(No Model.) 2 Sheets—Sheet 1.

F. B. BADT.

ELECTRIC RAILWAY.

No. 480,543. Patented Aug. 9, 1892.

FIG. 1.

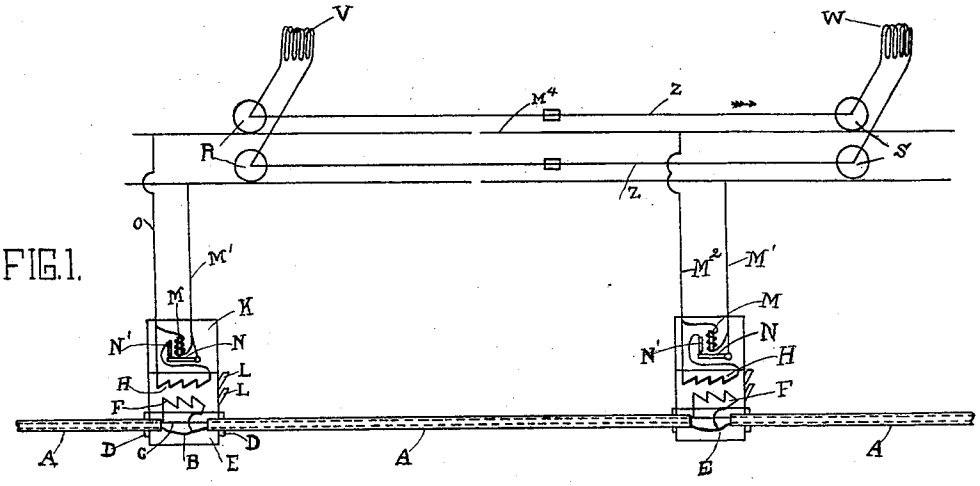


FIG. 2.

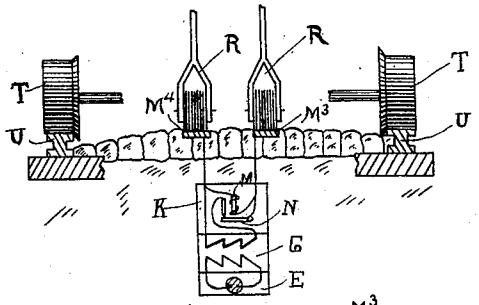
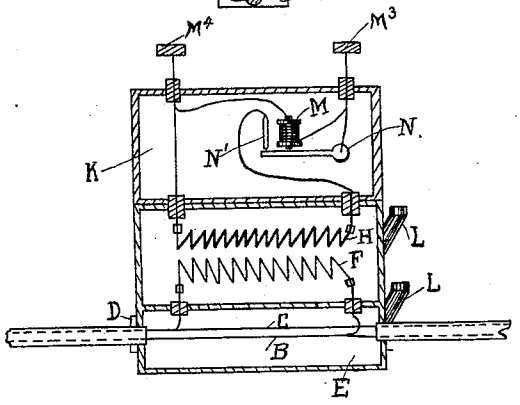


FIG. 3.



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(No Model.) 2 Sheets—Sheet 2.

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ELECTRIC RAILWAY.

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FIG. 4.

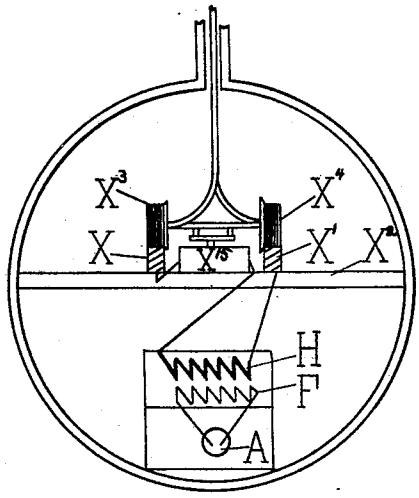
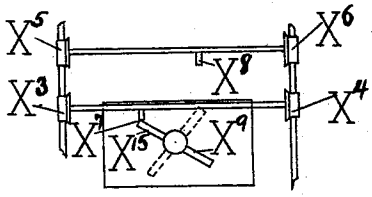


FIG. 5.



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UNITED STATES PATENT OFFICE.

FRANCIS B. BADT, OF CHICAGO, ILLINOIS, ASSIGNOR OF TWO-FIFTHS TO LESTER S. HILLS AND A. M. SEARLES, OF SAME PLACE.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 480,543, dated August 9, 1892.

Application filed December 19, 1891. Serial No. 415,668. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS B. BADT, a subject of the King of Prussia, residing at Chicago, Cook county, Illinois, have invented a new and useful Improvement in Electric Railways, of which the following is a specification.

My invention relates to improvements for operating electric street-railways, and particularly concerns itself with means for and methods of supplying current from underground cables or main conductors to a moving car on the surface. It is illustrated in the accompanying drawings, wherein—

Figure 1 is a diagrammatic view of the parts in their relative vertical positions. Fig. 2 is a similar partly-diagrammatic cross-section. Fig. 3 is an enlarged detail of the transformer and its associated parts. Fig. 4 is a cross-section showing the application of the device in an ordinary underground conduit. Fig. 5 is a detail of a mechanical switch.

Like parts are indicated by the same letter in all figures.

A is an underground cable containing two conductors B C, which may be arranged in any desired manner with reference to each other. The cable proper is composed of successive sections, each of which is securely let into the side of the box E by means of the stuffing-box D. Within this box the main conductors may be bared and a hand-hole provided and from them lead the terminals of the primary coil F, contained within the converter-box G and in opposition to the secondary coil H, whose terminals lead through the stuffing-boxes J J into the switch-box K. The boxes E and G are preferably tightly filled by means of the funnels L L with oil of such character as to assist in insulation. In the box K is located the switch consisting of the electro-magnet or solenoid M, which is included in the local circuit composed of the conductors M′ M^2, leading, respectively, from the sectional rails M^3 M^4. Opposed to the electro-magnet or solenoid M is the pivoted armature N, normally disengaged from the contact-block N′, which forms one extremity of the conductor which leads from the secondary converter-coil. The other conductor O from the secondary leads through the stuffing-box O′ to the sectional rail M^4. The funnels L L and the hand-hole may be sealed in any desired manner after the oil is introduced. Thus the sealing and insulating of the wires within these chambers are accomplished. The armature N may be held away from the contact-point N′ by spring, gravity, or otherwise, as may be convenient. The rails M^3 M^4 are made in successive fairly-well insulated sections laid upon the surface. These sections may be of any suitable length, but preferably, as shown, slightly less in length than the distance between the trolley-wheels R R and S S.

T T are the wheels of the cars running on the rails U U and carrying the motors V W.

The switch device is designed, as hereinafter explained, to throw the conductor-rails next in advance of the car into circuit in time to permit these rails to furnish the working current as soon as the car is moved forward over them to the proper position.

In Fig. 4 I have shown a modification of my device in diagram, exhibiting its application to conduits already constructed. Here the rails X X′ may be supported on the cross-bars X^2 and receive, respectively, the trolleys X^3 X^4, which are connected in any suitable manner with the moving car above. One of the rails X′ may be connected with one extremity of the secondary converter-coil H and the other by means of the switch X^{15} with other rails. I have shown here a switch-box; but in Fig. 5 I show more in detail a mechanical switch which will serve the purpose of making the circuit when the car has approached the rails through which it is desired to have the current led. In this case, as before, the rails are sectional and insulated to a degree and two sets of trolley-wheels are used, one preferably associated with the forward end and the other with the rear end of the car. The forward trolley-wheels are called K^3 X^4, and the rear may be indicated by X^5 X^6; but the forward set has a downwardly-depending pin X^7 and the rear set has a similar pin X^8. The switch-handle X^9 on the box X^{15} is normally in the position shown in full lines in Fig. 5 and the circuit is broken. As the forward trolley-track is carried on by the car the pin X^7 engages the end of the handle and carries it round to

something like the position shown in the dotted lines, where the circuit is closed and remains closed until the rear trolley, coming up with its pin X^8, restores the parts to their original position.

The use and operation of my invention are as follows: Given an underground cable arranged and disposed as indicated in the diagrams, there will be in such cable two or more conductors, preferably carrying a high potential alternating current or multiphase currents—as, for example, a current of two thousand volts. Such current or currents pass through the primary coils of each converter, preferably connected in parallel to the primary wires, and when the local secondary circuit is closed will generate in such local circuit a low potential—say fifty-volt current—which is to be used to drive motors on the cars. If for any reason the local circuit is closed, no particular loss of current ensues, for the insulation easily obtained is substantially sufficient to confine the current of such low voltage. Moreover, if by any possibility a local short circuit should be completed by accident small damage, if any, would be done on account of the low voltage of the local current. Suitable fuse-plugs would be placed in any or all of the circuits or connections, as desired, for the purpose of insuring safety, and the car is preferably provided with two motors, though more or less could be used, and with two sets of trolley-wheels, brushes, or rollers or the like. One set will be placed forward on the car and the other toward the rear. The conductor rails or strips are preferably arranged between the tracks or rails on which the car is supported, and consist each of successive sections insulated in the ordinary manner and so far as may be convenient from each other. These sections are each slightly less in length than the distance between the two sets of trolleys. Various means may be devised for closing the switch in the first instance to start the car—as, for example, a storage-battery cell or two may be associated with the car. Assuming that current taken up by the forward trolleys is being passed through the motors on the car and through the magnet of the switch to hold its armature up and the circuit closed, the car will of course tend to move forward under the action of its motors. Its forward motion speedily carries the forward trolleys toward the next succeeding set of conductor rails or strips. The rear trolleys will, however, at such time necessarily be on the set of rails or strips in the rear of those against which the forward trolleys act. Thus current is being supplied to operate the car and to keep the rear rail-sections in circuit through the rear trolley. At the same time the forward trolleys, being connected, as shown, with the rear trolleys, a circuit is closed through the switch associated with the next converter, and a sufficient current is diverted through such circuit to close the switch or lift up the armature and complete the circuit through the secondary coil of the forward converter. This brings the forward trolleys into circuit and they lead a current through the motor or motors of the car. When the rear trolleys pass off of the set of conductor-rails on which they are acting, they will of course cause the release of the switch and the local circuit connected with these rails will be broken; but before this action takes place, since the conductor-rails are somewhat less in length than the distance between the trolleys, the forward trolleys will have passed onto the second successive or forward conductor-rails and will have brought them into circuit and the current will be supplied through them, as last above described. Now when the rear trolleys pass onto the next set of rails they will be thrown into circuit in a manner similar to that last above described. Thus there will be a successive making of circuits by one set of trolleys for the other set; but at least one set will always be in circuit and the car-motors will always be receiving current from one and the greater portion of the time from both trolleys. To more particularly describe this relation and the circuits, I may add that in the position shown in Fig. 1 the local circuit with the motor V is as follows: From the secondary coil H through the conductor O to rail M^4 to trolley R, through motor V back to the other trolley R and rail M^3, thence through conductor M′ to the armature N to contact N′ to the other extremity of the secondary coil H, and current is being furnished to this motor at the same time, and by means of the conductors Z Z current is led to the forward trolleys S S, and from them a local circuit is completed through the conductors M^2 M′, including the magnet M. This magnet is therefore energized and draws up its armature and thus closes the local circuit, which includes the rail-sections upon which the trolleys S S are resting. This circuit will so remain closed as long as there is current passing through either of the motors or received by either of the sets of trolleys, and in the same manner the circuit on the rear set of trolleys would be closed or kept closed. The circuit received by either set of trolleys is momentarily broken at the point of separation between the ends of the adjacent rails; but one set of trolleys being always in circuit the two switches are always closed after the car is started.

Referring to the mechanical switch, which might of course be substituted, the motion of the forward trolley with its projecting pin closes the switch, while the rear trolley following lifts it open; but one mechanical switch will thus always be closed and one set of trolleys will be receiving current. The trolleys, as shown, are arranged in two sets of two trolleys each, and they may, for convenience, be called "fore-and-aft" trolleys. The circuits from one rail through the electromagnet or solenoid to the other rail and from one rail to the other through the secondary coil of the converter I call "part circuits."

The rails are in sections, and the sections may be described as arranged in "sets," meaning thereby the two opposite or associated rails.

I claim—

1. In an electric-railway system, the combination of exposed conductor-rails arranged in sections and adapted to be brought into circuit with the moving motor with insulated main conductors, a series of converters, each having a primary coil permanent in the main circuit and a secondary coil having a part circuit terminating at each end in one exposed rail, said part circuit normally open, and devices to close the same on the approach of the car, said devices including a permanently-closed conductor between the rails with which the ends of such part circuits are connected.

2. In an electric-railway system, the combination of exposed conductor-rails arranged in sections and adapted to be brought into circuit with the moving motor with insulated main conductors, a series of converters, each having a primary coil permanently in the main circuit and a secondary coil having a part circuit terminating at each end in one exposed rail, said part circuit normally open and devices to close the same on the approach of the car, said devices comprising a permanently-closed conductor between the rails with which the ends of such part circuits are connected, and an electro-magnet or solenoid about which such conductor passes.

3. In an electric-railway system, the combination of exposed conductor-rails arranged in sections and adapted to be brought into circuit with a moving motor with insulated main conductors, and a series of converters, each having a primary coil permanently in the main circuit and a secondary coil having a part circuit terminating at each end in one exposed rail, said circuit normally open and devices to close the same on the approach of the car, and fore-and-aft trolleys in multiple and adapted one set to furnish the current which operates such devices associated with the other set.

4. In an electric-railway system, the combination of exposed conductor-rails arranged in section and adapted to be brought into circuit with a moving motor with insulated main conductors, and a series of converters, each having a primary coil permanently in the main circuit and a secondary coil having a part circuit terminating at each end in one exposed rail, said circuit normally open and devices to close the same on the approach of the car, and fore-and-aft trolleys in multiple and adapted the one set to furnish the current which operates such devices associated with the other set, said devices including each a permanently-closed conductor between the two rails with which the ends of the open part circuit are to be controlled are connected.

5. In an electric-railway system, the combination of exposed conductor-rails arranged in sections and adapted to be brought into circuit with a moving motor with insulated main conductors, and a series of converters, each having a primary coil permanently in the main circuit and a secondary coil having a part circuit terminating at each end in one exposed rail, said circuit normally open and devices to close the same on the approach of the car, and fore-and-aft trolleys in multiple and adapted one set to furnish the current which operates such devices associated with the other set, the shortest distance between the fore-and-aft trolleys being greater than the length of the rail-sections.

6. In an electric-railway system, the combination of an insulating high-tension-current system permanently including the primary coils of successive converters, with local low-tension part circuits normally open and including each the secondary of one converter and terminating in the partially-insulated but exposed sectional conductors from which the moving motor derives its current and a switch in each of such local circuits, and fore-and-aft trolleys arranged in sets, each set adapted to supply current to close the switch and thus close the local circuit for the time being, associated with the other set and also to supply current to the motor to run the car.

7. In an electric-railway system, the combination of high-tension-current mains with converters whose primary coils are permanently in circuit, exposed sectional conductors with which the motor on the car is adapted to be connected, local part circuits whose terminals are opposite rails, one of such local circuits normally broken and containing the converter secondary coil and the other permanently closed, and means connected with the latter to close the former responsive to a current delivered from the car.

8. In an electric-railway system, the combination of high-tension-current mains with a series of primary converter-coils in multiple therewith, a series of exposed sectional conductors arranged in sets, the secondary coil of each converter connected in multiple with one set of rails by a normally-broken local part circuit, a motor on the moving car, trolleys on such car in multiple and adapted to simultaneously engage the rails of a set, and means operated from the car to close such local circuit.

9. In an electric-railway system, underground insulated high-tension mains, a triple compartment-box through one compartment of which said mains pass, converter-coils in the second compartment, and a local circuit-switch mechanism in the third compartment, suitable conductors connecting the elements in the various compartments, and two conductors leading, respectively, to the conductors from which the motor on the car receives its current.

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