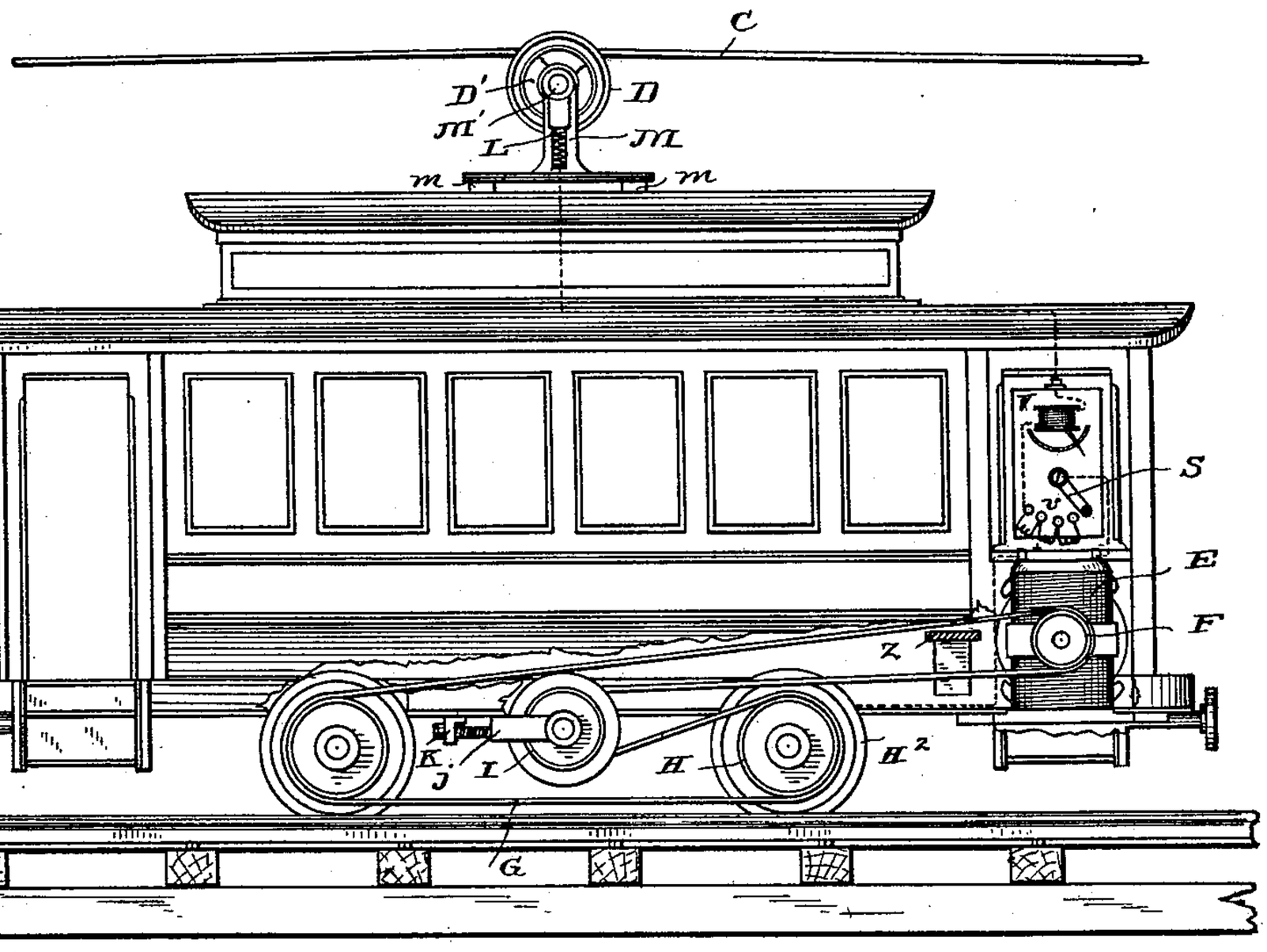


Fig. 1.



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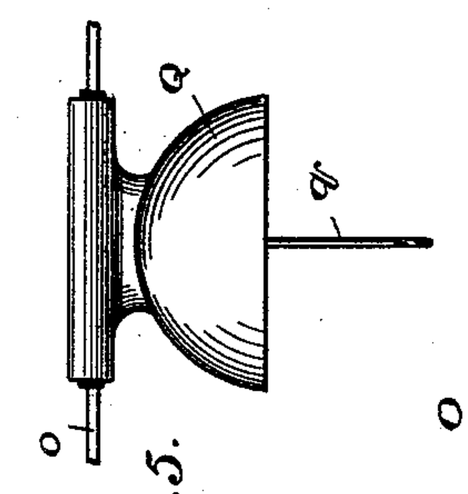

Fig. 5.

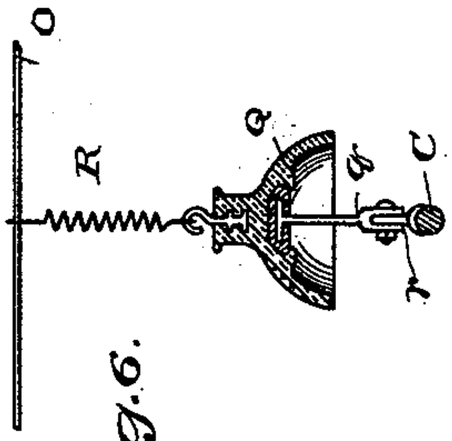

Fig. 6.

Fig. 4.

Fig. 3.

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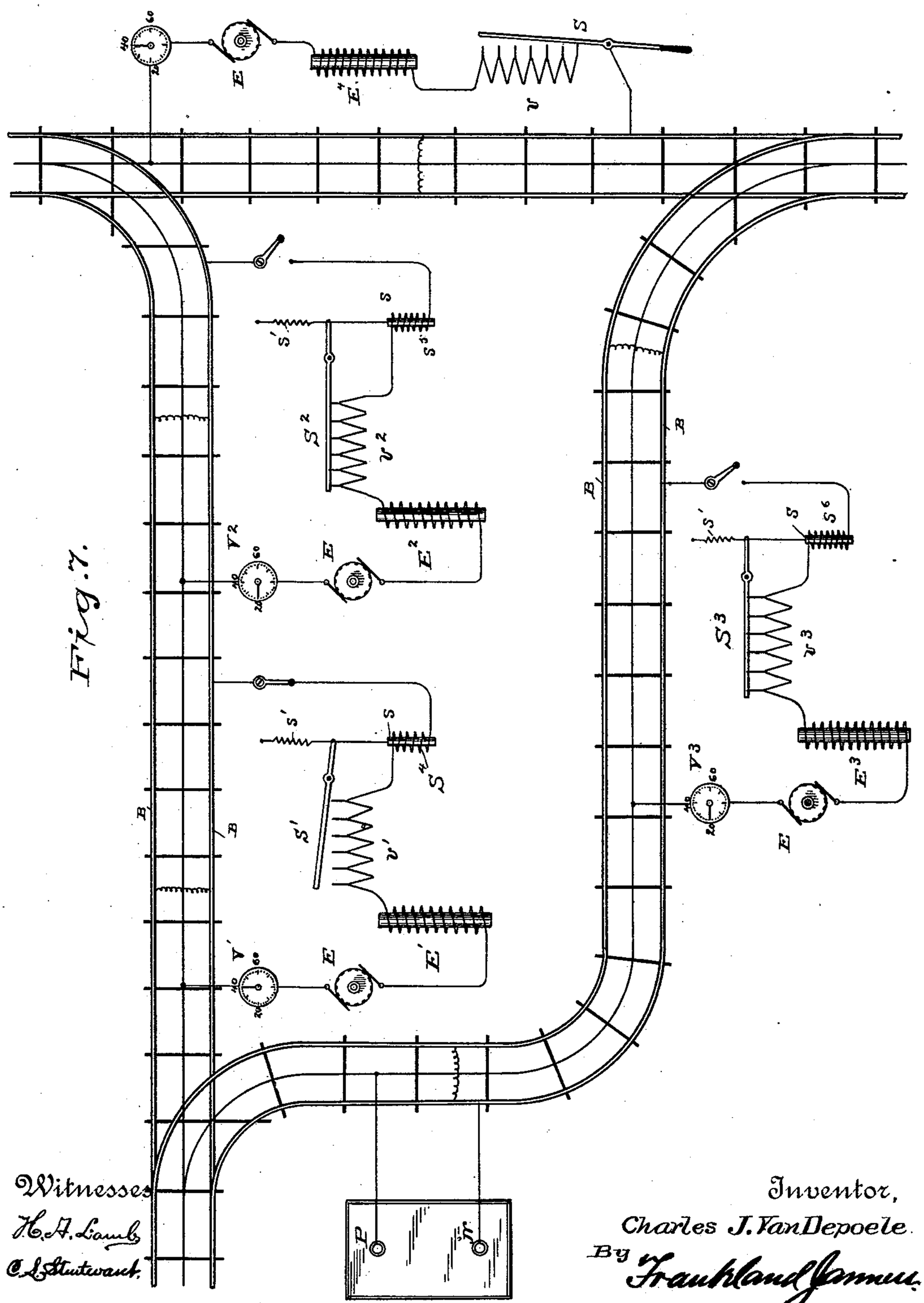

Fig. 7.

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UNITED STATES PATENT OFFICE.

CHARLES J. VAN DEPOELE, OF LYNN, MASSACHUSETTS.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 403,801, dated May 21, 1889.

Original application filed June 22, 1885, Serial No. 169,410. Divided and this application filed February 15, 1889. Serial No. 300,049. (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 Railways, of which the following is a description, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon.

This application is a division of an application filed by me June 22, 1885, Serial No. 169,410.

My invention relates to new and improved means for constructing and operating electric railways; and it consists in the mode of applying the power of the electric motor to the driving-wheels of the cars, as also the mode of conveying the electric current from the generator to the motor.

The following is a description of the system, reference being had to the annexed drawings, forming part of this specification.

Figure 1 is a side view of an ordinary tram-car arranged to be propelled by electricity, showing the mode of applying the power from motor to driving-wheels and the means of taking the current from the suspended conductor, and also the current indicator and regulator. Fig. 2 is a plan view of the car, showing the disposition of the motor, the driving and driven pulleys, and means for tightening the driving-belts. Fig. 3 is an end view of a portion of an electric railway arranged according to my invention, the end of one of the cars being partly broken away, showing the motor and the driver's seat. Fig. 4 is a detail view, partly in cross-section, showing the conductor-suspending insulator. Fig. 5 is a side view of the conductor suspending and insulating device. Fig. 6 is a side view showing a different arrangement of the conductor-suspending devices. Fig. 7 is a diagrammatic view showing part of a railway, together with a number of motors and their current dividing and regulating devices.

As indicated in the drawings, A represents an ordinary tram-car.

B B are the rails, and are used as one of the electric conductors, both being connected, say, to the negative pole of the generator.

C is the suspended electric conductor, preferably of hard drawn copper and connected to the positive pole of the generator.

D is a grooved contact-wheel carrying the suspended conductor C.

D′ is a disk or web of soft rubber interposed between the hub and tire of the wheel D to give lateral flexibility to the grooved metallic periphery thereof. The tire and hub are, however, electrically connected by means of a proper flexible conductor.

E is an electric motor by which the car A is propelled.

F and F′ are driving-pulleys upon the armature-shaft of the motor.

G and G′ are endless belts for transmitting power from the driving-pulleys F F′ to driven pulleys H H′, secured upon the axles of the carrying-wheels H^2 H^3 of the car.

I and I′ are tightening-pulleys for the belts G and G′.

J and J′ are forks in which the pulleys I and I′ are hung.

K K′ are supports or brackets attached to the car, through which the shanks *k k′* of the forks J J′ pass. The shanks *k k′* are screw-threaded and provided with adjusting-nuts at their outer extremities, and are free to be moved longitudinally through their supports by the said adjusting-nuts. The tension of the belts G G′ is regulated as desired by setting the adjusting-nuts upon the shanks of the belt-tighteners.

M is a frame within which is mounted the contact-wheel D.

M′ is a hanger or cross-head supporting the wheel D and moving in vertical ways in the frame M, and sustained by a spring, L.

N N are posts planted at suitable intervals along each side of the line of railway, and between the upper ends of opposite posts are stretched cross-wires O, for supporting the main supply conductor or conductors.

Q Q are insulators for connecting the conductor with the cross-wire and at the same time effectually insulating it therefrom.

The insulators Q are desirably constructed of porcelain, glass, or other hard insulating material. The insulator is in the form of an inverted cup, to the under side of which is suitably attached a metallic hook, *q*. The

hook *q* is desirably formed with a head which may be T-shaped, and said head is adapted to be inserted within a cavity in the under side of the insulator, where it is firmly secured by filling the cavity with melted sulphur or other similar material. A tubular extension is formed upon the upper part of the insulator for attaching the same to the cross-wire, and in order to prevent breakage when the insulator is of frangible material I provide a lining of elastic substance—such as rubber—which not only increases the insulating properties of the device, but serves as a cushion between the cross-wire and the insulator, which will absorb most of the vibrations and prevent breakage of the insulator. To the hook *q* is attached a spiral spring, R, or other flexible or elastic connection, which is then secured to a belt, *r*, which is brazed or soldered to the conductor for sustaining the same. The flexible connection or spring R may, however, be attached directly to the cross-wire and to the upper portion of the insulator, and the hook *q* be attached directly to the conductor-sustaining belt *r*, instead of as just described. (This arrangement is seen in Fig. 6.) With either arrangement the conductor will be flexibly supported and conform readily to the movements of the contact-wheel due to oscillation of the vehicle. It will also readily accommodate itself to slight variations in the height or diameter of the contact-wheel.

W indicates the driver's seat, and Z the operating-lever of a rotatable commutator-brush carrier, which is located in convenient proximity to the seat W.

The rails of the track are electrically connected by suitable conductors at intervals and constitute one side of the main circuit, the other being the suspended conductor, the conductors arranged to be engaged by the traveling contact-wheel carried by the vehicle. The circuit of the motor is from the suspended conductor through the contact-wheel and a suitable conductor extending therefrom to the motor, thence from the motor by a suitable conductor to the supporting-wheels in constant metallic contact with the track, which represents the other side of the circuit. The motor-cars are therefore connected in multiple arc with the supply-circuit regardless of their number or relative positions upon the line of railway. It will be evident, therefore, that the motors upon the cars will consume current in proportion to their respective resistances.

Where, as in the present instance, a number of cars are to be operated in multiple arc some provision must be made to practically utilize their consumption of current, so that they may be operated or started and stopped without interference each with the other, assuming that the intensity of the current in the supply-conductors is adequate to the normal demands of all the motors in operation at the same time. An electro-dynamic motor running at normal speed will develop a certain counter electro-motive force which acts as a resistance to prevent the flow of current through the armature of the machine, and therefore may be depended upon as a means of self-regulation after the motor has attained a certain speed. So long as all the cars are running at the same speed, the counter electro-motive force in each motor will be about equal. Consequently their resistance will be the same, and the current will divide itself evenly through the different motors. When a motor is to be stopped, the current is gradually cut off by the introduction of resistance into the motor-circuit. Therefore, when it is desired to start a car an artificial resistance must be added to the resistance of the motor-circuit in order to prevent an abnormal rush of current therethrough, which might result in destructive heating.

Let us now suppose that we have to start a car. The armature will be standing still, and consequently no counter electro-motive force will be present to prevent more current passing through the machine than is required when the motor is running, thus temporarily diverting the necessary current from the motors already run. Therefore, whenever a motor is started a resistance about equal to the counter electro-motive force developed in the armature when the motor is running should be placed in circuit thereof, which resistance is to be gradually withdrawn as the counter electro-motive force rises with the speed of the motor. The resistance may be introduced and withdrawn as called for, either by manual or by automatic means.

As indicated in Fig. 1 and also in Fig. 7, V is a current-indicator in circuit with the artificial resistance *v*, both being in series with the motor E. S represents a manually-movable contact-lever, also in the motor-circuit, and arranged to connect more or fewer of the coils of the resistance *v* in the motor-circuit, as desired. My invention is not, however, confined to the use of a manually-operated adjustable resistance in circuit with a motor in multiple between supply-conductors, since the automatic means referred to in the application of which this is a division may be substituted therefor. As there pointed out, a simple solenoid may draw in its core when the current is too powerful and introduce the resistance in circuit, and on the weakening of the current by increase of speed in the armature of the motor the said core will gradually be retracted from the solenoid and operate the resistance-contacts, so as to gradually cut the same out of circuit. The moment the motor is running at normal speed no resistance whatsoever is needed, since by displacing the commutator-brushes of the motor more or less counter electro-motive force can be produced by each motor independently, which will be sufficient to regulate the speed and power of the motor.

In Fig. 7, E′ E^2 E^3 indicate motors provided with the automatic adjustable resistances

just referred to. V′ V² V³ represent current-indicators. *v′ v² v³* are adjustable resistances; S′ S² S³, movable contact devices adapted to engage more or fewer of the contacts of the resistances *v′ v² v³*. S⁴ S⁵ S⁶ are solenoids connected in series with the resistances and provided with iron plungers *s*, connected to the resistance-switches S′ S² S³ for raising the same in accordance with the flow of current therethrough. Adjustable tension-springs *s′* are also connected to the resistance-switches for lowering the same when released by the weakening of the current in the regulating-solenoid. The motor E′ is assumed to have just been started, and therefore in the absence of any counter electromotive force to afford a passage for the maximum current, the indicator V′ showing the flow of a current of, say, forty ampères. The armature resistance being low, a comparatively large amount of current will flow through the resistance-coils *v′*, thereby energizing the solenoid S⁴ to a comparatively high degree, causing it to draw in the plunger *s* and raise the resistance-switch S′, which, by separating the terminals of the resistance, will compel the current to flow through the separate coils or divisions of the resistance *v′* in series, and so oppose such an obstacle to the flow of current as to diminish the volume thereof to the desired point. The motors E² E³ are assumed to have reached their normal speed when the counter-electromotive force in the armature has risen to a point that prevents the passage of more than a normal amount of current, which may be assumed to be one-half that would pass through the armature if stationary and unobstructed by artificial resistance.

The circuits of the system are as follows: From any suitable source of electricity the current is led by a proper conductor to both rails of the track, the rails being properly connected at their junctions, so as to have electrical continuity throughout their whole length. From the track the current passes by means of the car wheels and axles, and by a suitable conductor to one of the terminals of the motor and through the coils thereof, thence by the second terminal of the motor to switch-lever S′ of current-regulator, from switch S′ through any desired portion of the resistance and through the current-indicator, and thence by suitable conductor to the contact-wheel and suspended conductor, or vice versa. To operate the car, the driver assumes a position where he can handle the brush-shifter Z, and also the switch-lever of the current-regulator. As above stated, the motor transmits the power to the drive wheels or pulleys by means of two belts. In practice I find that good belts are perfectly satisfactory, being noiseless, and will have very little wearing effect upon the different transmitting parts, besides giving a flexible connection between the motor and the driving-wheels. The belts are made endless and are tightened by means of the arrangement shown in J and K. Further, in order to protect the belts from wet or snow they may be incased by a suitable cover.

In order to minimize the wear and strain upon the conductors, and also as to always insure good contact, the contact-wheel D, instead of being mounted rigidly upon its frame, is suspended therein and held up by means of a suitable spring. The upward pressure of the spring is so regulated as to insure a good contact in the highest plane of the conductor, and likewise to be pressed down when the conductor hangs low. This will prevent the conductor being bent under the passage of the wheel, thereby avoiding as much as possible the crystallization of the copper by bending.

In order to prevent further vibration of the conductor, the wheel, as stated, is provided with a flexible web holding the rim and the hub together. To further deaden the noise of the contact D, running upon the conductor C, the frame M is mounted upon rubber supports *m m*, &c. It will thus be seen that the connections between the car and the upper conductor are rendered as perfect as possible, and that all the different movable parts are flexibly mounted, insuring the practicability of the system and a long life to the different parts. Even the insulating-cups are flexibly mounted, all tending to avoid vibration of conductor.

To insure a good electrical contact between the track and the wheels of the car, all the axles are electrically connected together, and in case of a train of cars all are so connected between their axles and the coupling-pins that by simply coupling the cars they are all in electrical contact with one pole of the electric motor on the motor-car.

It often happens that in streets the tracks are covered with mud or other substances which, when dry, interfere with the passage of the current. By connecting all the wheels and axles together I give more opportunities for the current to pass, in one place if not in the other.

Various modifications in the structure and arrangement of the parts and apparatus hereinbefore referred to may be made by one skilled in the art to which my invention refers without departing from the nature or scope thereof.

The matters herein shown and described but not claimed are included in the application filed June 22, 1885, Serial No. 169,410.

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

1. In a system of electric railways, means for dividing the supply-current at starting between a plurality of motors connected in multiple arc between the main conductors, comprising an additional resistance in circuit with each motor and means for gradually withdrawing the resistance as the speed of

the motor increases, substantially as described.

2. In a system of electric railways, a plurality of motors in multiple arc between the supply-conductors, a resistance in circuit with each motor acting to prevent a sudden fall of potential in the supply-circuit at starting, and means for gradually withdrawing the resistance as the counter electro-motive force rises in the motors being operated, substantially as described.

3. In a system of electric railways, a plurality of motors in multiple arc between the supply-conductors, a resistance substantially equal to the counter electro-motive force of the motor-armature at normal speed in circuit with each motor at starting, and means for gradually withdrawing the resistance as the counter electro-motive force rises, and vice versa, substantially as described.

4. In electric railways, the combination, with the supply-circuit, of a multiple-arc branch including a current-indicator, an automatic adjustable resistance, and an electro-dynamic motor, all arranged in series, substantially as described.

5. In electric railways, the combination, with parallel supply-conductors, of a plurality of motors in multiple arc between said conductors, each motor-circuit comprising a current-indicator, an adjustable resistance about equal to the counter electro-motive force of the armature of the motor at full speed, and means for automatically introducing and withdrawing the resistance in proportion to the rise and fall of counter electro-motive force in the motor, substantially as described.

6. In a system of electric railroading where a large number of vehicles are electrically propelled at one time and from the same source, a means for regulating the current by an additional resistance in circuit with each motor at the time of starting, preventing the short-circuiting of the current by placing such resistance in each motor-circuit independent of the other and corresponding to the electro-motive force of the current employed, and means for gradually withdrawing said resistance as the motor attains a certain speed, substantially as described.

7. In an electric-railway system, the combination of poles or supports placed on each side of the line of way, supporting-wires extending across the line of way and secured to opposite pairs of poles or supports, a main supply conductor or conductors suspended from the cross-wire, so as to have its under side free, and a grooved upward-pressing contact device engaging the free side of the conductor, substantially as described.

8. In an electric-railway system, the combination of poles or supports placed on each side of the line of way, supporting-wires extending across the line of way and secured to opposite pairs of poles or supports, a main supply conductor or conductors, insulating devices connected to the conductor and to the cross-wire for suspending said conductor, and a grooved upward-pressing contact device engaging the under side of the suspended conductor, substantially as described.

9. In an electric-railway system, the combination of poles or supports placed on each side of the line of way, supporting-wires extending across the line of way and secured to opposite pairs of poles or supports, a conductor or conductors arranged below the cross-wires and above the line of way, ears or bails permanently secured to the upper side of the conductor or conductors, and insulating devices connected with the ears or bails, and the cross-wires for sustaining the conductor or conductors, and an upward-pressing contact-wheel engaging the under side of the conductor, substantially as described.

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

CHARLES J. VAN DEPOELE.

Witnesses:
FRANKLAND JANNUS,
JOHN W. SIMS.