(No Model.) 2 Sheets—Sheet 1.

R. M. HUNTER.

ELECTRIC RAILWAY.

No. 452,920. Patented May 26, 1891.

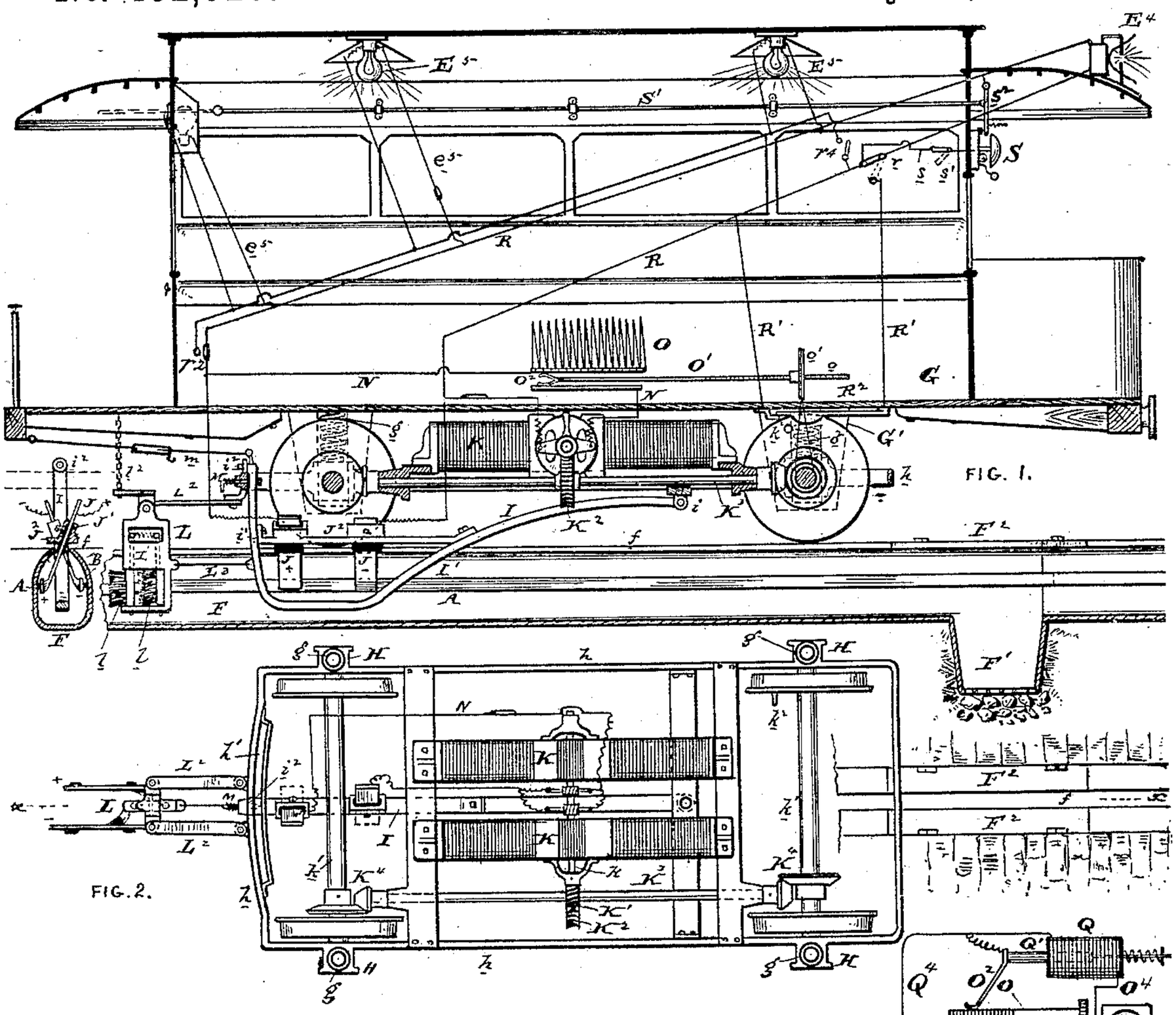

FIG. 1.

FIG. 2.

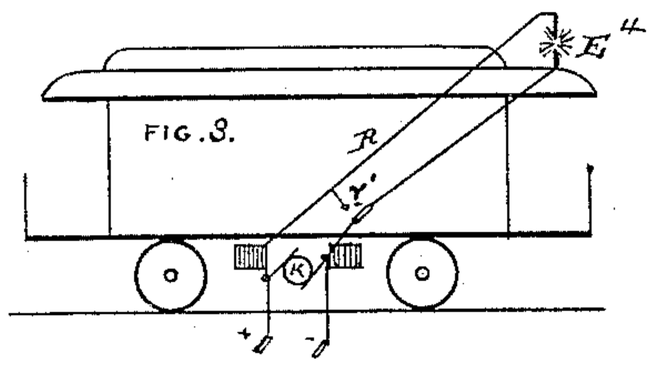

FIG. 3.

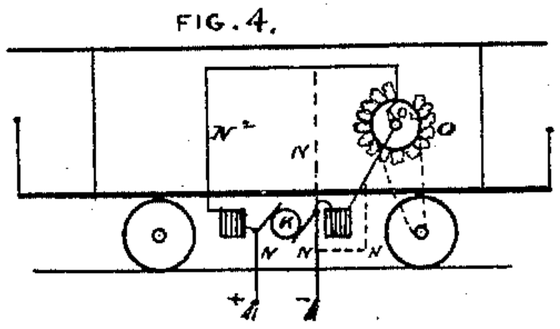

FIG. 4.

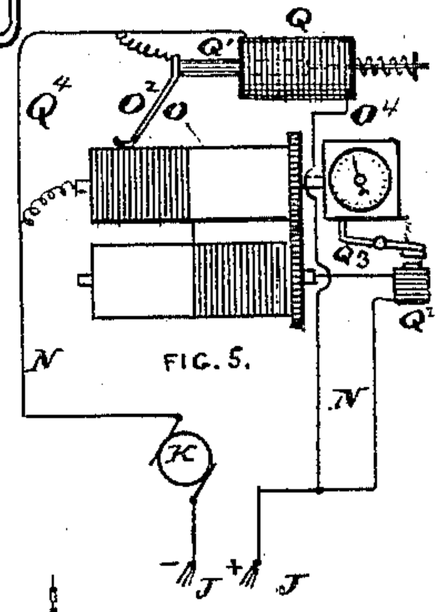

FIG. 5.

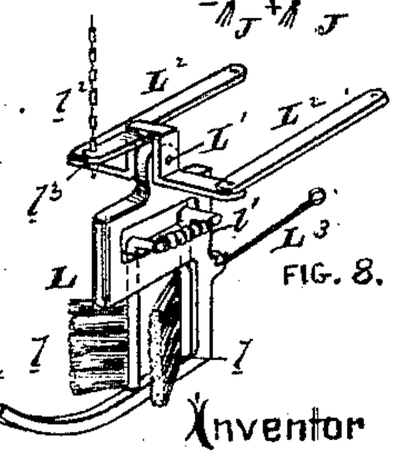

FIG. 8.

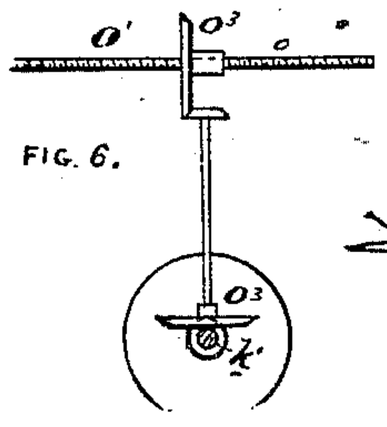

FIG. 6.

Attest
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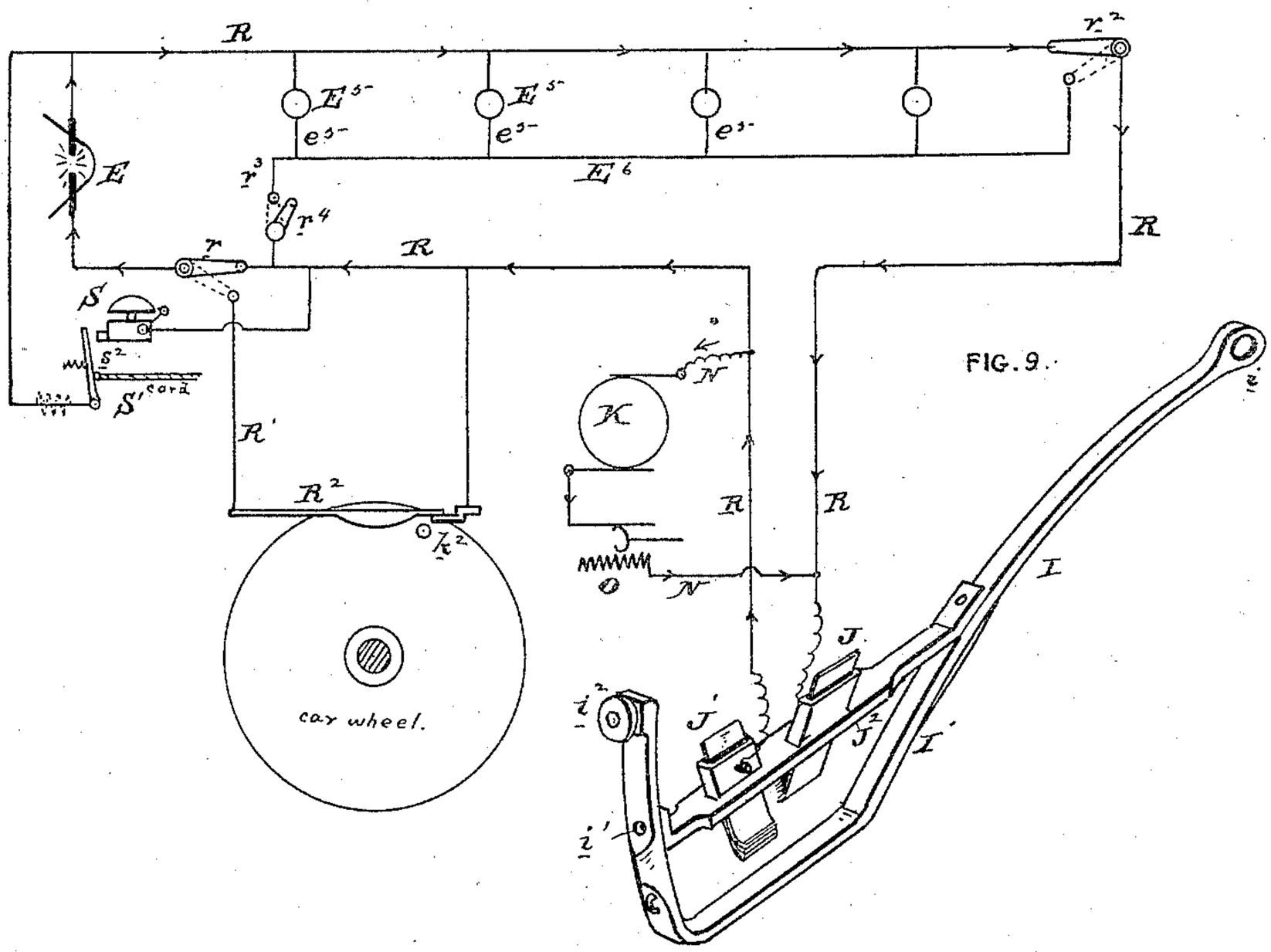
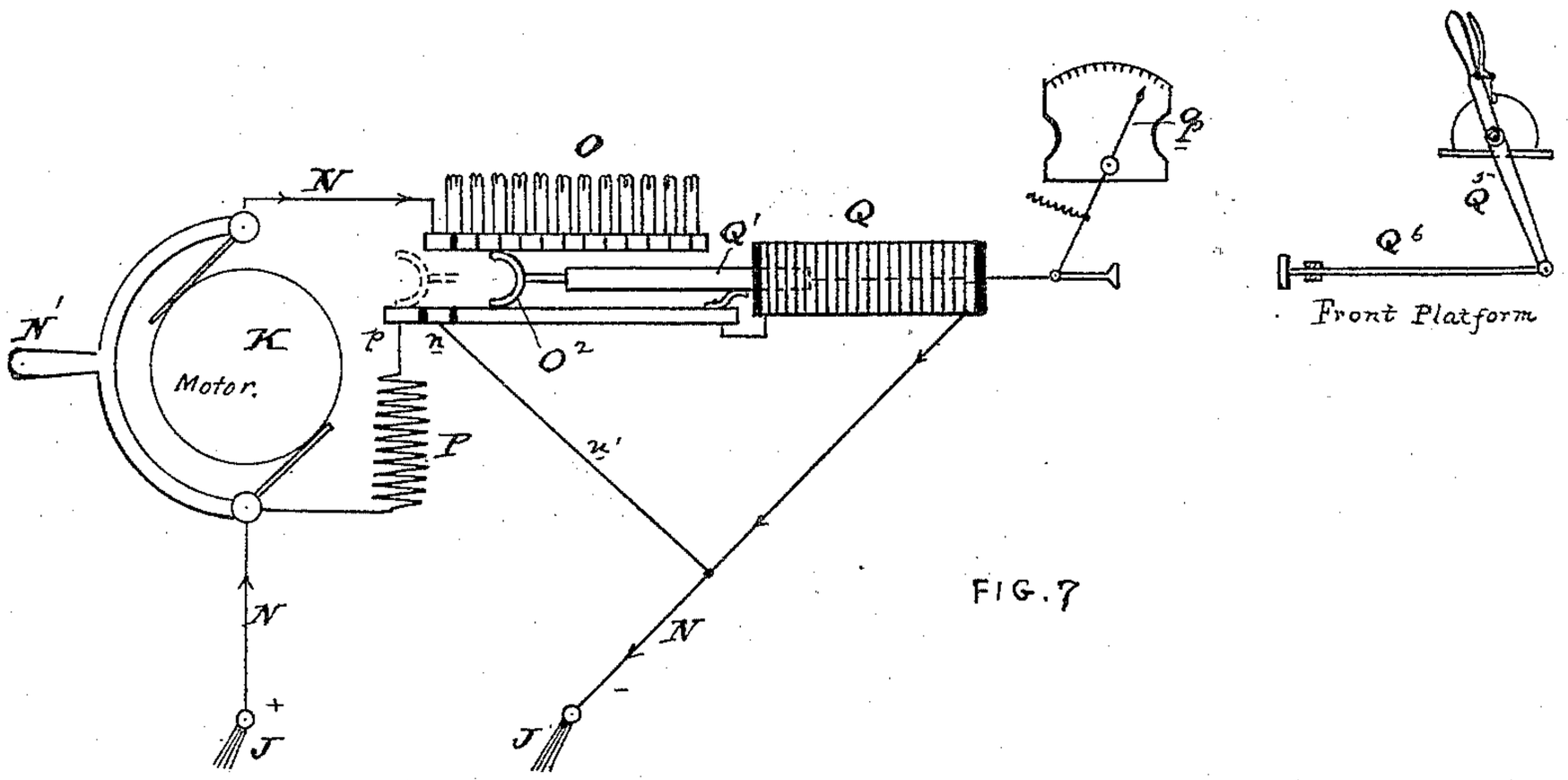
(No Model.) 2 Sheets—Sheet 2.

R. M. HUNTER.

ELECTRIC RAILWAY.

No. 452,920. Patented May 26, 1891.





Attest
E. McDermott.
C. M. Breckinreed.

Inventor
Rudolph M. Hunter.

UNITED STATES PATENT OFFICE.

RUDOLPH M. HUNTER, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO THE ELECTRIC CAR COMPANY OF AMERICA, OF SAME PLACE.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 452,920, dated May 26, 1891.

Application filed April 28, 1886. Serial No. 200,400. (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, all of which are fully set forth in the following specification and shown in the accompanying drawings, which form part thereof.

In carrying out my invention I have had the following objects in view, viz:

First, to provide a car with a frame secured to the axle-boxes and independent of the car-body, which is supported upon springs, and to which frame the brushes or collectors are suspended, whereby the car-body may move vertically upon an elastic support; but the collectors shall remain on the same level with the working-conductors.

Second, providing an electric motor or car with electric lights, arc or incandescent, arranged in multiple arc or series and receiving their current from fixed working-conductors. In the case of incandescent lights they would be arranged in a shunt around the motor. In the case of arc lights they may be arranged either in series with the motor or in multiple arc therewith.

Third, providing the motor or car with an electric bell or gong receiving current from the motor-circuit and preferably arranged in a shunt around the motor and combined with a circuit-closer and signal cord, wire, or bar passing through the car, whereby a passenger may signal the driver to stop the car.

Fourth, providing an electric motor or car with a resistance changer or controller to govern the resistance of the motor-circuit. This resistance-changer may be operated by hand or automatically either by the travel of the car or by the variation in the strength of the current in the motor-circuit. The object is to prevent too strong a current traversing the motor, to prevent injury to its winding, and insure a practically-uniform speed normally, and by increasing the resistance the motor may be slowed down. This automatic device is very useful when a series of motors is arranged in multiple arc on an electric railway, for if one motor be running at a much higher velocity than another on the line the counter electro-motive force in the two motors will be different and relatively proportionate to their velocities, and this causes a variation in the resistance, so that the slower-running motor will receive an excess of current if the automatic resistance-changer does not respond and automatically increase the resistance to prevent this evil and accompanying danger to the motor. While acting to control the speed of the motor from variations in the counter electro-motive force, the regulator also automatically varies the resistance to suit the position of the motor upon the line-circuit, increasing the resistance of the motor-circuit for variations in the resistance offered by working-conductors. By this means the speed of the motor is absolutely and automatically controlled. In conjunction with this I provide a short-circuiting devices whereby the motor may be cut out of circuit and an equivalent resistance simultaneously inserted into the motor-circuit; also, I provide means under the control of the operator to cut out the resistances and also the resistance of the regulator-magnet, putting it preferably in shunt-circuit, whereby a strong impulse of current unretarded by useless resistance may be sent through the motor at starting to give the first impetus to the armature. This regulator is furnished with a dial and pointer or indicator to show at a glance the position of the resistance-changer and the amount of resistance in circuit.

Fifth, providing the motor with a brush-holding frame pivoted at one end to the car or a frame supported by the axles or boxes thereof and free to swing laterally at the other end, said frame projecting down through the slot in conduit and supporting and guiding the brushes or collectors. This pivoted frame is also adapted to rise up out of the slot in case it should be necessary to lift out the collectors for shifting the car in case of obstruction of the streets by fire. When raised, the frame is locked clear of the roadway, and the car may be pulled by horses around the obstruction beyond and once more adjusted to working position on the line. This feature of

hinging the collectors is also useful in case an obstruction should accidentally get into the slot, in which case the collectors would be automatically thrown out of the conduit.

Sixth, providing an electric car or motor with collecting brushes or devices which depend from suitable supports on the car and project obliquely from said support through the slot and press upon the respective working-conductors contained therein. These collectors are made of spring-metal and are made vertically adjustable upon said holder or support and insulated from the support and the conduit.

Seventh, providing an electric motor or car with a cleaning device adapted to sweep the walls of the conduit, and thereby keep the working-conductors clean and free from all dirt and accumulations which might short-circuit the current. This cleaning device is preferably formed of two brushes insulated from each other and hinged to a flat shank or frame depending through the slot and suspended to the motor or car by a universal joint, whereby it follows the variations in the slot. The brushes are pressed against the side walls by the springs and are capable of closing up when it is desired or necessary to draw it from the conduit. The raising of the collector-frame also lifts the brush-shank. The brush is pivoted to a plate by a transverse axis, and the plate is connected to the car by a parallel link connection. The brush-shank is also supported from the car or the motor-frame by a chain to limit the depth of the brushes, and the slight vertical movement, with the continuous longitudinal movement, will insure a perfect cleansing of the conduit-walls and conductors. If the brush should not be sufficiently raised by the rising collector-frame, the obstruction would strike the curved shoe on the brush and eject it from the slot, as desired.

The foregoing is a brief enumeration of the essential points involved in this application, and I will now describe the accompanying drawings, in which—

Figure 1 is a sectional elevation through a car and conduit on line *x x* embodying my invention. Fig. 2 is a plan view of same with the car-body removed. Fig. 3 is a side elevation showing the connection of the headlight when arranged in series with the motor field-magnets. Fig. 4 is a similar view showing one arrangement of variable resistance carried by the car and arranged either in multiple-arc or series connection with the motor. Fig. 5 shows the arrangement of the resistance-changer when made like a rheostat and operated by clock-work or other motive power and controlled by an electro-magnet affected by the motor-circuit. Fig. 6 illustrates a modified way of operating the resistance-changer from the axle of the car to be used in place of the belt shown in Fig. 1. Fig. 7 is an elevation showing one desirable arrangement of automatic resistance-changer. Fig. 8 is a perspective view of the cleaning-brush removed from the motor and slot; and Fig. 9 is a diagram showing the arrangement of the electric circuits on the car or vehicle both for lighting, signaling, and propelling.

We now come to the motor and car as shown on Sheet 1.

G is the car-body and is supported upon springs *g*, which rest upon the axle-boxes H or frame *h* secured to said axle-boxes. The collecting devices and motor are carried upon this frame *h* and have a fixed distance with the conduit and conductors therein, while the car-body is free to vertical movement.

K K are two motors connected by the same armature-shaft and are carried by frame *h*. The armature-shaft is provided with a worm K′, which gears into a worm-wheel K^2, secured upon the shaft K^3, also carried by the frame *h*, and therefore by the axles *k′*, and is geared to said axles by bevel-gears K^4.

Pivoted at *i* to the forward part of frame *h* by a universal joint is the collector-frame I, which is made of bent wrought-iron and has a supporting-bridge J^2 for the collectors. The rear end of the frame I is made curved from *i* as a center and is supported by the rear end of the frame *h*, which is also curved from *i* as a center, which two curvatures admit of a vertical and lateral movement to the collector-frame and its collectors J. A small anti-friction wheel i^2 reduces the friction of movement of the frame I on the curved part *h′* of the frame *h*. The forward part I′ of the frame I is made curved, so that if it strikes an obstruction the frame will be raised out of the conduit, riding over the obstruction.

M is a spring-catch carried by the frame *h* and adapted to catch into hole *i′* in the rear part of frame I to hold it in a raised position if thrown fully up, in which position it is clear of the conduit, and the car might be run from one track to another or drawn by horses around an obstructed street, as in case of fires, and when once more over the slot the collector-frame and collector-brushes may be once more lowered into the slot, preferably through one of the doors F^2 in the conduit, it being more easy to withdraw the collectors than to reset them. The upper and rear end of the frame I may be connected to the car-body from a drag-bar *m*.

J J are the two collectors or brushes which project through the slot *f* of the conduit F and take the current from the bared working-conductors A B. These brushes project into the conduit obliquely and in opposite directions, as shown at the left of Fig. 1, and are insulated from their supports J^2 by insulating material J′, which projects down into the slot and is protected by the frame I from undue wear against the sides of the slot. These brushes or collectors are preferably arranged upon each side of the axle *k′*, so that as the frame I rises they shall clear the axle.

N is the motor-circuit connecting the col-

lectors J with the motors, and when two or more motors are coupled together or operating upon the same drive-shaft or to propel the same car I prefer to divide the current by coupling up the motors in multiple-arc circuit, reducing the resistance, and this connection in practice increases the efficiency.

O is a variable resistance, which may be located in the motor-circuit and controlled either by hand or automatically by the current passing through the motor. As shown in Fig. 1, this resistance is gradually increased or decreased by a traveling contact O^2, moved by a rod O′, screw-threaded at *o* and moved by a revolving nut *o′*, driven from an axle of the car by bands o^2 or gearing O^3, the latter being shown at Fig. 6, which figure shows the mechanical connection between the axle *k′* of the car and resistance-changing shaft O′, in order that the resistance may increase as the train approaches the generating-station. In Fig. 4 this variable-resistance changer is shown in the form of a circle with a revolving contact o^2, which may be driven by the same means—that is to say, by a band from the axle of the car or other revolving part or by the gearing, as shown in Fig. 14, the dotted lines in Fig. 11, connecting with the axle, indicating a band for revolving the contact-arm o^2.

In Fig. 4 the resistance-changer lever O^2 makes one revolution to put in or out all of the resistances O, and in practice this revolution would take place only with the full travel of the car over the line. In this figure the dotted lines connecting the motor-circuits indicate the location of how the resistances can be placed in the motor-circuit between one collector and motor, while the solid lines indicate the resistances arranged in a shunt around the armature and including the field-magnets. In the former case the current would go from the positive collector through the armature, and then through the resistance-changer back to the negative collector, while the field-magnets would be in a shunt-circuit, these methods of coupling up the motor being well known. I do not limit myself to the particular way shown of coupling up the circuits.

In Fig. 5 the resistance-changer is shown like a well-known rheostat, which may be driven by clock-work O^4, or, as in the cases before specified and controlled, by a magnet Q^2 and its armature Q^3, controlled by the current in the motor-circuit. This would regulate the resistance to compensate for any gradual increase or decrease in the line-resistance. To make this automatic for variations in the motor-circuit, a contact-brush O^2, connected with the motor-circuit, may be operated by a helix Q in a shunt-circuit Q^4, or, if desired, in the motor-circuit N, to sweep over the bare wire wound on one of the cylinders to vary the resistance interposed in the motor-circuit by the clock-work and its magnet. By this means the travel of the armature Q′, carrying the contact O^2, will have but a small movement.

If the clock-work alone were relied upon to vary the resistance to compensate for fixed variations in the line-circuit resistance, it is evident that if from some undue cause the car had to stop for a long period the regulator would not accomplish its object. For this reason I provide the magnet Q^2, whose function it is to stop the clock when the resistance inserted or removed is too much. This device does not allow for slight variations due to extraneous and local causes, and to compensate for these local changes I use the helix Q and its contact-brush O^2 and make it cut in or out automatically, according to the requirement, a portion of the resistance controlled by the clock-work and magnet Q^2. Magnet Q^2 is in the motor-circuit, which also includes the lower cylinder of the rheostat, which is of metal, as is well known. If desired, the armature and its contact may be moved by the operator whenever it may be desirable to abnormally change the resistance from any cause. The construction preferred is shown in Fig. 6, which is very similar to what is shown in Fig. 1, with the exception that the resistances are electrically controlled.

N′ is the brush-shifting lever for reversing the motor. The motor-circuit N takes in the resistances O, the number of which is varied by moving the contact O^2 by the helix Q through the agency of its armature Q′. As shown, helix Q is in the motor-circuit; but it might be in a shunt-circuit, as in case of Fig. 5. The armature Q′ is connected to an indicator-hand which moves over a dial forming an indicator *q* to show any variation in the current and also the amount of resistance in circuit. A small contact-block *n* is arranged in the path of the contact O^2, whereby by pushing the contact O^2 to said block by hand the resistances O, as well as that of the helix Q, may be cut out of the motor-circuit, which would be particularly useful in starting. If it is pushed still farther, as indicated in dotted lines, the motor is cut out by a contact-block *p*, and a resistance P may be put in place of the motor to prevent abnormal changes in the resistance of the line-current. These two extreme positions may be secured by a lever Q^5 and rod Q^6. I do not confine myself to any particular way of interposing these resistances or in their manner of construction, as they may be changed in many ways.

The car is provided with electric lights E^5, either small arc or incandescent, the latter being preferred, and these are connected in multiple arc by wires e^5 and conductors R, connected with the motor-circuit and preferably shunted around the motor. These circuits e^5 may have switches to cut out each lamp. The circuit R may include the headlight E^4, which may be either of the arc or

large incandescent type or a group of incandescent lamps. If the switch r is closed, the head-light E^4 will be continuous.

Referring to Fig. 9, it will be observed that when the circuits are as shown the head-light E alone will burn and it will be continuous. If now switch r be turned to break circuit R and include the circuit R′ and its interrupter-switch R^2, then the head-light will be a flash-light. If the switch r be closed, as before, and the switch r^2 turned to include circuit E^6, then the incandescent lamps E^5 will be arranged in multiple arc with each other and in series with the arc or head-light E. If it is desired to burn the lamps E^5 alone, the switch r is opened and switch r^4 closed in the circuit r^3, connecting the conductor E^6 with one of the collectors. If now the switch r be closed to circuit, the head-light will be in multiple-arc connection with the incandescent lamps, and if the switch is turned to circuit R′ then the head-light will flash and the incandescent lamps burn continuously. To accomplish the flashing of the head-light I make the circuit R′ with a circuit-breaker R^2, which closes by a spring action and is opened by a pin k^2 on the car wheel or axle or other moving part of the vehicle. As said pin moves around it opens the circuit, extinguishing the lamp, and as it passes the switch closes and re-establishes the arc.

In place of putting the light in a derived or shunt circuit around the motor, it may include the field-magnets of the motor, as shown in Fig. 3, and a switch r' may be used to cut out the lamp without cutting out the field-magnets.

I do not limit myself to any arrangement of the lamps on the car or to their particular circuits, and in place of taking the current from the motor-circuit they may receive current from separate collectors, the essential feature of the invention being the lighting of an electric motor or car by electric lamps receiving electricity from a common source with the motor.

L is the brush carried by the car and adapted to sweep the walls of the conduit and the conductors contained therein. As shown, it consists of a flat shank or frame L, to which the two pivoted brushes l are secured. These brushes are turned by a spring l', so as to force them out laterally on opposite sides into contact with the side walls of the conduit to sweep them clean and remove all collections which might allow of escapage or leakage of current. This brush-shank is pivoted on a transverse axis to a frame L′, which has a rearwardly-projecting arm l^3 and two lateral arms, which are connected by flexible parallel bars L^2 with the frame h. The extension-arm l^3 is connected by a chain l^2 with the car body or frame. The lower part of the shank below the slot is also connected by a rod or link L^3 with the frame I. By this connection it will be seen that normally the brush is free to move laterally to suit variations in the slot, and should the frame I be thrown up by an obstruction the link L^3 will drag the shank of the brush forward and upward, it turning upon its transverse axis, and if not sufficiently high to clear the obstruction it will be raised still higher by its rearwardly-extending shoe L^4, (see Fig. 8,) and the spring-arms L^5 and chain l^2 will give to allow of this movement. When it is desired to transfer the car, the frame I is fully raised and locked, the chain l^2 disconnected, and the brush turned up forward and secured clear of the road-bed.

F′ are draining and cleaning wells, into which any dirt and water from the conduit may run or be swept. In this application I do not claim, broadly, the application of the brush or broom to clean an electric-railway conduit and propelled by the electric motor, as that forms subject-matter of an application of mine filed March 18, 1886, and serially numbered 195,742.

S is a signal electric bell or gong to enable a passenger or conductor to notify the driver or operator to stop the car and receives its current from a shunt-circuit around the motor or from the motor-circuit by wires s, and a switch s' may be used to cut it out of circuit. Normally the bell is out of circuit; but by pulling upon a bell-rope S′, running through the car, the switch s^2 may be closed to signal the operator to stop the car. The novelty in this arrangement consists in that the current to operate the bell is received from the motor-circuit or the stationary conductors in the conduit.

In starting the car on heavy upgrades and when it is heavily loaded there would be great duty required of the motor, and unless it were made excessively large for normal duty it could not be relied upon in such abnormal circumstances as above supposed. To overcome this necessity for excessive increase in the size of the motor, I provide suitable means to give the first impetus to the rotation of the armature without directly relying upon the electric current. The armature once being started, the power will be found sufficient to overcome the resistance to propulsion or the inertia of the car. Before giving this impulse mechanically to the armature the regulator may be operated to cut out all the resistances O and the resistance of the helix Q, as hereinbefore set out, and when this excessive current is flowing the mechanical impulse may be given. To give this mechanical impulse to the armature, I provide its shaft with a friction-wheel W, which may be clutched by lever W^2, which is hinged to arm W′, loosely journaled on shaft K′ of the armature or centered about its bearing. The lever W^2 is provided with gripping-faces w', which are normally kept clear of the wheel W by springs w. This lever W^2 is connected to an operating hand-lever W^3 by rod w^2. By pulling or pushing quickly upon lever W^3 the lever W^2 is rocked sufficiently to grip the wheel W,

and a further movement will rotate it. By this means the armature may be rotated in either direction. This gripping mechanism may be made in many ways; but the principle will remain the same.

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

1. The combination of two or more electric motors, a vehicle conveyed and propelled thereby, power-transmitting devices between the two motors and each of the axles of the vehicle, reversible commutator-brushes for each motor, means controlled at will by the operator for actuating said brushes to change the direction of rotation of the motor, a resistance in the motor-circuit, and means for automatically controlling said resistance.

2. The combination, with an electrically-propelled vehicle, of an electric circuit thereon, two or more motors on said vehicle and in the electric circuit, adapted to run at the same speed, a single speed-regulator for all of the motors independent of the motor-brushes and under control of the operator, a resistance in the motor-circuit, and an electric device in said circuit connected with and controlling said resistance independently of the hand operation.

3. The combination of a vehicle, two motors for operating the axles of the vehicle to propel it, circuits connecting the armatures of the motors in series with the field-magnets of both motors, a source of electric energy, a motor-circuit leading from the source of supply, and a current-regulator in the motor-circuit for simultaneously controlling the current to both motors.

4. The combination, with a line conductor extending along the railway and a vehicle, of an electric circuit thereon, a current-collecting device having its weight wholly sustained by the vehicle and making a moving contact with the conductor, two or more electric motors in series and adapted to propel the vehicle, and a single hand speed-regulator for both motors under control of the operator.

5. The combination, with an electric motor adapted to run at a variable speed, connected to main conductors between which there is a constant difference of potential, of a resistance in the motor-circuit, automatic devices for increasing the resistance upon a decrease in the speed of the motor, and hand-operated means for controlling at will the automatic devices.

6. The combination of two or more motors having their field-magnets connected in series adapted to run at similar speeds, means common to both motors for automatically regulating the current delivered to the motors, a vehicle propelled by the motors, a line-circuit, and a traveling connection between the conductor and motors on the vehicle.

7. The combination of a vehicle, two motors for operating the axles of the vehicle to propel it, circuits connecting the armatures of the motors in series with the field-magnets of both motors, line conductors extending along the railway, a motor-circuit leading from the line conductors and making a moving contact therewith, and a current-regulator in the motor-circuit for simultaneously controlling the current to both motors.

8. The combination, with an electric motor on a multiple-arc circuit, of a variable load for the same, a resistance in the motor-circuit, an automatic electrical controller for the same adapted to respond to a definite current, and a hand-operated part to control the operation of the automatic electrical controller.

9. The combination, with a railway-track, of a slotted conduit having two electric conductors therein at fixed heights relative to said railway, a vehicle traveling thereon having springs between its journal-boxes and its body, and two insulated conductors supported from said journal-boxes by a common frame and extending into said slotted conduit to make a traveling connection with the respective conductors inclosed therein and connected at their upper ends with an electric motor arranged to propel the said vehicle.

10. The combination, with the track of an electric railway, of two electric conductors extending along said track at fixed heights relative thereto, a vehicle having springs between its journal-boxes and its body, and two insulated electric conductors supported from said journal-boxes by a laterally-movable frame common to both contact devices and terminating in contact devices extending to said conductors to make a constant electrical connection therewith.

11. The combination, in an electric railway, of two insulated inclosed conductors at a constant height relative to the track of the railway, an electrically-propelled vehicle having springs between its body and its axle, and a vertically and laterally movable frame supported from journal-boxes on said axle and carrying contact devices adapted to maintain the electrical connection between the conductors and the propelling-motor.

12. The combination, in an electric railway, of a conductor extending along the railway, a vehicle having journal-boxes supported on the axles, a car-body supported thereby through intermediate springs, an electric motor supported by the journal-boxes independently of the car-body, and a contact device also supported by the said journal-box and adapted to maintain the electrical connection between a conductor and electric motor.

13. The combination, with an electrically-propelled vehicle, of a conduit inclosing a conductor, and two contacts or collectors supported from said vehicle and extending into the conduit, one upon each side of an axle of the vehicle, and movable in common by a frame supported by the axles with provision for lateral movement.

14. The combination of a railway having a slotted conduit, a bared conductor arranged in said conduit, an electrically-propelled vehicle, and a cleaning-brush for the conductor, having its weight supported wholly by the vehicle and extending within the conduit to a depth sufficient to reach the conductor, but sustained clear of the bottom of the conduit.

15. The combination, with an electric locomotive having a car-body supported on springs, of a slotted conduit, a frame supported by the axles independently of the car-body, a broom or cleaning device depending from an independent frame into the conduit and removable therefrom through the slot and movable vertically and laterally, and a connection between the frame supported by the axles and the independent frame.

16. The combination, with an electric locomotive and a slotted conduit containing an electric conductor, of a cleaning device consisting of an open frame having its weight sustained wholly by the locomotive, brushes extending laterally from each side of the open frame, and a support for the same having a transverse movement relative to the locomotive and connected to the axles independently of the car-body.

17. The combination, in a car, of the axles, a frame supported by the axle-boxes and extending between the axles, a motor sustained by said frame, and power-transmitting devices between the motor and each axle.

18. The combination of working-conductors, a traveling electric-motor vehicle receiving electricity therefrom, an automatic resistance-changer controlled by the current in the motor-circuit to vary the resistance of the motor-circuit, and mechanism under the control of the operator and leading to the front platform of the vehicle to vary the resistance in opposition to or with the tendency of the automatic resistance-changer.

19. The combination of working-conductors, a traveling electric-motor vehicle receiving electricity therefrom, an automatic resistance-changer controlled by the current in the motor-circuit to vary the resistance of the motor-circuit, mechanism under the control of the operator and leading to the front platform of the vehicle to vary the resistance in opposition to or with the tendency of the automatic resistance-changer, and an indicator to indicate the changes in resistance.

20. In an electrically-propelled vehicle, two axles, a frame supported upon the axles by journal-boxes and extending around the outside of the wheels and having cross or transverse supports, a vehicle-body supported upon the axles by springs, an electric motor supported by the transverse bars, and a mechanical power-transmitting connection between the motor and axle.

In testimony of which invention I hereunto set my hand.

RUDOLPH M. HUNTER.

Witnesses:
RICHD. S. CHILD,
E. M. BRECKINREED.