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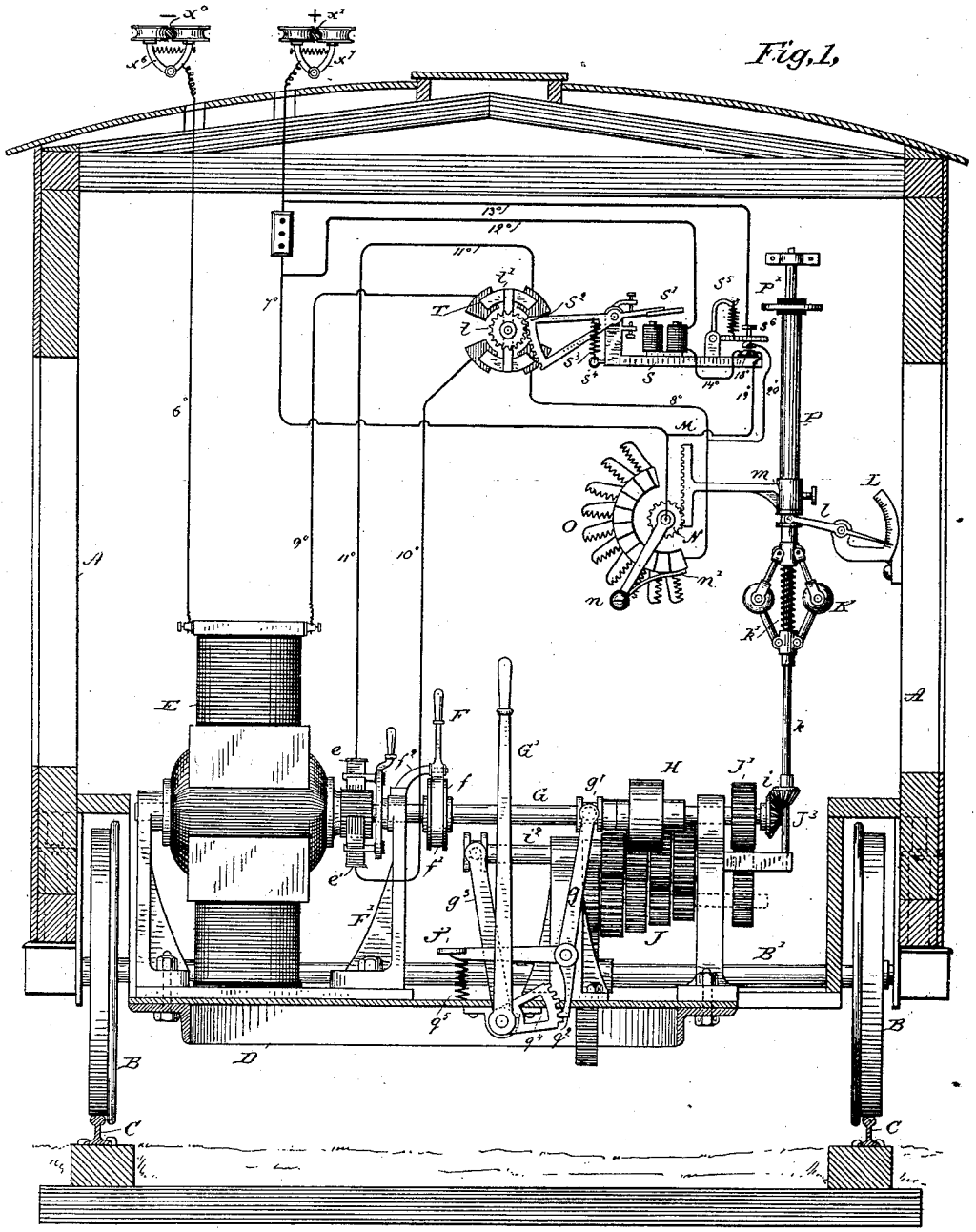
J. C. HENRY.

ELECTRIC RAILWAY.

No. 345,845. Patented July 20, 1886.

Fig. 1.



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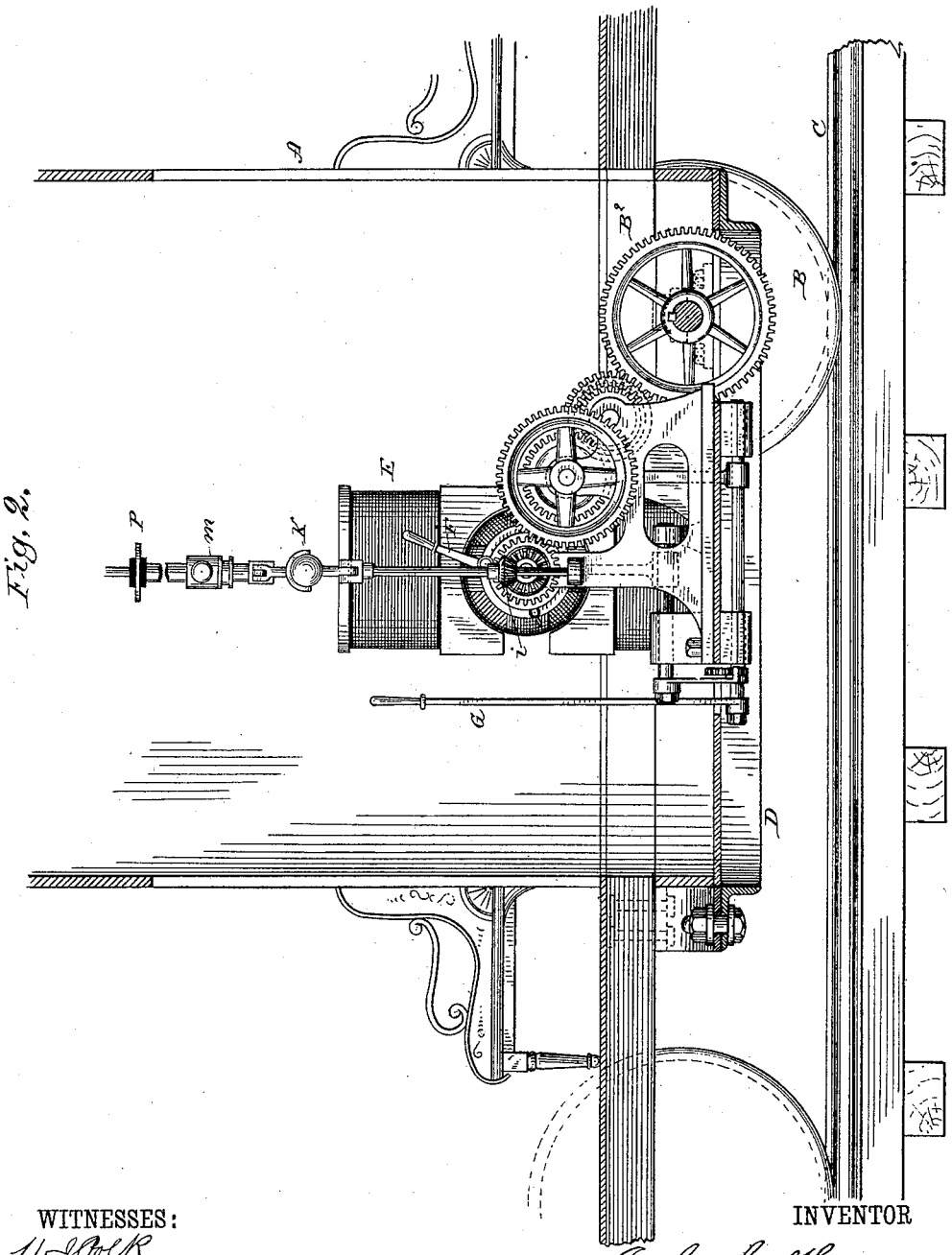

Fig. 2.

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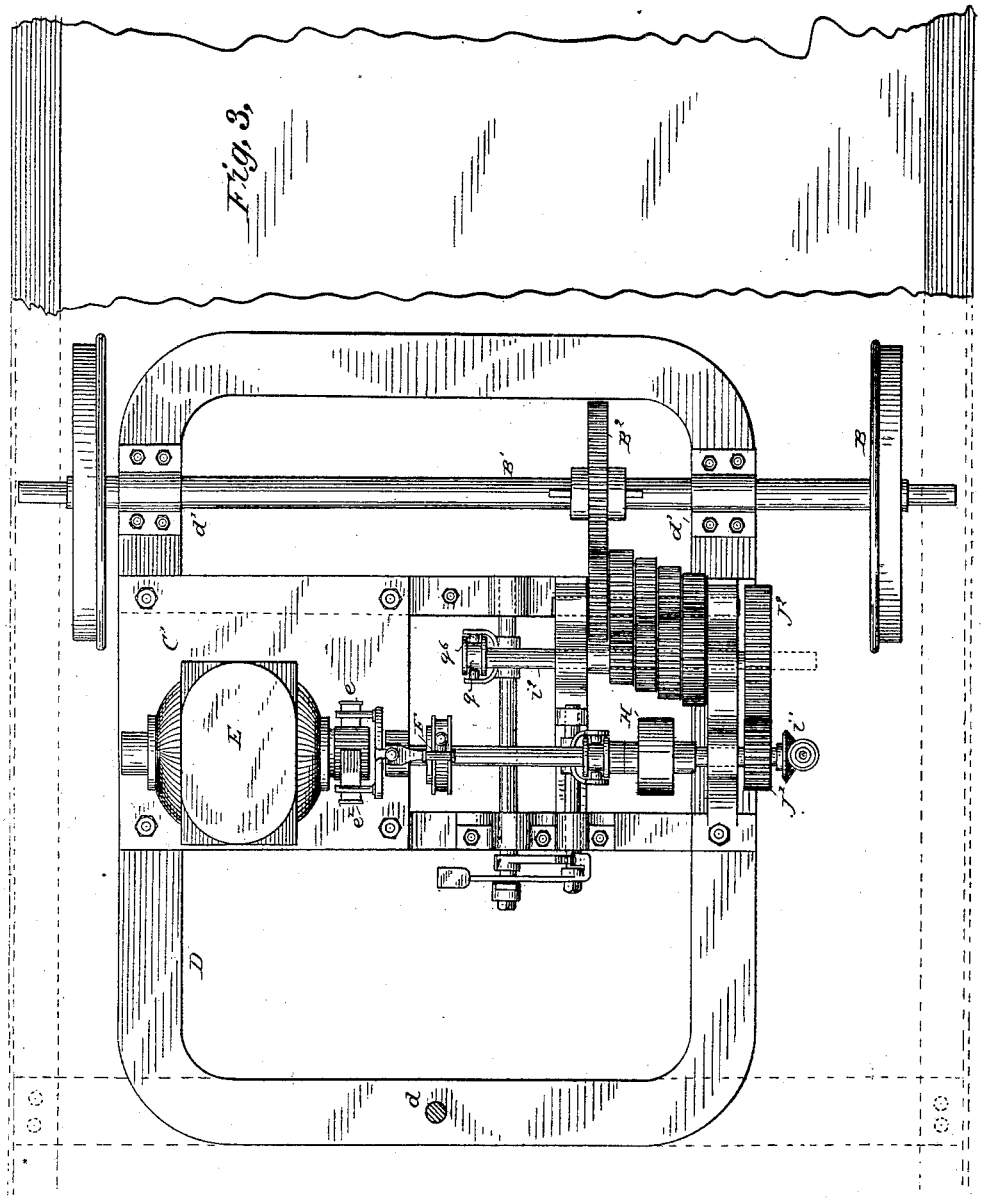

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(No Model.) 5 Sheets—Sheet 4.

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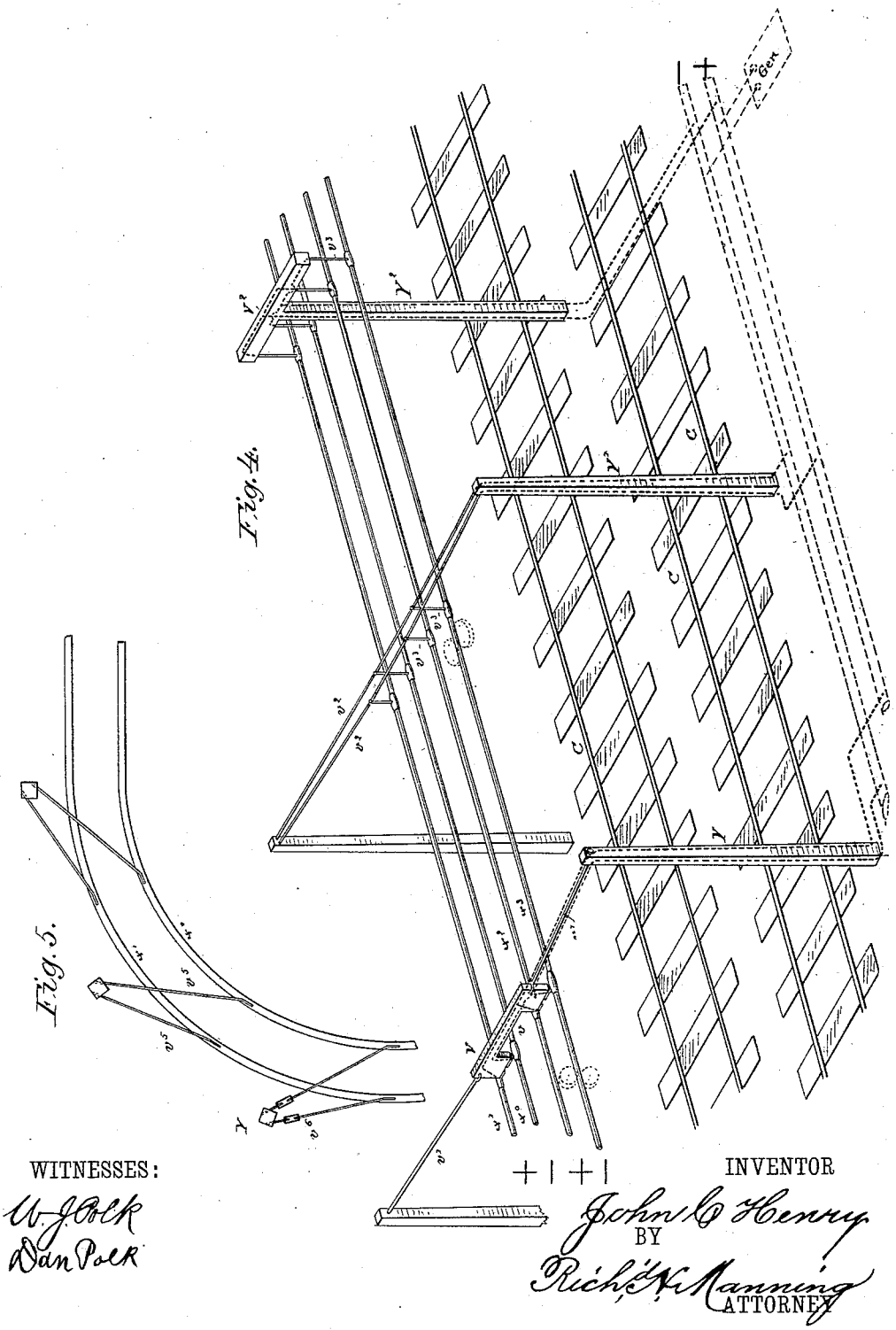

Fig. 4.

Fig. 5.

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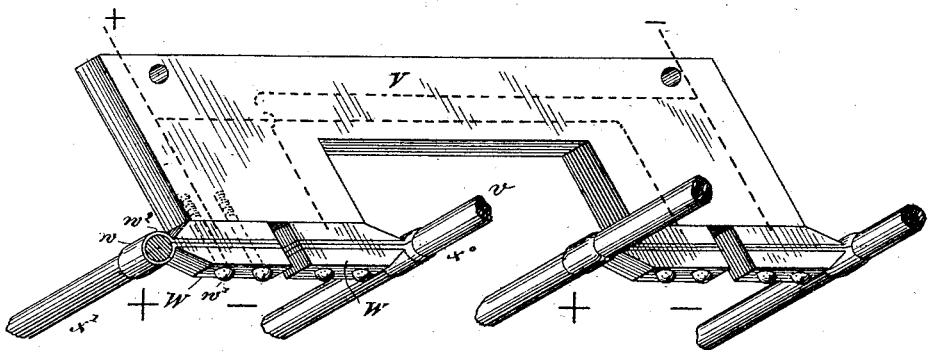
Fig. 6.



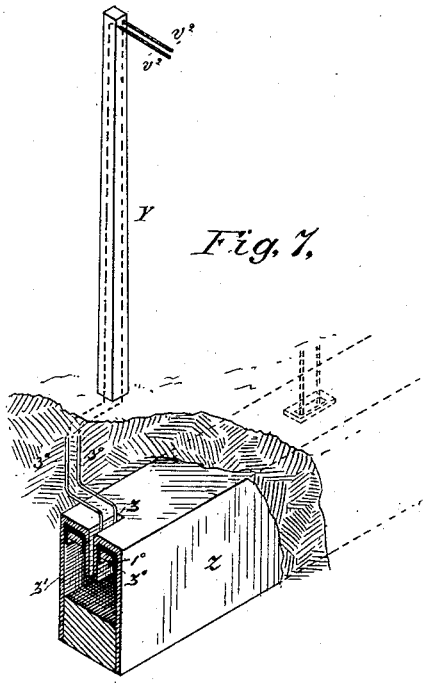


Fig. 7.

Fig. 8.

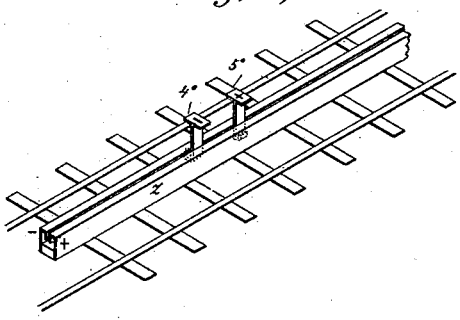
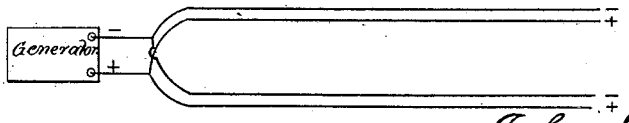


Fig. 9.



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UNITED STATES PATENT OFFICE.

JOHN C. HENRY, OF KANSAS CITY, MISSOURI.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 345,845, dated July 20, 1886.

Application filed October 17, 1885. Serial No. 180,151. (No model.)

To all whom it may concern:

Be it known that I, JOHN C. HENRY, a citizen of the United States, residing at Kansas City, in the county of Jackson and State of Missouri, have invented certain new and useful Improvements in Electric Railways, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention has for its object, first, to control automatically along the line of an electric railway the supply of current to separate motor-carrying vehicles, whereby the current may be supplied to each motor in power proportioned to the work required and the grades of the road, and also to afford a uniform speed of the motor; secondly, to afford means for automatically reversing the poles of the motor and cutting out the resistance, when from any cause an increment of speed in the motor occurs, and indicating the degree of speed; third, to afford the proper means for the passage of the electric contacts or brushes along the conductors and avoid switching said contacts; fourth, to afford a re-enforced or quantity current to the overhead conductors, and the economical transportation of currents to long distances; fifth, to support the motor upon the car in such a manner as to conform in movement to the car and its axle, and in positive connection with both, and also to permit the motor to maintain a uniform speed irrespective of the speed of the car.

In the drawings, Figure 1 is a transverse sectional view through the car, showing the electromotor and operative mechanism connected therewith. Fig. 2 is a side view of the motor-car and operative mechanism. Fig. 3 is a plan view showing the frame upon which the motor is placed and the mode of attachment to the car and car-axle. Fig. 4 is a view of trackway and the overhead conductors, and showing the means for re-enforcing the current to the said conductors, and showing the means for enabling the passage of the contacts in either a horizontal or vertical relation. Fig. 5 is an illustration of the means for supporting the overhead conductors in describing curves. Fig. 6 is a detail view of the overhead insulator or support, showing the means for supporting the conductors and enabling the electric contacts to pass the points of support in a vertical relation. Fig. 7 is a view in perspective of the underground conduit and air-traps when serving to carry underground conductors for re-enforcing the overhead current. Fig. 8 is a view of the longitudinally-slotted conduit, serving as an air-trap and to carry the conductors and permit the passage of the contact-brushes. Fig. 9 is a view of an arrangement of circuits in double multiple arc.

In carrying my invention into practice I suspend aerially above the tracks C C the conductors $x' x^0 x^2 x^3$, the positive polarity of the wires being indicated by the sign +, and the negative pole by the sign —, and said conductors are arranged along said roadway in double multiple arc. The means of suspension of the conductors are, as shown, in analogous ways, first, by standards *y* on either side of the tracks C C, and guy-wires $v' v'$, which are attached to an intermediate insulated block, V. A central opening, *v*, is made in the block, V of a sufficient width and height to permit the passage of opposite contact-carriages. The conductors + x' and — x^0 are attached to the block V by means of the strengthening-clamps W. These clamps are made in two parts, and are beveled at one end, or at w^2, in the direction of the conductors. The metallic retaining-loops *w* are wound around each conductor, and the ends of said loops placed between the clamps W. The clamps are then secured to the block V by means of the screws $w' w'$. To prevent sparking, the end of the clamps W, which are contiguous to the conductors, are beveled in the longitudinal direction of the conducting-wires, as seen in Fig. 6. In this form of support the rollers of a contact-carriage may pass without obstruction in a vertical relation over the conducting-wires. The standards Y' Y' carry the parallel guys $v^2 v^2$, which extend across from one standard to another. From these guys $v^2 v^2$ depend in alternate relation the supporting-strips v^3, which are looped over the wires, as heretofore explained.

Y^2 represents a single standard which is placed between the tracks, and carries a non-

conducting transverse strip, V^2, which extends in opposite directions over each relative track, and the supporting-strips v^3 for the conductors depending therefrom. In this manner the rollers of a contact-carriage may pass over the conductors in a horizontal relation.

In describing the curves in the track the overhead conductors x' x^0 are given the same relative curvature, and the standards Y are placed upon one side of the parallel wires and at short distance apart. The guy-wires v^5 are brazed at one end to the top or side of each respective conducting-wire, and are secured rigidly to the standards. These guy-wires are given more or less tension by means of swivel connecting-bolts v^6, which unite separate parts of the guy-wires, so that the continuity of the conducting-wires and the passage of the traveling contact-carriage is uninterrupted and switching of the contacts avoided.

In Fig. 9 I have illustrated my preferred way of making a series of conductors of positive and negative polarity, or the double multiple-arc system, and it will be observed in this connection that four small conductors are the equivalent electrically to two large ones, and these conductors are united near and to the respective poles of the generator in pairs through the medium of branch wires and insulated conductors.

It is found necessary in the transportation of the current long distances to re-enforce the overhead uninsulated conductors electrically, which I aim to accomplish by the means of large underground insulated conductors connected directly with the generator, as shown in Fig. 7. For the double purpose of carrying the insulated conductors beneath the surface of the ground, and also to prevent water from coming in contact with the conductors, I form a conduit, Z, the sides and top of which are composed of iron and the bottom of wood, and make such conduit continuous along the track, under or above ground, as preferred. At certain distances apart, corresponding to that of the standards Y Y', as shown in Fig. 7, and in the top of the conduit, is made in a central relation the slot z, which extends through said top and a suitable distance longitudinally. From the inner side of the top plate of the conduit, and on opposite sides of the slot z, depend the flanges z', of suitable length to form a receptacle for the conductors and an air-trap between the said flanges and the opposite walls of the conduit, the bottom thereof being made so as to conduct a volume of water in its established direction. The flanges z' extend the length of the conduit, and I place within the conduit, and so as to cover the inner surface of the top of said conduit, and also extend downwardly a portion of the distance on either side of the conduit and of the flange z, opposite thereto, a continuous non-conducting strip, z^0, preferably of rubber material. I then wedge the large conductors l^0 l^0, which are shown in rectangular shape, between the insulating-strips z^0, and by means of said strips, which inclose all but the lower side of said conductors, the conductors are retained in place. Conducting branch wires 3^0 3^0 extend through the slot z in the conduit and are connected with the conductors l^0 l^0 in said conduit, and to opposite conductors at one end. The conductors l^0 l^0 are connected to the opposite poles of a generator, and the branch conductors 3^0 3^0 are carried above the ground along the side of the standard Y, and connected with the overhead conductors, and by direct contact with the conductor of like polarity, or through the guy-wires v^2 v^2, each one of which supports conductors of like polarity.

As seen in Fig. 8, the conduit may be placed upon the ties between the tracks and slotted its entire length, to enable the contact brushes 4^0 5^0 to receive the current from the conductors therein, and at the same time prevent the water from rising too high in the air-trap and coming in contact with the conductors. In this form the propelling energy may be received directly from the conductors in the conduit, the contact-brushes secured to the under part of the car, and take and return current from and to the motor thereon.

The motor-carrying vehicle A, mounted on axle B', which in turn carries wheels B B, and supported on track C, is provided with a frame, D, to support and afford a more exact adjustment of the motor E and mechanism in power-connection with the axle. Frame D is attached to the axle B at one end by the journal-boxes d' d', and at its opposite end secured rigid to the frame-work, forming part of the bottom of the vehicle by means of the king or swivel bolt d. Thus it will be seen that the ordinary car-springs come between the car and axle and the points of support of the frame D, which enables a direct connection to be made with the axle from the driving-shaft of the motor E, and prevents a sun and planet movement between the pinion on the motor-shaft and speed-gear in connection therewith, as far as practicable, and also shocks to the machinery and motor in transit of the car.

I am aware that electromotors have been mounted upon a frame attached rigidly to the front and rear axles of a car, and also upon a frame attached at one end rigidly to the rear axle, and the opposite end to the bottom of the car through the medium of springs. This I do not claim, the object herein being to dispense with any and all movement of the frame except that resulting from the movement of the car-body upon its springs.

For the purpose of automatically controlling the supply of the current to the motors on each separate vehicle, whereby each motor takes what current it needs, and no more, the driving-shaft G of the motor E is connected by the bevel-gear i with the upright shaft k, carrying the governor K. A sleeve, P, on shaft k is attached to the governor K at one

end. From sleeve P, near the governor, extends a suitable distance the arm *m*, upon the end of which and at right angles thereto is the rack M. A pinion, N, pivotally attached to a suitable support, is in gear with the rack M, and rigidly attached to said pinion is a lever, *n*. A series of resistance-coils, O, is placed in a segmental relation to and near the pinion N, and a contact-brush, *n'*, extended obliquely from the end of lever *n* to the coils O, which coils are in electrical connection through branch conductors 7^0 and 8^0 with the main conductors. When from any cause the speed of the motor shaft varies from the prescribed limit, the rack N is drawn upwardly or downwardly by the governor K, which moves the contact-brush *n'* over the commutator of the resistance-coils, increasing or decreasing the resistance to the current.

For the purpose of automatically reversing the poles of the motor, the two opposite poles of the switch T are connected to the wires 9^0 11^0, 9^0 running to the motor-field and 11^0 to the commutator-brush *e*. A segment-rack lever, s^2, is pivoted to a suitable support, and said rack is geared with pinion *t*. A spring, s^3, is attached to the rack-lever s^2, and also to a staple, s^4, on the support, which keeps the rack of said lever held in one relative position under tension. The opposite end of the lever s^2 is provided with the armature *s'*, and in the field of the electro-magnets S. Two short circuits, 12^0 13^0, extend from the branch conductors 7^0. 12^0 is in electro connection with the magnets S. 13^0 is connected with a circuit-closer, s^5, which is pivotally attached to a suitable support, and the key of which is held in a horizontal position by means of a spring, s^6. A short wire, 14^0, extends from the electro-magnets S and approaches the circuit-closer s^5, so as as to make the circuit. Should the shaft of the motor attain a rate of speed above that necessary to propel the car, the governor accelerates its speed and is thrown out, thereby drawing down the sleeve P, and the projection P' depresses the key of the circuit-closer s^5, the magnets S become excited and act to draw down armature *s'* on lever s^2, and the pole-changer *t* is rotated, which changes the polarity of the motor and allows it to generate instead of exhaust a current. When the poles of the motor are reversed and the motor is acting as a generator, the current is shunted from the resistance-coils through a leak-circuit or the conductors 19^0 20^0, and the circuit is made through the circuit-closer s^5, the wires 19^0 and 14^0 being insulated from each other at the point of contact by means of the insulator 18^0. The branch conductors 12^0 and 13^0 are shown, for illustration, in the drawings adjacent to each other. In practice, however, they are placed so far apart as to shunt the necessary current to excite the magnet S, or the resistance of the conductors may be varied to effect the same result. In contact with the arm *m* on sleeve P is the end of needle *l* of the indicator L, which is secured to the side of the car and serves to indicate the speed of the motor-shaft.

The driving-shaft G of the motor is provided with an intermediate friction-clutch, H, placed in power-connection between the motor E and gear J^3. One portion of friction-clutch H is provided with a neck, *g'*, and in which neck the end of lever *g* of the interlocking device is held by pins g^6, as seen in Fig. 3. The lever *g* extends from the shaft G to the lower part of the supporting-base to the speed-gearing J, to which it is pivotally attached. One part, J', of said lever is extended at right angles from its pivotal point, and a short portion, g^2, extends downwardly and tapered at right angles, so as to engage with the gear-sector g^4, which is pivotally attached to the frame D. A hand-lever, G', extends vertically from the gear-sector g^4, to which it is rigidly attached, and a lever, g^3, is attached to the same pivotal point, and also in rigid connection with the lever G', and is connected with the end of the reciprocating plunger i^2, which is reciprocated in the direction of the speed-gearing and for engaging the gear, so that when it becomes necessary to change the speed of the vehicle or change the relation of the gear without checking the speed of the motor-shaft the foot-lever *j'* is operated to throw the friction-clutch H apart, which releases the end g^2 of lever *g* from the sector-gear g^4 and the lever G' operated to throw the plunger in or out of connection with the various gears. The gear J' on shaft G meshes with gear J^2, and the said gear J^2 is mounted upon the same shaft i^2 as the speed-gearing, which in turn communicates power to the gear B^2, attached to the axle B'.

For the purpose of preventing the movement of the car at certain times, or to control in a measure the speed of the driving shaft, I attach to the shaft G a drum, *f*. A metal band, *f'*, is then carried around the drum *f* and attached to a small hand-lever, F, which lever is pivotally attached to an arm, f^2, on the upper end of the support F' of shaft G, so that by throwing the lever forward or backward tension upon the band *f* is sufficient to control the speed of the motor-shaft.

The brush of the resistance-coil may be moved by hand for the starting, checking, or reversing the speed of the car whenever desired.

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

1. In electric railways, a system of electrical transmission through suitable main conductors and a main source of supply, a vehicle, and a motor on said vehicle, branch conductors in electric connection with the motor and having a traveling contact with the main conductor, a pole-changing switch in an electric-supply circuit, and an electro-magnet in a normally-open shunt-circuit for

operating said switch, and a governor on the vehicle, and suitable circuit-completing mechanism whereby the governor acts to reverse the poles of the motor.

2. In electric railways, the combination, with the car-motor operated by means of a branch circuit from a main circuit, of an adjustable resistance, and a pole-changing switch placed in said branch circuit, a shunt-circuit from the main circuit, and an electro-magnet placed in said shunt-circuit, and mechanism operated by said electro-magnet for reversing the poles of the switch, a governor on the car in speed-connection with the shaft of the motor, and mechanism operated upon automatically by said governor for adjusting the degree of resistance of the resistance-coils and reversing the poles of the said switch.

3. In electric railways, the combination, with the car-motor operated electrically by means of a branch circuit from a main circuit, of an adjustable resistance, and a pole-changing switch placed in said branch circuit, a shunt-circuit from the main circuit, and an electro-magnet and a circuit-closing device placed in said shunt-circuit, and mechanism operated by said electro-magnet for reversing the poles of the switch, a governor on the car in speed-connection with the shaft of the motor, and mechanism actuated by said governor for adjusting the degree of resistance of the resistance-coils and operating the circuit-closing device, and a leak-circuit for cutting out said resistance, and in electrical connection with the branch and shunt circuits.

4. In electric railways, the combination, with the generator, of conductors for the transmission of electrical currents in double multiple arc, consisting of a series of conductors alternating in polarity and connected in pairs to the opposite poles of a generator.

5. In electric railways, the combination, with a main source of electric supply, of suitable suspended continuous aerial conductors and buried insulated conductors and branch conductors of corresponding polarity, and connected at intervals with the aerial conductors.

6. In electric railways, the combination, with a main source of electric supply, of suitable buried insulated continuous conductors in single multiple arc, as described, of suitable continuous uninsulated aerial conductors for the transmission of electrical currents in double multiple arc, and connecting branch conductors at intervals of corresponding polarity.

7. The combination, in an underground slotted conduit, of an inverted receptacle, forming an air-trap along the length of the conduit, of a conductor in the top of the air-trap, whereby water in the conduit is kept from the conductor, as set forth.

8. In electric railways, an underground slotted conduit and an interior flanged inverted receptacle carrying a continuous insulator, and a conductor retained in said receptacle by means of said insulator.

9. In electric railways, an underground slotted conduit and an interior flanged inverted receptacle adapted to receive an insulated conductor, one of the flanges of said receptacle forming the side to the conduit, and an opposite flange extending so far toward the bottom from the top of said conduit as to form an air-trap.

10. The combination, with aerial electrical conductors in electric railways, extending along the line of said railway, and suitable traveling electric contacts, of an insulated block for supporting and retaining opposite conductors the proper distance apart, suspended above the railway by suitable means, and having an opening or passage-way through said block.

11. The combination, with aerial electrical conductors in electric railways, extending along the line of said railway in double multiple arc, and suitable traveling electric contacts, of an insulated block suspended above said railway by suitable means, adapted to insulate opposite conductors from each other, and having a suitable passage-way for the said contacts and between said conductors retained the proper distance apart by said insulated block.

12. The combination, with a vehicle and electromotor, and the driving-shaft of said electromotor having opposite parts independently connected by means of a friction-clutch, of variable-speed gear in power connection with said shaft, a reciprocating plunger adapted to connect and disconnect loose with fixed gear, and a lever pivotally attached to said vehicle at one end and to the plunger at the opposite end, a hand-lever in rigid connection with said lever at its pivotal point, and a gear-sector rigidly atached to the pivotal end of said hand-lever, and a foot-lever engaging with said sector, as and for the purpose specified.

13. The combination, with a vehicle and electromotor, and the driving-shaft of said electromotor having opposite parts independently connected together by means of a friction-clutch, of variable-speed gear in power-connection with said shaft, a reciprocating plunger adapted to connect and disconnect loose with variable fixed gear, and a lever pivotally attached to said vehicle at one end and to the plunger at the opposite end, a hand-lever in rigid connection with said lever at its pivotal point, and a gear-sector rigidly attached to the pivotal end of said hand-lever, and a foot-lever having an extension to engage with the friction-clutch on the driving-shaft, and also an extension interlocking with the gear-sector, as described.

14. In electric railways, the combination, with curved track, of parallel aerial conductors arranged to describe the curve of

said track, and insulated standards placed upon one side of the said parallel conductors and at suitable distances apart, and guys secured to the top or side of each respective conductor and the said standard, as described.

15. In electric railways, the combination, with the curved track, of parallel aerial conductors arranged to describe the curve of said track, and insulated standards placed upon one side of the said parallel conductors, and at suitable distances apart, and guy-wires secured to the top or side of each respective conductor, and means for increasing or decreasing the tension of said guy-wires, as described.

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