No. 646,229. Patented Mar. 27, 1900.

R. LUNDELL.

SURFACE CONTACT SYSTEM OF ELECTRIC RAILWAYS.

(Application filed July 12, 1899.)

(No Model.) 5 Sheets—Sheet 1.

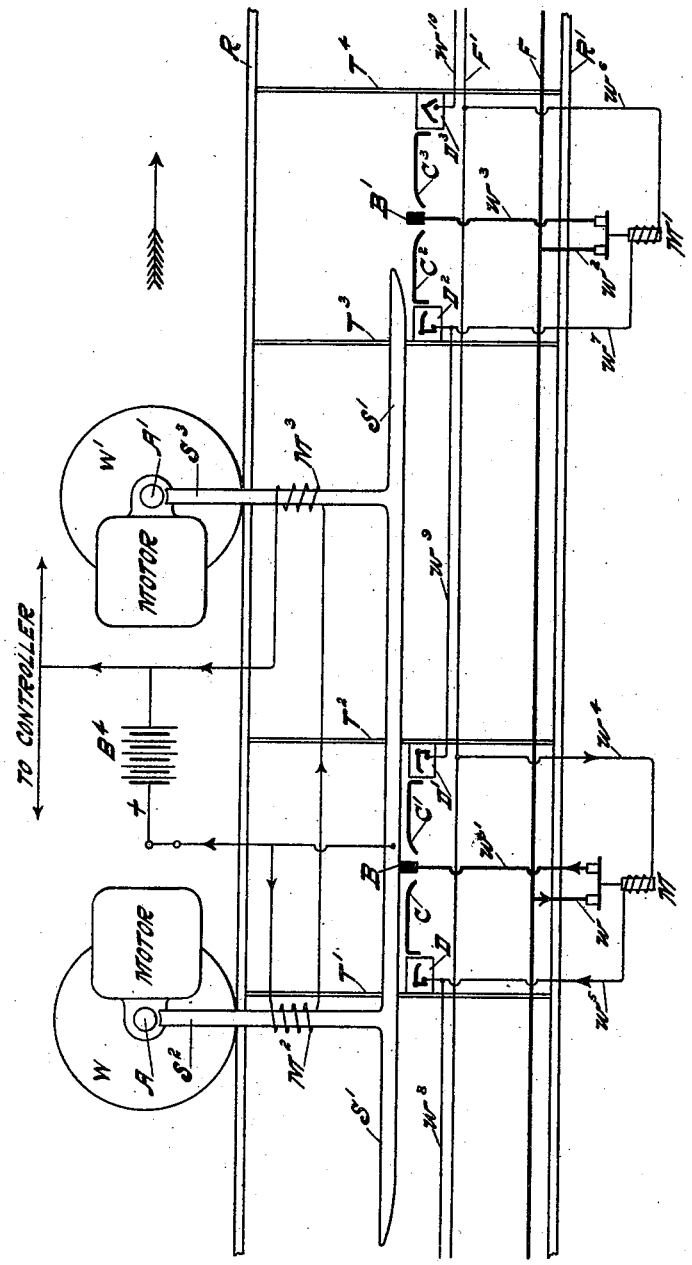

FIG. 1

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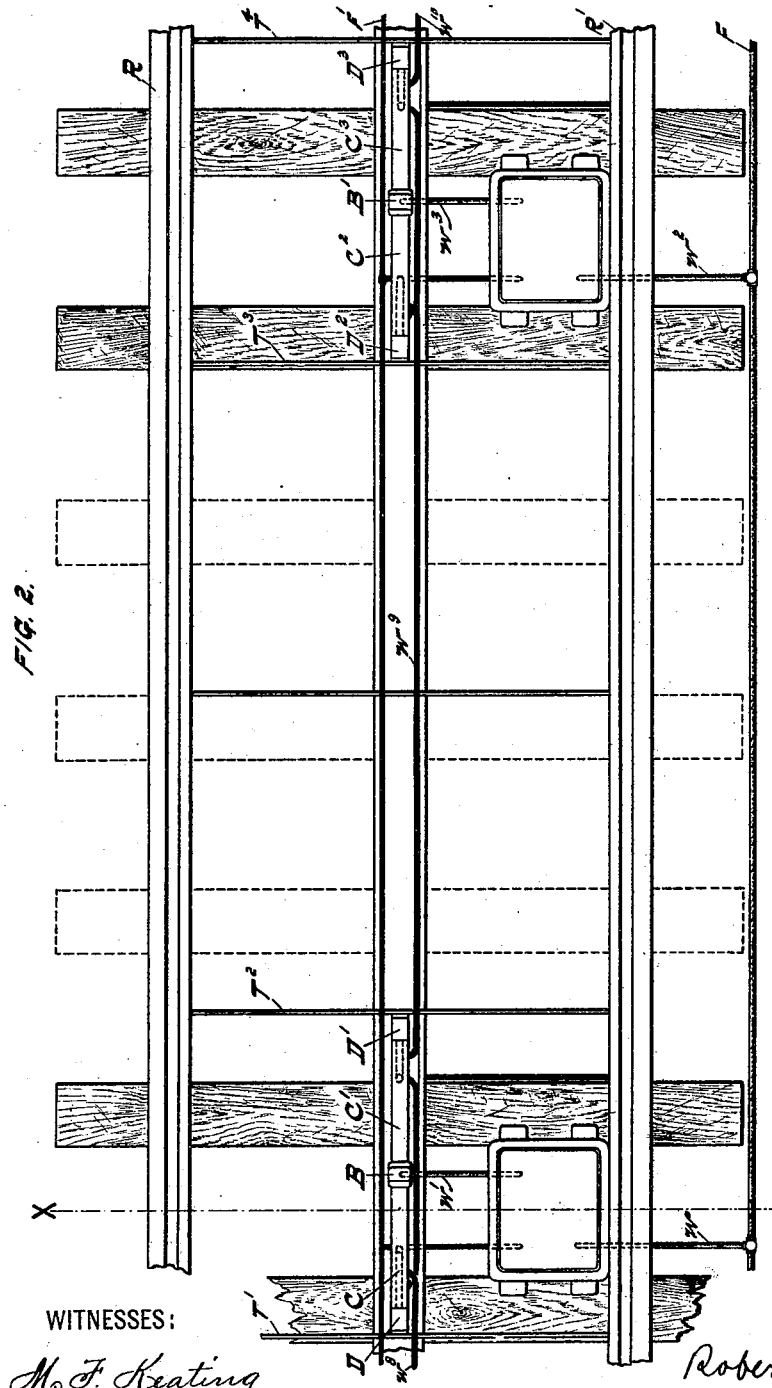

FIG. 2.

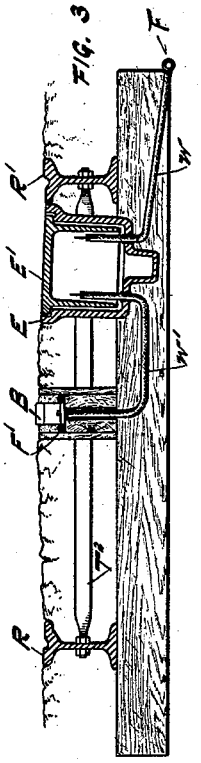

FIG. 3.

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(No Model.) 5 Sheets—Sheet 3.

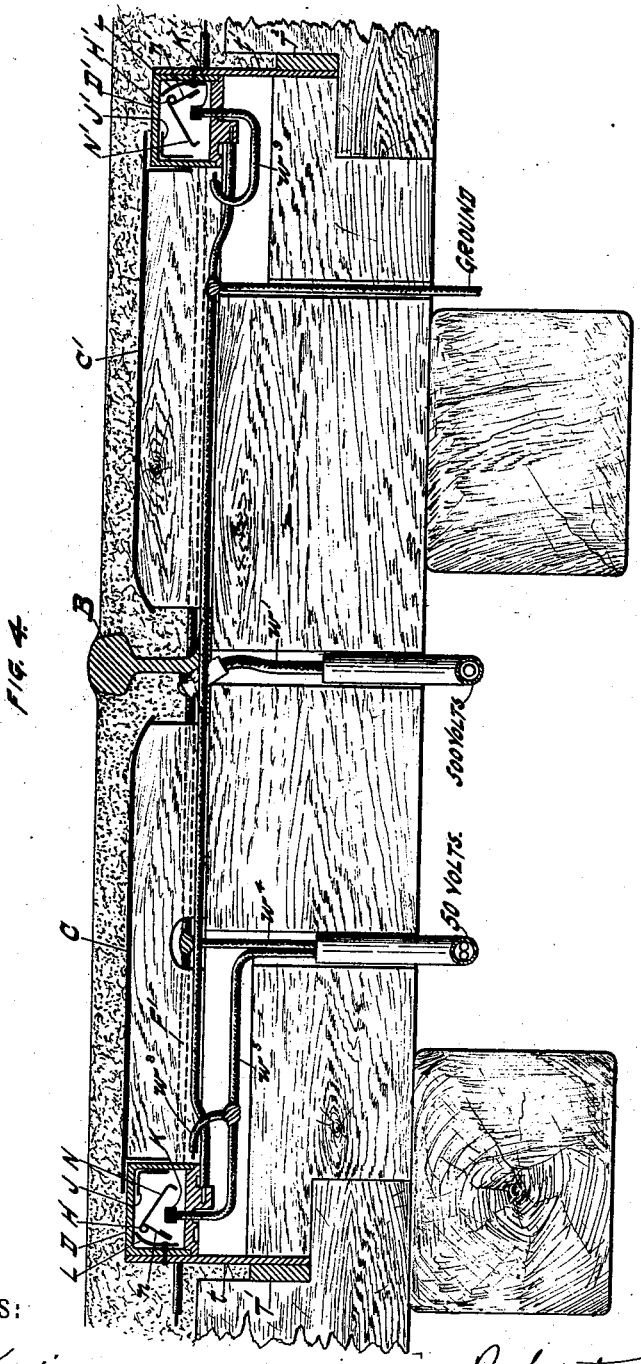

FIG. 4.

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FIG. 5.

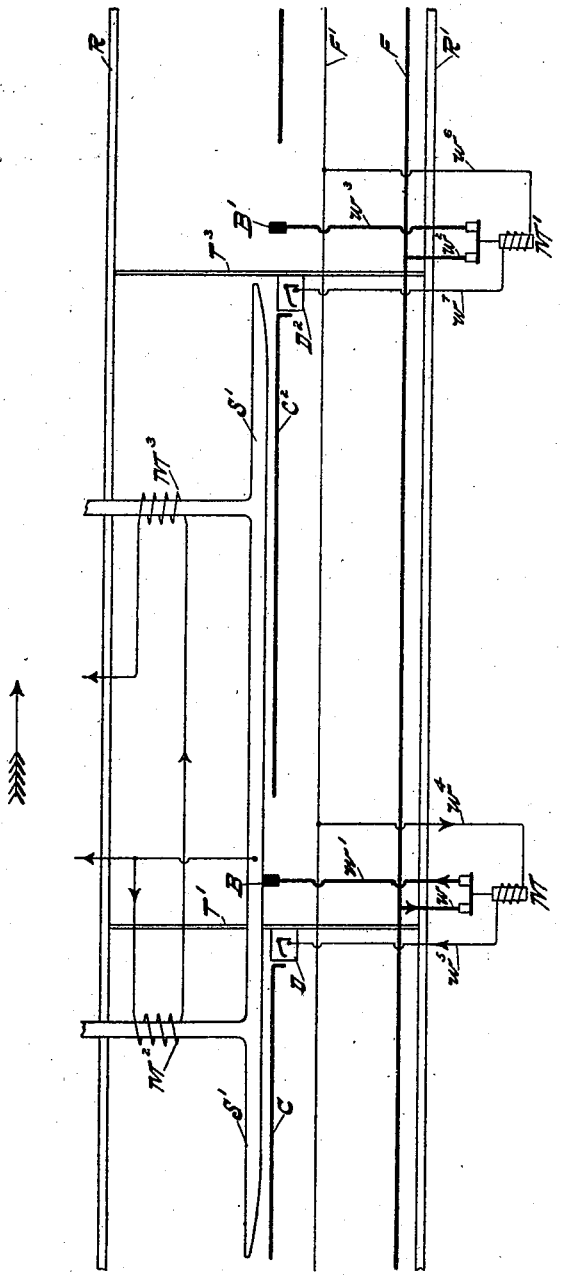

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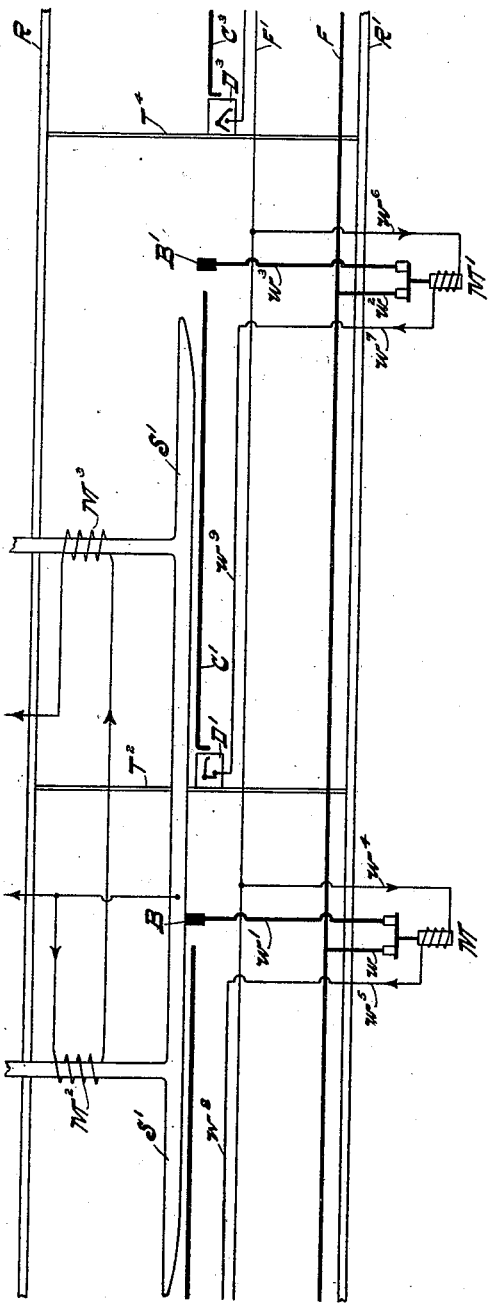
FIG. 6.



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UNITED STATES PATENT OFFICE.

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SURFACE-CONTACT SYSTEM OF ELECTRIC RAILWAYS.

SPECIFICATION forming part of Letters Patent No. 646,229, dated March 27, 1900.

Application filed July 12, 1899. Serial No. 723,601. (No model.)

To all whom it may concern:

Be it known that I, ROBERT LUNDELL, a citizen of the United States, residing at New York, in the borough of Manhattan, county and State of New York, have invented a new and useful Improvement in Surface-Contact Systems of Electric Railways, of which the following is a specification.

The present invention is directed to improvements in that type of electric railways known as "surface-contact" systems, and has special reference to the system described by me in prior United States patent, No. 625,512, in which system the sectional service-conductors were automatically made alive underneath a car by electromagnetic switches actuated by magnetic relays, which in turn were operated by a powerful magnetic field carried beneath the car and over the relays.

The invention has for its objects, first, to provide means whereby a requisite time allowance may be given to the electromagnetic switches and to the relays before they are called upon to perform their functions; second, to provide an efficient magnetic circuit between the magnetic field carried underneath the car and the magnetic relays, so that their operation may become infallible, and, third, to reduce the cost of the system by the simple and effective construction hereinafter described.

For a full and clear description of the invention reference is made to the accompanying drawings, in which—

Figure 1 represents a diagrammatic view of the electric and magnetic circuits underneath a car. In this diagram the track is shown in plan view, but the car-wheels, the motors, the current-collecting shoe, the relays, and the main magnets are represented in side elevational view to facilitate a clear understanding of the mode of operation. Fig. 2 is a plan view of the track as it will appear with its electric equipment. Fig. 3 shows a cross-section of the road-bed, taken on the line X X of Fig. 2, disclosing the main switch-box, a sectional service-conductor, track-rails, and a tie-rod joining said rails. Fig. 4 represents a longitudinal vertical section of the center of the road-bed, showing a sectional service-conductor, two relays with their pole-extensions, tie-rods, &c. Figs. 5 and 6 are diagrammatic views of modified forms of the invention.

Referring now to the drawings in detail, and particularly to Fig. 1, F represents a five-hundred-volt feeder or main, w w^2 branch feeders therefrom leading to fixed contact-points in electromagnetic switching devices M and M′, and w' w^3 are wires leading from opposite contact-points to sectional service-conductors B B′. F′ is a fifty-volt feeder or main with wires w^4 w^6 leading to the coils of the electromagnetic switches M M′, the other ends of the coils being connected with wires w^5 w^7 to fixed and normally-open contact-points or magnetic relays in hermetically-sealed boxes D D^2. The movable contact members in said boxes D D^2 are permanently connected to the ground or return conductor, so that when contact is established between the fixed and the movable members a current will flow through the coils of the magnets M M′, causing the switches to close, and thus establish connections between the sectional service-conductors B B′ and the five-hundred-volt feeder F. Supplementary magnetic relays of like construction (see D′ D^3) are placed ahead of their respective electromagnets and connected by wires w^8 w^9 w^{10}, &c., in parallel with the set of relays above referred to in such manner that a switch M′, for instance, can be closed by either one or both of the relays D′ D^2. R and R′ represent the track-rails. T′ T^2 T^3 T^4, &c., are iron tie-rods, which in this system serve the additional purpose of completing a magnetic circuit between the contact-shoe S′, the magnetic relays, and the track-rails. C C′ C^2 C^3, &c., are pole extensions for the magnetic relays D D′ D^2 D^3, &c., made of thin sheet-iron and embedded in the asphalt of the road-bed in a plane in the center thereof and about an inch below the contact-shoe S′. These pole extensions serve the purpose of collecting the magnetic lines of force from the shoe S′ and conducting the same into the vicinity of the free ends of the magnetic contact-needles contained in the relay-boxes D D′ D^2, &c., causing said free ends to be attracted and lifted upward until the lower non-magnetic parts of the contact-needles are stopped against the stationary con-

tacts above referred to. The other ends of said contact-needles are by means of additional downwardly-projecting pole extensions in magnetic proximity to the tie-rods above referred to. (See Fig. 4.) S^2 S^3 represent diagrammatically the magnetic cores of the contact-shoe S', around which the energizing-coils M^2 and M^3 are wound, which coils receive their energizing-current from a small storage battery B^4, carried on the car, or from the main motor-current, as the case may be. The upper portion of said magnetic cores are in close proximity to the car-axles A and A', as indicated in Fig. 1.

It will be noticed from inspection of the electric circuits leading from the storage battery B^4 to the contact-shoe S', to the controllers on the car, and to the coils M^2 M^3 of the magnetic cores that said cores will be magnetized either by the battery-current or by the main motor-current in such manner that their lower ends will have north polarity and their upper ends south polarity. If their lower ends are, as is the case, joined together by the steel shoe S', it follows that the magnetic lines of force will travel in the following manner: from cores S^2 S^3 to shoe S', to the soft sheet-iron pole extensions C C' C^2 immediately underneath the same, to the free ends of the magnetic needles in the relay-boxes, through the needles to the downwardly-projecting pole extensions on the other side of the relay-boxes, to the tie-rods T', T^2, and T^3, where the lines of force divide themselves, one half flowing one way to the track-rail R, the other half flowing the opposite way to the track R', and hence through car-wheels and car-axles to the upper ends of the magnetic cores S^2 S^3, thus completing the circuit. As the car travels forward the magnetism remains constant in the contact-shoe S', cores S^2 S^3, car-axles A A', and in the car-wheels W W'; but it travels along the rails in very much the same manner as the magnetism in an armature-core which is rotated in front of a pole-piece. It will thus be understood that the magnetic needles in the relay-boxes, with their thin annealed sheet-iron pole extensions and tie-rods, are the only parts required to quickly receive their magnetization, which parts, on account of their small dimensions and magnetic properties, should respond to magnetic changes as readily as the laminated cores of an alternating-current transformer.

The operation of the electric circuits is as follows: Assume the car is traveling in the direction of the arrow, from left to right in the position of the car indicated in Fig. 1. The sectional conductor B is made alive by reason of the relay D being closed, which in turn has closed the electromagnetic switch M in a manner previously described. Said sectional conductor B is now supplying current from the five-hundred-volt feeder F to the motors, and, if the current happens to be strong enough, also to the magnets M^2 M^3 and to the battery B^4, charging the same, as indicated on the diagram. The relays D' and D^2 will also be closed, and the electromagnetic switch M' has had time to close while the shoe S' traveled from the pole extension C' of relay D' to the pole extension C^2 of relay D^2. In other words, the relay D' serves the purpose of closing the switch M' ahead of the contact-shoe, so that the sectional conductor B' may be alive and ready for service before it has been reached by the traveling contact-shoe. Relay D^2 will keep the switch M' closed while current is being supplied from the sectional conductor B' in the same manner as shown by the relay D, switch M, and sectional conductor B on the diagram.

Referring now to Figs. 2, 3, and 4, R and R' represent the two track-rails; B and B', a couple of sectional service-conductors, which consist of short pieces of ordinary T-rail, as clearly shown by Figs. 3 and 4. Said sectional conductors are fastened to an insulating block or stringer, preferably made of asphalt-treated wood built up in suitable sections, which in turn are fastened to the cross-ties. To the sides of this stringer are spiked asphalt-treated pieces of board standing on end, as shown in Fig. 3, the whole forming a continuous narrow trough in which (in addition to the sectional conductor B' B^2, &c.,) the relay-boxes D D' D^3 D^4, &c., with their pole extensions, wires w^8 w^9 w^{10}, &c., and fifty-volt feeder F' are contained. This trough is filled with the best kind of insulating-asphalt around the sectional conductors and relay-boxes, and the top layer is made extra hard and smooth, so as to form a good surface for the contact-shoe to slide on. The sectional conductors B B', &c., project only a very slight distance (about one-fourth of an inch) above the asphalt surface, just enough to insure good contact with the traveling contact-shoe. E represents the cast-iron switch-box, with its cover E', in which the electromagnetic switch (not shown in Fig. 3) is contained. This switch is preferably of substantially the same construction as the one described in my prior United States patent, No. 590,420. F is the five-hundred-volt main, and w is a branch connection therefrom leading to a normally-open contact-point in the switch, and w' is the wire which connects the opposite contact-point in the switch with the sectional service-conductor B. Fig. 4 shows clearly the relay-boxes D and D', which are made of brass or other non-magnetic material. N and N' are the magnetic needles above referred to. They are made of well-annealed sheet-iron, (about one thirty-second of an inch thick,) and they are loosely hinged at points H H', at which points they are in permanent electrical connection with the boxes D and D'. Said boxes are in turn connected to the ground or return conductor. The free ends of the magnetic needles are, as previously stated, in the vicinity of the pole-piece extensions C and C' and swing in close proximity to additional pole-piece extensions J and

J′ inside the boxes when magnetized by the traveling contact-shoe. The lower parts *n* and *n′* of the needles are made of spring-copper or other non-magnetic material and are adapted to make contact against the insulated carbon-points K and K′, which are permanently connected to their respective switch-coils, as shown on diagram Fig. 4. At the hinged ends of the needles N and N′ are placed other sheet-iron pieces L and L′, inside the boxes, for the purpose of reducing the magnetic reluctance between the needles and the downwardly-projecting pole-piece extensions *t* and *t′* on the other side of the relay-boxes.

In Fig. 5 is illustrated diagrammatically a modified form of the invention, in which the relays D′ D^3 and polar extensions C′ C^3 and the accompanying conductors w^9 w^{10} for closing the circuit to the next sectional service-conductor B′ in advance of the current-collecting shoe S′, as illustrated in Fig. 1, are done away with, the function attributable to said parts being accomplished in this instance by arranging the polar extensions C C^2 as shown, each having a length approximating the distance between the boxes D D^2 and the sectional service-conductors B B′, with their downwardly-turned ends resting against said boxes and in close proximity to the free ends of the magnetizable needles inclosed therein. With this modified form of the invention immediately after the front end of the current-collecting shoe S′ reaches the contact B in passing from left to right in the direction of the arrow the polar extension C^2 becomes magnetized, and therefore acts upon the magnetic needle in the box D^2, thus causing the switch-magnet M′ to actuate its switch and close the contacts between the branch feeders w^2 w^3 to the sectional service-conductor B′, thereby affording a requisite time allowance for the action of the switches, it being obvious that by reason of the magnetic relation of the shoe S′ and long magnetic polar extensions C^2, lying parallel with and in close proximity thereto, there will be given sufficient magnetic effect upon the latter during the passage thereover to actuate the switch next in advance under all conditions of speed.

Fig. 6 represents diagrammatically still another modified form of the invention, in which the relays D D^2 and polar extensions C C^2, as illustrated in Fig. 1, are done away with. The relays D′ D^3 are turned around and their laminated polar extensions C′ C^2 are extended toward the sectional conductors in advance of the relays, as shown on the diagram. In this form a switch M′, for instance, is given the requisite time allowance to close by reason of the controlling-relay D′ being placed ahead of the switch and its sectional conductor B′. The long polar extension C′ serves to keep the relay D′ and the switch M′ closed until the contact-shoe S′ has left the sectional conductor B′.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. In an electric-railway system of the described type a current feeder or main; a series of sectional service-conductors and electromagnetic switching devices with relays for actuating said switching devices, in combination with means for causing each relay and switching device to connect to the main that sectional service-conductor next in advance to the one which is supplying current to the motor through the current-collecting shoe, so that it is made alive and ready for service before it has been reached by said shoe.

2. In an electric-railway system of the described type a current feeder or main, a series of sectional service-conductors normally disconnected therefrom; a series of relays and electromagnetic switching devices for connecting said sectional service-conductors with the current feeder or main in sequence; in combination with means for causing each relay and switching device to connect the corresponding service-conductors to the current feeder or main before the current-collecting shoe reaches it.

3. In an electric railway a current feeder or main including a source of electrical energy, a series of sectional service-conductors and electromagnetic switching devices for operatively connecting said service-conductors in sequence to the current feeder or main; means in the nature of a conducting contact-shoe carried by the car and adapted to bridge the space between the successive pairs of sectional conductors; in combination with two sets of stationary relays for operating said electromagnetic switching devices, said relays being so interconnected that when one of the sectional service-conductors is supplying current to the propelling-motor on board of the car the sectional service-conductor next in advance and not yet in contact with the contact-shoe is operatively connected with the current feeder or main, substantially as described.

4. In an electric railway a current feeder or main including a source of electrical energy, sectional service-conductors and electromagnetic switching devices for operatively connecting said sectional service-conductors in sequence to the current feeder or main; means carried by a car or vehicle for conducting current from said sectional service-conductors to and through an electric motor located therein, in combination with two sets of stationary relays for operating said electromagnetic switching devices, said relays being included in circuit with a separate or independent source of electrical energy and so interconnected that when one of the sectional conductors is operatively connected to and through the propelling-motor, the next sectional service-conductor in advance is operatively connected to the current feeder or main, thereby establishing a requisite time allowance to the electromagnetic switching

devices as the car or vehicle advances, substantially as described.

5. In an electric-railway system of the described type, a current feeder or main including a source of electrical energy, in combination with sectional service-conductors normally disconnected therefrom; switching devices located in circuit with an independent source of electrical energy and adapted to close the circuit from the current feeder or main through the sectional service-conductors in sequence; means carried by the car for conducting the current from the sectional service-conductors to a propelling-motor on the car, said switching devices being so constructed and arranged that when the current is being conveyed from a given sectional conductor through the propelling-motor, the next sectional conductor adjacent thereto is operatively connected to the current feeder or main and before the current-carrying means comes into mechanical and electrical contact therewith, whereby a requisite time allowance is effected for the operation of the switching devices, substantially as described.

6. Means for establishing a magnetic field underneath a tram-car supported by magnetizable tram-rails, wheels and axles, consisting of a magnetizable shoe located substantially parallel with the tram-rails and in magnetic proximity to the axles of the vehicle; in combination with means for giving to said shoe magnetism of a definite polarity, together with magnetizable tie-rods connecting the tram-rails, the arrangement being such that magnetic lines of force are caused to flow through the shoe, the cross-ties, rails, wheels and axles of the vehicle, substantially as described.

7. Means for establishing a magnetic field underneath a tram-car supported by magnetizable tram-rails and wheels consisting of a magnetizable shoe located substantially parallel with the tram-rails, in combination with magnetizable tie-rods located in close proximity to said shoe and uniting the tram-rails; together with means for giving to the shoe magnetism of a definite polarity and to the wheels and rails upon which the car stands magnetism of a reverse polarity, substantially as described.

8. In an electric-railway system of the described type a current feeder or main including a source of electrical energy, in combination with sectional service-conductors normally disconnected therefrom; electromagnetic switching devices adapted to connect said sectional service-conductors to the current feeder or main in sequence; magnetic relays adapted to control the movements of the switching devices; together with means in the nature of a magnetizable shoe carried by the car and adapted to bridge the space between successive pairs of sectional service-conductors, said magnetizable shoe being provided with means for giving to it a definite magnetic polarity, and to the wheels and tram-rails which support the vehicle magnetism of opposite polarity, substantially as described.

9. In an electric railway of the described type a series of relays consisting of magnetizable needles pivotally supported in water-tight boxes in the road-bed, in combination with a magnetizable pole-piece or extension located in proximity to each of said needles for concentrating the magnetic lines of force and causing the needles to move with greater certainty of action, substantially as described.

10. In an electric railway of the described type a series of relays having each a magnetic needle inclosed in a non-magnetic box located in the road-bed, in combination with magnetizable pole-pieces or extensions located in a plane in the center of the road-bed and in proximity to said needles for concentrating the magnetic lines of force and causing the needles to move with greater certainty of action, substantially as described.

11. In an electric railway of the described type a current feeder or main including a source of electrical energy, sectional service-conductors normally disconnected therefrom, and electromagnetic switching devices for operatively connecting said sectional service-conductors in sequence with the current feeder or main; means, in the nature of a magnetizable shoe, carried by a car or vehicle for conducting current from said sectional service-conductors to and through an electric motor located on the car, stationary relays for operating said electromagnetic switching devices, said relays being included in circuit with a separate or independent source of electrical energy and consisting of magnetizable needles inclosed in water-tight boxes; in combination with magnetizable pole-pieces or extensions, one for each needle, located in proximity thereto, said needles and pole-pieces being located in close proximity to the magnetizable shoe; together with means carried by the car for giving to the magnetizable shoe magnetism of a definite polarity, all of said parts acting substantially as and for the purpose set forth.

In testimony whereof I have hereunto subscribed my name this 10th day of July, 1899.

ROBERT LUNDELL.

Witnesses:
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M. F. KEATING.