(No Model.) 3 Sheets—Sheet 1.

B. FORD.

ELECTRIC RAILWAY.

No. 562,890. Patented June 30, 1896.

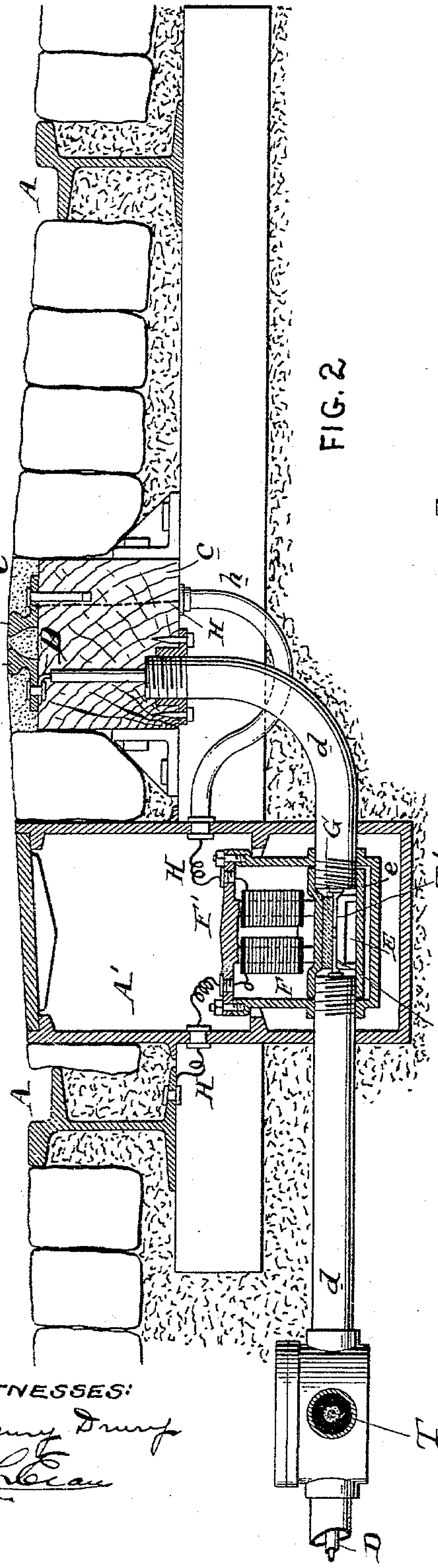


FIG. 2

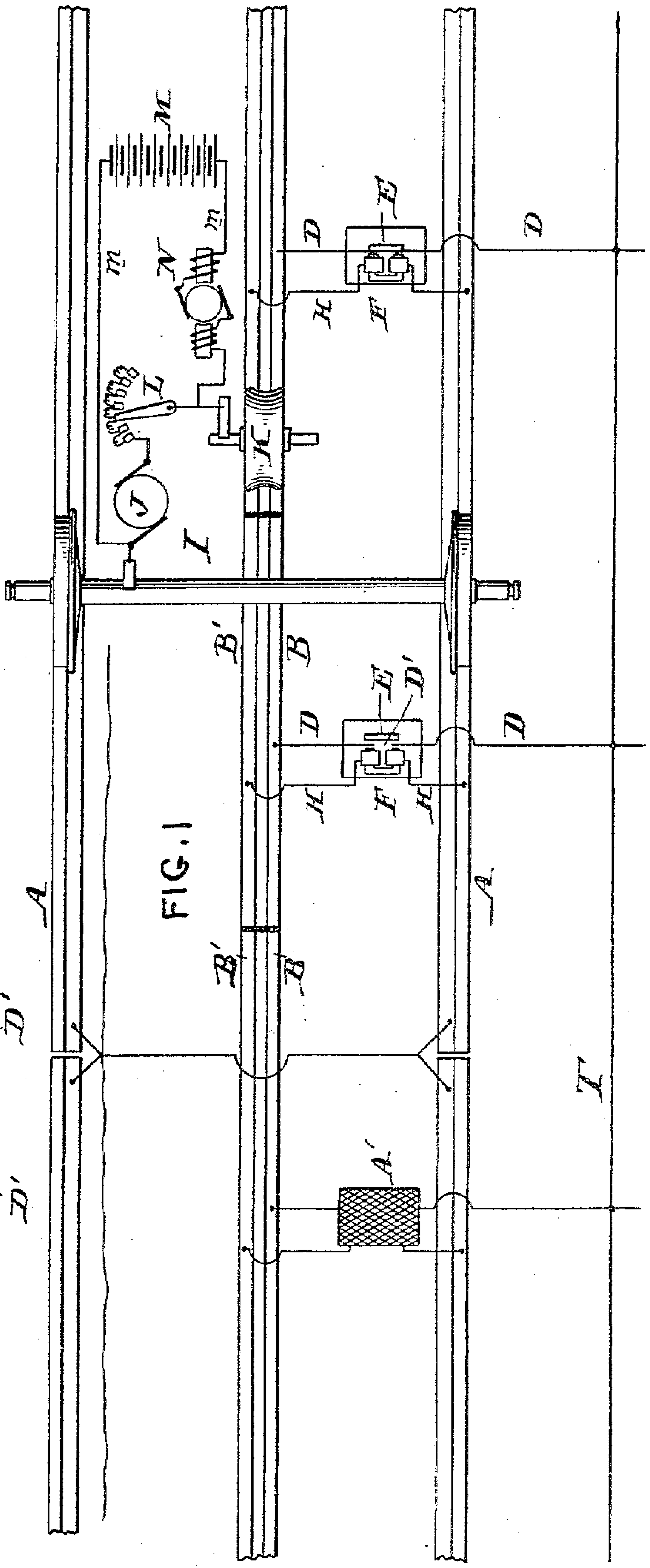


FIG. 1

WITNESSES:

Henry Drury

Wm. L. Lean

INVENTOR:

Bruce Ford

By his atty

[signature]

(No Model.)

3 Sheets—Sheet 2.

B. FORD.

ELECTRIC RAILWAY.

No. 562,890. Patented June 30, 1896.

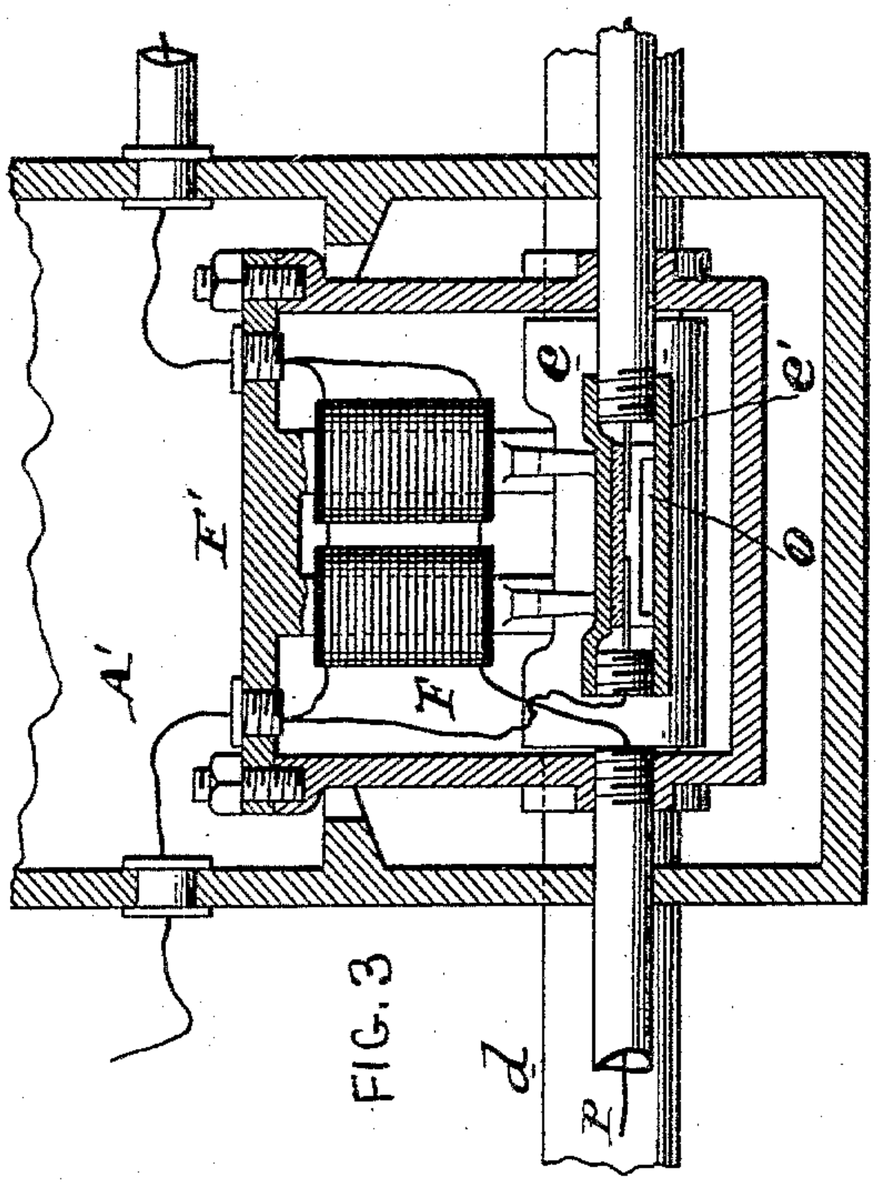


FIG. 3

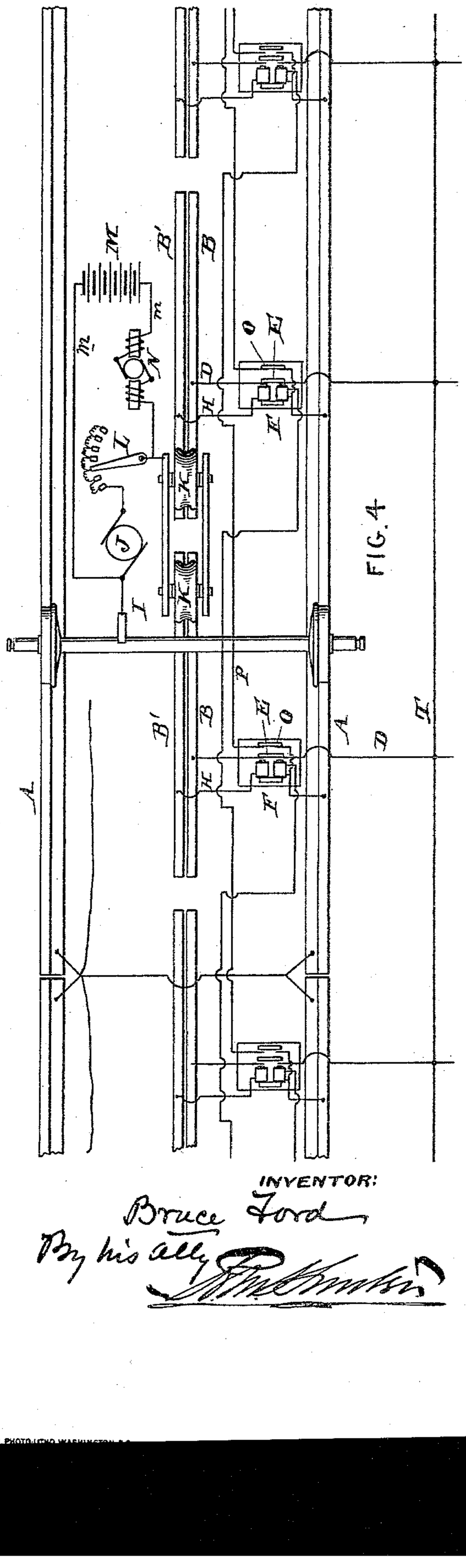


FIG. 4

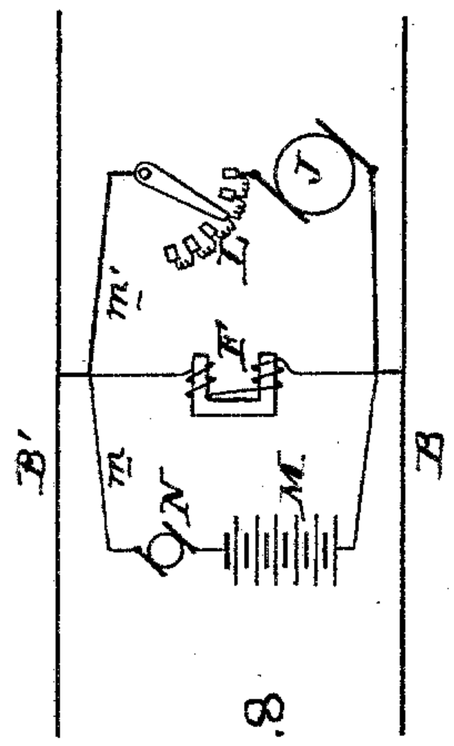


FIG. 8

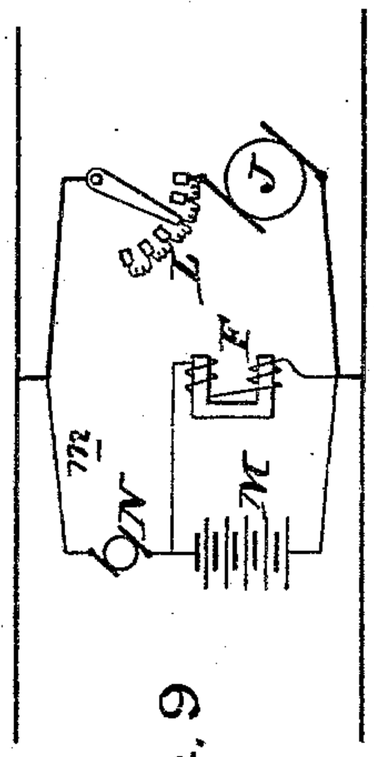


FIG. 9

WITNESSES:
Henry Dorsey
Thos. L. Evans

INVENTOR:
Bruce Ford
By his atty
Thos. L. Evans

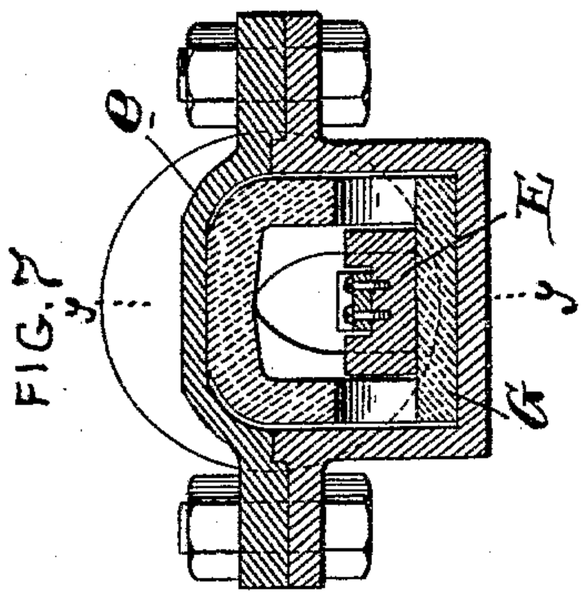
(No Model.)

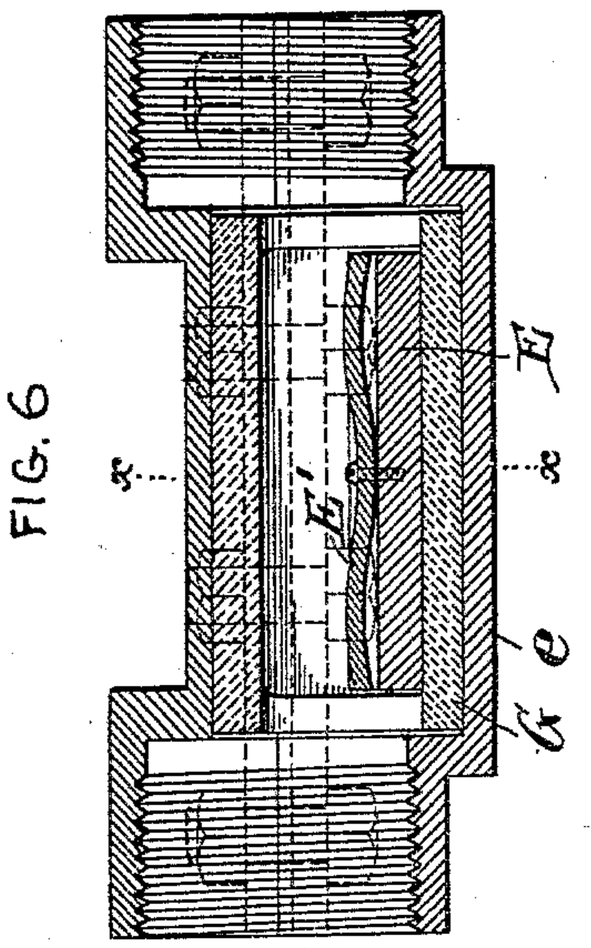
3 Sheets—Sheet 3.

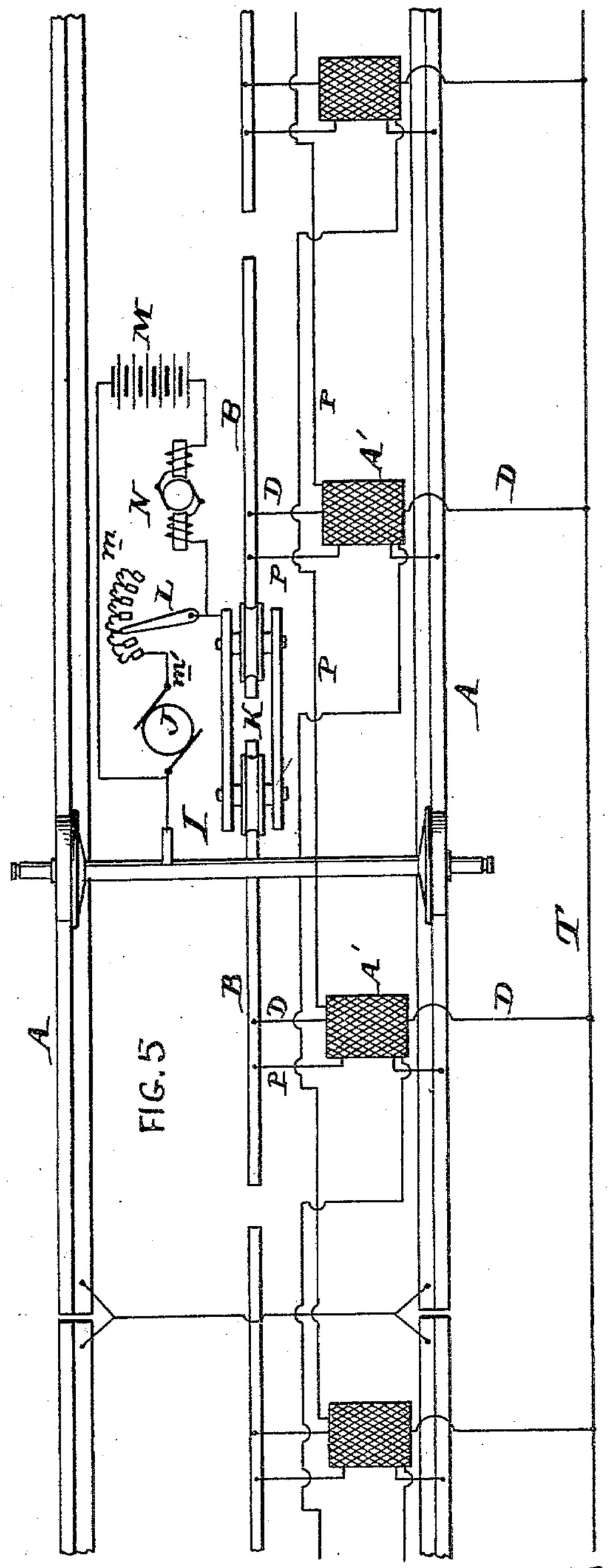
B. FORD.

ELECTRIC RAILWAY.

No. 562,890. Patented June 30, 1896.







WITNESSES:

Henry Drury

Thurlow Crane

INVENTOR:

Bruce Ford

By his atty

[redacted]

UNITED STATES PATENT OFFICE.

BRUCE FORD, OF JOHNSTOWN, PENNSYLVANIA.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 562,890, dated June 30, 1896.

Application filed August 30, 1895. Serial No. 560,965. (No model.)

To all whom it may concern:

Be it known that I, BRUCE FORD, of the city of Johnstown, in the county of Cambria 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 of certain improvements, all of which are fully set forth in the following specification and shown in the accompanying drawings, which form a part thereof.

The object of my invention is to provide a suitable construction adapted to supply current from a fixed source of energy to a moving car without the employment of exposed constantly-charged conductors.

My object is further to provide a closed conduit system of supply which shall dispense with the use of large traveling magnets on the car for operating the circuit-switches.

In carrying out my invention I employ sectional circuits along the track, which are successively brought into electrical connection with the supply-conductor by means of electromagnetically-controlled switches, and said switches have their coils in circuit with the supply-conductor and sectional surface conductor, so that the traveling of the car and its collector device will cause the current to flow over the said coils and energize the magnets immediately under or adjacent to the car successively.

My invention further comprehends the employment of a battery or accumulator in circuit with the collector for energizing the switches at starting, or at other times when no current from the line is passing. In connection with the latter portion of my improvements, I also employ a small high-speed motor, in series with the accumulator, generating a counter electromotive force to regulate the flow of current through the accumulator-circuit, and protect the accumulators.

My various improvements, including the features above specified, will be better understood by reference to the accompanying drawings, in which—

Figure 1 is a plan view of an electric railway with the circuits indicated thereon. Fig. 2 is a transverse section of same. Fig. 3 is a sectional elevation of one of the magnet-boxes adapted to a modification of my invention shown in Fig. 4. Fig. 4 is a plan view showing the electric circuits of an electric railway embodying a modification of my invention illustrated in Fig. 1. Fig. 5 is a plan view corresponding to that of Fig. 1, showing a modification of the electric circuits. Fig. 6 is a longitudinal section of one of the armature-boxes, taken on line *y y* of Fig. 7. Fig. 7 is a transverse section of same on line *x x* of Fig. 6, and Figs. 8 and 9 are diagrams illustrating the method of connection of the controlled magnet-circuits relatively to the circuit of the car.

The rails A are suitably connected to form the return circuit, and the outgoing of positive circuit is formed of the conductors B B', arranged in sections. These sections are so arranged that each pair of conductors forming a section is brought into contact with the feed-wire only as the trolly or current-collector of the car is in contact with them. In some cases this conductor is formed of a single rail divided in sections, while in other cases it is double, one part being connected to the ground through the switch-magnet F. Each section of the outgoing conductor is connected with the supply-conductor T by a branch conductor D, having therein a cut-out switch in the form of an armature E, inclosed in a case *e*, lined with glass, porcelain, or other suitable non-conducting and non-destructible substance G. This armature E is operated under the magnetic influence of a magnet F, contained within the magnet-box G', (also inclosing the case *e*,) which magnet is energized by current from a circuit H, one end of which is in circuit with the rails or return and the other end with a section of the outgoing or trolley conductor B'. In practice the conductor D would extend through and be insulated from tubes *d*, which terminate at their adjacent ends in the armature-box *e*, which is lined with glass or porcelain G, so that the armature E, when raised, will press the terminals D' on the divided branch conductor D against the said glass, and at the same time electrically connect the same. The armature E may have spring-contacts E', if desired.

It will now be evident that as the trolley or contact device K on the car I is moved over the conductor-sections B B' it will bridge successive sections, and hence current from the

preceding section or the one the car is leaving is delivered to the magnet F of the succeeding section or the one the car is approaching, causing it to raise its armature E and close the branch circuit D, supplying current from the supply-conductor T directly to the section B immediately under the car. As the car moves along, the trolley receives current from the conductor-section B, and part thereof is delivered to the motor J by a motor-circuit m' on the car, and part to conductor-section B', from which it passes to magnet F and keeps it magnetized until the next section is reached. The current in the motor-circuit on the car may be regulated by a rheostat or controller L of any suitable construction, and is returned to the rails or return-conductor by the wheels of the car I. It is evident that the particular arrangement of the motive power on the car is immaterial, as it may be made in any of the present well-known manners, if so desired. From this construction it is evident that there is no current in the sectional conductors, except when a car is in the immediate vicinity of the sections energized, and that in the ordinary operation of the system the several sections of outgoing or trolley conductor are energized and deënergized successively. There is therefore no danger to horses or pedestrians, and I am enabled to dispense with all overhead wires and slotted conduit constructions.

If from any cause the circuit should be broken, or when first starting, the magnet F will not be energized, and hence no connection with the supply-conductor T will be made by the armature *e* and branch conductor D. To secure connection under these conditions, I provide a small battery or accumulator M on the car, and include it in a circuit *m* in parallel with motor J. The current from this battery is thus utilized to energize the magnets when no current is flowing from the supply-conductor, and its action in any case is only for an instant, because as soon as the motor-circuit is closed the utility of the battery ceases. As the potential of the battery is necessarily less than that of the supply-conductor, a suitable cut-out or regulator is required to protect said battery, and this is fulfilled by interposing in the battery-circuit *m* in series with the battery M a small motor N, whose speed only allows enough current to flow to get up a speed so that its counter electromotive force will guard the battery against the high potential line-circuit, change in its voltage, short circuits, and from discharging through the main or power motor.

Under ordinary working the counter electromotive force of the power-motors will insure the requisite current passing through the magnets F, they being in shunt relation to said power-motors.

The armature-box *e* is inclosed within the magnet-case F', and this in turn is preferably placed in an outer box A', leading to the surface of the roadway, as is clearly shown in Fig. 2.

The construction which I have described above in detail corresponds to what is indicated in Figs. 1, 2, 6, and 7.

Turning now to the construction shown in Fig. 4, we have substantially the same circuits as those shown in Fig. 1, but in this case we have an additional armature-switch O, also controlled by the same magnets F which control the armature E. The armature O connects the rail by the circuit P with one of the sections B' of the trolley-conductor in advance, or to the rear, as desired, of the sections corresponding to the armature, and said circuit includes a reverse winding for the magnet F of the section to which it leads. This construction is clearly shown in Figs. 3 and 4. This addition will prevent any possibility of the armature E being held up after the car has passed, even in case of foreign matter electrically connecting and short-circuiting the trolley-rail section B B' at any place. This addition in being a safety device comprehends two equal but opposite windings upon the magnet F, one main winding in circuit H, whose action is to connect the trolley-rail section B with the supply-conductor, as described in connection with Fig. 1, and other being in the circuit P, and is energized when the collector of the car passes on to the next section and when the collector is removed from that section corresponding to the magnet under consideration. By this means the magnet F of the section is positively neutralized after the car has passed beyond that section which corresponds to it, even though there is a short-circuiting electrical connection between the two conductors B B' of said section.

In operation the closing of the armature O, corresponding to the section on which the car is, permits a current to flow over circuit P to a magnet F, corresponding to a section which the car has left, and this current flows around the second or demagnetizing winding of said magnet and annuls any magnetism which might be in the magnet in case there happens to be a short circuit between conductors B B' of that section.

In Fig. 3 I show the second armature O for the magnet F, it being likewise contained in the magnet-box *e'*, the remaining elements being the same as in the construction shown in Figs. 1 and 2.

In Fig. 5 I have shown a modification of my invention, in which there is but a single trolley-rail divided into sections. In this case I rely entirely upon the auxiliary circuit to open the sections passed by the car. This case is the same as if the two rails should become short-circuited, and it would therefore be in all material respects the same as Fig. 4 with the section B B' merged into single sections.

The magnets F may be in shunt relation relatively to the power motor and regulator

of the car and also to the storage battery and regulating-motor, as shown in Fig. 8 diagrammatically, or it may be arranged in shunt relation to the power-motor and its regulator and also to the storage battery, but in series relation with the regulating-motor, as clearly indicated in the diagram of Fig. 9. The particular location is immaterial so long as it accomplishes its object. It is evident that the principle of my invention may be secured irrespective of the special location of the conductor-sections B B', and hence they may be arranged at any convenient elevation or position relatively to the rails.

In conclusion I would remark that while I prefer the construction shown I do not confine myself thereto, as the details may be modified without departing from my invention.

What I claim as new, and desire to secure by Letters Patent, is—

1. In an electric railway, the combination of a supply-conductor extending along the railway, a trolley-rail formed of two parallel conductors each divided into sections, branch conductors between the respective sections of one of the trolley-conductors and the supply-conductor, electromagnetic switches in said branch conductors, conductors between the corresponding sections of the other trolley-conductor and the return-circuit and including the coils of the electromagnetic switches, an electrically-propelled car, a trolley or contact device on the car for simultaneously closing the circuit between the two conductors of the trolley-rail and supplying current to the motor, a source of electrical energy on the car for temporarily actuating the electromagnetic switches, a circuit on the car connecting said source of energy with the trolley or contact device, and automatic means for controlling the current passing to and from said source of electrical energy.

2. In an electric railway, the combination of a supply-conductor extending along the railway, a trolley-rail formed of two parallel conductors each divided into sections, branch conductors between the respective sections of one of the trolley-conductors and the supply-conductor, electromagnetic switches in said branch conductors, conductors between the corresponding sections for the other trolley-conductor and the return-circuit and including the coils of the electromagnetic switches, an electrically-propelled car, a trolley or contact device on the car for simultaneously closing the circuit between the two conductors of the trolley-rail and supplying current to the motor, a source of electrical energy on the car for temporarily actuating the electromagnetic switches, a circuit on the car for connecting said source of energy with the trolley or contact device, and a variable counter-electromotive-force generator in series with the said source of energy to protect it against the action of the current from the supply-conductor.

3. In an electric railway, the combination of a conductor extending along the railway and divided into sections, electromagnetic switches for successively bringing into circuit the said sections, a car, a motor on the car for propelling it receiving current from the sectional conductor, a battery on the car for temporarily energizing the electromagnetic switches, and a variable counter-electromotive-force generator in series with the battery and in parallel with the motor to protect the battery from the line-current and abnormal discharge.

4. In an electric railway, the combination of a conductor for supplying current to the car divided into sections, a supply-conductor, branch conductors between the sections and supply-conductor, armature-switches interposed in said branch circuits, sealed boxes wholly inclosing said armatures, and fixed electromagnets for operating the armatures exterior to said boxes.

5. In an electric railway, the combination of a conductor for supplying current to the car divided into sections, a supply-conductor, branch conductors between the sections and supply-conductor, armature-switches interposed in said branch circuits, sealed boxes wholly inclosing said armatures, electromagnets for operating the armature exterior to said boxes, inclosing cases for the magnets, and means leading to the car for energizing the magnets when the car reaches their vicinity.

6. In an electric railway, the combination of a supply-conductor extending along the railway, a trolley-rail formed of two parallel conductors each divided into sections, branch conductors between the respective sections of one of the trolley-conductors and the supply-conductor, electromagnetic switches in said branch conductors, conductors between the corresponding sections of the other trolley-conductor and the return-circuit and including the coils of the electromagnetic switches, a differential winding upon each of the electromagnets, auxiliary circuits respectively including the differential winding of the magnets and connected respectively with the last-mentioned sections of trolley-conductor in advance of the car as it moves over the railway, and circuit-closing devices controlled by the car for successively closing the auxiliary circuits as the car passes beyond the sections controlled by the magnets.

7. In an electric railway, the combination of a supply-conductor extending along the railway, a trolley-rail formed of two parallel conductors each divided into sections, branch conductors between the respective sections of one of the trolley-conductors and the supply-conductor, electromagnetic switches in said branch conductors, conductors between the corresponding sections of the other trolley-conductor and the return-circuit and including the coils of the electromagnetic switches, an electrically-propelled car, a trolley or contact device on the car for simultaneously clos-

ing the circuit between the two conductors of the trolley-rail and supplying current to the motor, a differential winding upon each of the electromagnets, auxiliary circuits respectively including the differential winding of the magnets and connected respectively with the last-mentioned sections of trolley-conductor in advance of the car as it moves over the railway, and circuit-closing devices controlled by the car for successively closing the auxiliary circuits as the car passes beyond the sections controlled by the magnets.

8. In an electric railway, the combination of a supply-conductor extending along the railway, a trolley-rail formed of two parallel conductors each divided into sections, branch conductors between the respective sections of one of the trolley-conductors and the supply-conductor, electromagnetic switches in said branch conductors, conductors between the corresponding sections of the other trolley-conductor and the return-circuit and including the coils of the electromagnetic switches, a differential winding upon each of the electromagnets, auxiliary circuits respectively including the differential winding of the magnets and connected respectively with the last-mentioned sections of trolley-conductor in advance of the car as it moves over the railway, and circuit-closing devices controlled by the electromagnets and operated by the car for successively closing the auxiliary circuits as the car passes beyond the sections controlled by the magnets whereby all magnets in the rear of the car are positively neutralized or cut out of the circuits.

9. In an electric railway, the combination of a supply-conductor extending along the railway, a trolley-rail formed of two parallel conductors each divided into sections, branch conductors between the respective sections of one of the trolley-conductors and the supply-conductor, electromagnetic switches in said branch conductors, conductors between the corresponding sections of the other trolley-conductor and the return-circuit and including the coils of the electromagnetic switches, a differential winding upon each of the electromagnets, auxiliary circuits respectively including the differential winding of the magnets and connected respectively with the last-mentioned sections of trolley-conductor in advance of the car as it moves over the railway, and electromagnetic circuit-closing devices controlled by the car for successively closing the auxiliary circuits as the car passes beyond the sections controlled by the first-mentioned magnets.

10. In an electric railway, the combination of a conducting-path for supplying current to the car divided into sections, a supply-conductor, branch conductors between the sections and the supply-conductor, electromagnetic switches in said branch conductors, a differential winding upon each of the electromagnetic switches, auxiliary circuits respectively including the differential winding of the magnets and connected respectively with the sections of the conducting-path in advance of the car as it moves over the railway, and circuit-controlling devices controlled by the car for successively closing electromagnetic switches and also the auxiliary circuits as the car passes beyond the sections controlled by the electromagnets.

In testimony of which invention I have hereunto set my hand.

BRUCE FORD.

Witnesses:
H. C. STIFF,
EDWARD OTT.