No. 678,086. Patented July 9, 1901.

G. T. WOODS.

ELECTRIC RAILWAY SYSTEM.

(Application filed July 24, 1895.)

(No Model.)

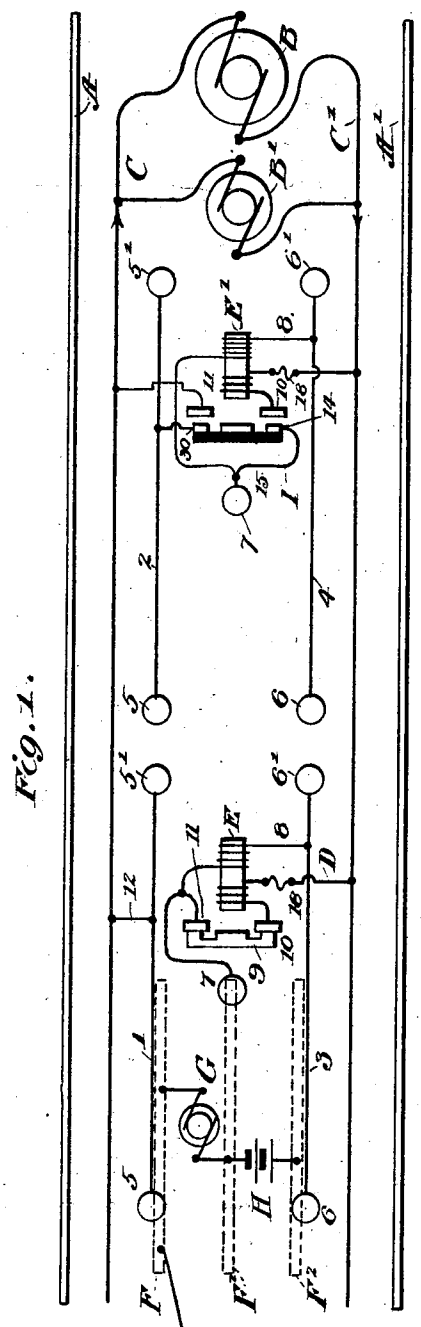

Fig. 1.

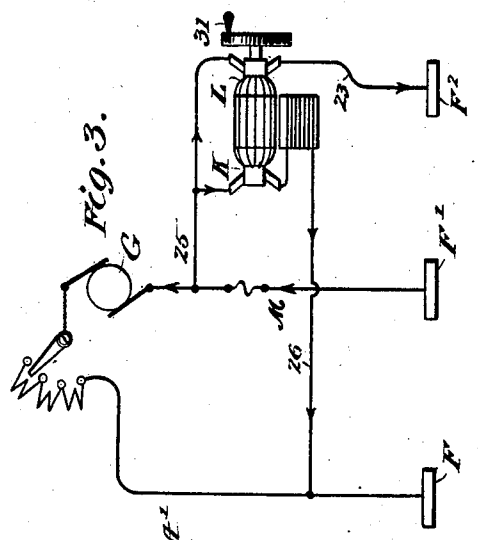

Fig. 3.

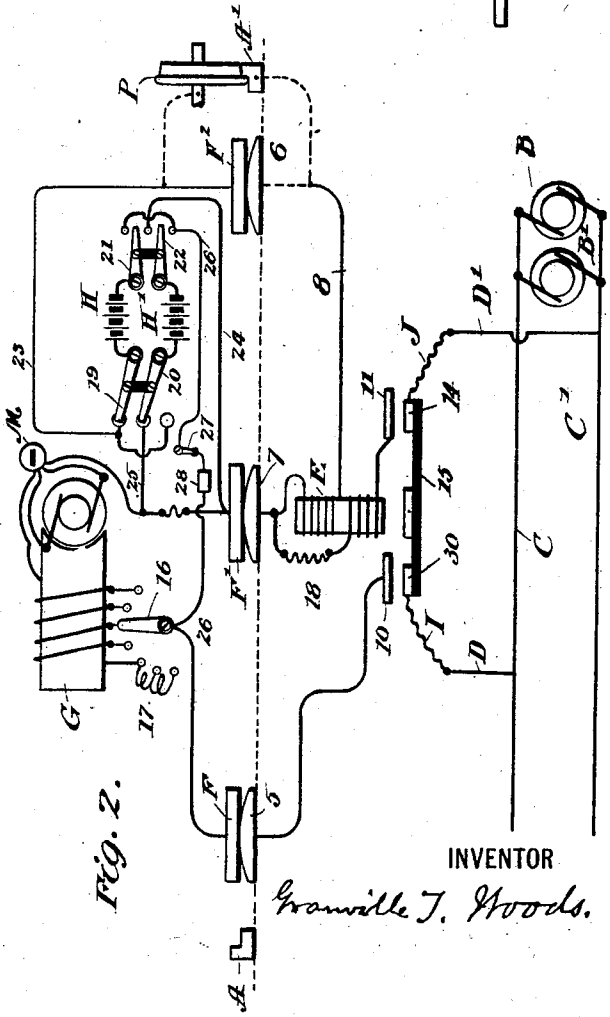

Fig. 2.

WITNESSES:

Henry T. Hazard.

W. K. Capel.

INVENTOR

Granville T. Woods.

UNITED STATES PATENT OFFICE.

GRANVILLE T. WOODS, OF NEW YORK, N. Y., ASSIGNOR TO THE ELECTRO-MAGNETIC TRACTION COMPANY, OF WASHINGTON, DISTRICT OF COLUMBIA.

ELECTRIC-RAILWAY SYSTEM.

SPECIFICATION forming part of Letters Patent No. 678,086, dated July 9, 1901.

Application filed July 24, 1895. Serial No. 557,045. (No model.)

To all whom it may concern:

Be it known that I, GRANVILLE T. WOODS, a citizen of the United States, and a resident of New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in Electric-Railway Systems, of which the following is a specification.

My invention relates to electrical-railway systems, and particularly to that class of such systems wherein the current for driving the car-motor is taken from working conductors upon the road-bed, to which through the agency of electromagnetically-controlled switches along the line of way the current is fed only at the time the collectors on the car are in engagement with said conductors.

The object of this invention is to construct a system of this sort in the simplest and most economical manner consistent with reliability in action and durability.

To this end my invention consists in the construction, combination, and arrangement of parts hereinafter described, and fully set forth in the claims.

In the accompanying drawings, which form a part of this invention, Figure 1 represents diagrammatically a plan of the system. Fig. 2 is a diagrammatic representation of a section through the road-bed and of a modified arrangement of the apparatus upon the car. Fig. 3 is a similar representation of a modified form of car apparatus.

In the drawings, A A′ represent the track-rails, which by preference are in no wise connected to the circuit, though obviously one or both might be used on the return, particularly in elevated structures, where no harm could result therefrom.

B B′ indicate principal and auxiliary generators, respectively, for supplying current. From these the lead or feeding circuit C′ and return-circuit C extend along the line of way or road and are suitably insulated in any well-known manner. They are preferably placed under the pavement between the rails, though they may be otherwise disposed.

Along the road series of working circuit conductors or contacts are placed. In a surface road these are preferably located in the pavement and between the track-rails and insulated in any suitable manner. They are graphically represented as circular blocks 5 5′, 6 6′, and 7, though they may obviously be of any other shape. By preference, however, to reduce the extent of exposed conductors I make them as shown. To minimize the number of switches controlling the flow of current to the working conductors, I connect the conductors of two of the series in pairs longitudinally of the line of way, as by buried connections, such as seen at 1, 2, 3, and 4, joining the contacts 5 5′ and 6 6′. The pairs thus formed may be considered as constituting sections. The pairs 1 and 2 of return-circuit conductors may be directly connected to return-circuit C, as by wire 12, or they may be connected thereto through one of the switch-contacts, as seen at section 2. The other pairs or sections represented by sections 3 and 4 each constitute one terminal of a local or pick-up circuit, while the conductors 7 each constitute the other terminal of said circuit and at the same time are the terminal of each branch D D′ of the feeder-circuit.

The electromagnetic switches for controlling the flow of current to the working conductors may be variously constructed. I preferably, however, use one in which the circuit is initially closed from a source of current carried on the cars and which when closed will be so maintained by the power-current as it flows through the car-motor. The switch-magnets may be of any suitable form, though I have shown them at E as having a single core bearing two coils, one of which is designed to initially energize the magnet for drawing up or picking up the armature to close the switch-contacts, while the other is in the motor-circuit to hold the switch closed so long as the motor is taking circuit over that particular branch. The switch at section 1 3 has an armature 9, provided at its ends with contacts for engagement with contacts 10 and 11 at either side of a break in the branch D, which branch passes about the core E of the magnet, as illustrated. The other or pick-up coil of the magnet is in the circuit 8, which extends from section 3 to contact 7, it being partially formed by a portion of branch D. At section 2 4 of Fig. 1 and in Fig. 2 the mov-

able part of the switch consists of the bar of insulation 15, carrying the armature of the magnet, and the contact-plates 14 and 30, which are connected, respectively, to working conductor 7 and to section 2. Contact 14 coöperates with contact 10 in the feeding branch D' to complete the circuit to contact 7, while contact 30 coöperates with contact 11 to complete a circuit from section 2 to the return-circuit C. The local or pick-up circuit 8 extends, as before, through a coil on core E^2 to contact 7.

For engagement with the several working conductors there are carried upon the motor-cars suitable contact-makers of such length in proportion to the distance apart of the working conductors that they may span the distance between any two of them, and thereby engage with one in advance before leaving the one in immediate contact. These contact-makers are represented by dotted lines at F F' F^2 in Fig. 1 and in full lines in Figs. 2 and 3.

The car-motor is indicated at G and is connected between contact-makers F and F', while the source of current for the pick-up or local circuit is connected between contact-makers F' and F^2. This source may be of any nature desired, it being represented in Fig. 1 at H as a battery, in Fig. 2 at H H' as a set of alternately charged and discharged storage batteries, and in Fig. 3 as a rotary transformer or motor-generator, which is the preferred form for such source of current.

In Fig. 2 the field-circuit of the motor is provided with means, such as a switch with movable arm 16, for cutting in or out thereof more or less resistance, it being made to change the number of turns in the field-coil and to add external resistance, as coils 17, to the field-circuit. This provides for regulating the motor and also for varying the current through the magnet E, and thereby controlling the pressure between the contacts of the section-switches. In the motor-circuit is also shown at M a switch for reversing the motor. The local circuit in this figure consists of the branch conductor 8, including its magnet-coil on core E, the branch 23, either the battery H or H', depending upon the position of the three-point switches 19 20 and 21 22, and branch 24. The charging-circuit for the batteries is from C' over D', through 14 11 18 7 F' 25, and through either H or H', as the position of the three-point switches may determine, branch 26, switch 27, and resistance 28 to contact-maker F. In Fig. 2 I have also indicated at rail A' by dotted lines leading from branches 8 and 23 around contacts F^2 and 6 to said rail and a car-wheel, as P, how this line of track-rails may be made to take the place of the series of working or surface contacts 6 6'. The line of track-rails A may likewise be made to take the place of contacts 5 5'.

In Fig. 3 is typified the arrangement of the rotary transformer, it being in a branch 25 from the motor-circuit M, the motor side K of the transformer having its return-circuit over branch 26 to contact-maker F and the generator side L being in the branch 23, connected to the contact-maker F^2.

Any suitable means may be employed to start the generator for picking up or initially closing the track-switches when the motor-circuit is open, and I have simply shown a crank-disk 31 as indicative of any means suitable for this purpose.

One of the principal objections to railway systems having exposed working conductors is that of danger resulting from said conductors remaining alive after a car has ceased taking current therefrom and passed over it. In my system, constructed as described, each working conductor is cut out of circuit as soon as it is left by a car, because the switch-magnets become deënergized as soon as said conductors are out of circuit. I have, however, provided means for absolutely preventing a conductor from remaining alive even if a switch should from any unforseen cause remain closed after its contact is left by the contact-maker in the motor-circuit. Such means may consist of any suitable cut-out responsive to an abnormal increase in current; but by preference I employ a fuse, as 18, in the motor-circuit and an auxiliary or trailer contact-maker, as N, carried by the car and connected to the return-circuit contact-maker F and arranged in position behind contact-maker F' to engage with the contacts 7 of one section as the contact-maker F leaves conductor 5' of that section. Thus it will be seen that should a switch stick, N will short-circuit the motor, and thereby cause the fuse to be blown and the section at the defective switch to be rendered harmless. This is an exceedingly important feature in systems of this class.

The operation of my system is as follows: Supposing a car to be in position as indicated by the dotted contact-makers in Fig. 1, the track-switch has been closed by current flowing from the source of current H over contact-maker F^2 to working conductor 6 of section 3, thence over branch 8 and its coil on core E to individual working conductor 7 and contact-maker F' back to the source H. The switch being thereby energized, armature 9 is picked up and circuit closed through it between contacts 10 and 11, thereby completing the motor-circuit from feeder C' over branch D, its coil on core E to conductor 7, contact-maker F', and the motor G, thence to the return C over contact-maker F, working conductor 5 of section 1, and branch 12. These circuits will remain closed till the contact-maker F' has passed from conductor 7, before doing which it will have made contact with the corresponding conductor in the next section in advance.

The relative location of the working conductors 7 and the sections or pairs of contacts or conductors may be varied to suit the times for operating the track-switches or to

accommodate the arrangement of the contact-makers on the cars. The contact-makers may also be varied in location and relative lengths as desired.

It will be noted that the motor-generator occupies the same position in the car-circuit as does the battery and performs the same function. It has, however, many advantages over the battery, as will be readily understood by electricians. It obviates the difficulties always attendant upon the use of storage batteries, avoids the necessity of the complicated regulations of charge and discharge, and provides for a more uniform current in the local or pick-up circuit. The transformer may also be so designed as to furnish a pick-up current of any desired voltage, but preferably one of a considerably lower voltage than that of the motor-circuit. The operation of the system with this source of current is substantially as above outlined in connection with Fig. 1.

Many changes in the location, arrangement, construction, and proportioning of parts may be made aside from those already referred to without departing from my invention.

What I claim as my invention is—

1. In an electric railway, the combination with the source of power, of a series of working contacts or conductors extending along the line of way and connected together in pairs, circuit connections from the source of power through a car-motor to each pair of contacts, a normally open electromagnetic switch located in and controlling the flow of current through each of said connections, and a source of current carried on the car for initially closing said switch, as and for the purpose set forth.

2. In an electric railway, the combination with the source of power, of two series of working contacts or conductors extending along the line of way and having the contacts in each connected together in pairs, and a normally open circuit-switch for controlling the flow of current to a pair in each series of contacts, substantially as set forth.

3. In an electric railway, the combination of a series of working contacts joined together in pairs along the line of way, a connection from each pair to the source of power, a second series of individual contacts one for each of said pairs, a normally open switch in a connection extending from each individual contact to the source of power, and means on the cars for closing circuit between the individual contacts and the pairs of contacts, substantially as set forth.

4. In an electric railway, the combination of two series of pairs of contacts extending along the road, a series of individual contacts one for each pair in one of said series, a normally open electromagnetic switch in a connection from each individual contact to a pair of contacts corresponding thereto in the first series and to the source of power, a connection from each pair of contacts in the second series to the source of power, three separate contact-makers carried by a car for engagement with said several series of contacts, a source of current connected between the contact-maker for the individual contacts and that for the first series of pairs of contacts, and the car-motor located between the contact-maker for the individual contacts and that for the second series of pairs of contacts, as and for the purpose set forth.

5. In an electric-railway system, the combination with the series of working contacts or conductors upon the line of way and electromagnetic switches for controlling the current thereto, of three contact-makers carried on a car and arranged to engage with the working contacts, connections from one of these to each of the others, the car-motor in one of these connections, and a motor-generator in the other, as and for the purpose set forth.

6. In an electric-railway system, substantially as described, the combination with the electromagnetic switches having their coils in the branches of the feeding-circuit and their contacts also in said circuit, of means carried on the car for varying the current through said coils and thereby determining the pressure between said contacts.

7. In an electric-railway system, substantially as described, the combination with the electromagnetic switches having their coils in the branches of the feeding-circuit and their contacts also in said circuit, of a switch in the field-circuit of the car-motor for varying the resistance in said circuit and thereby regulating the speed of the motor and the pressure between the switch-contacts, as and for the purpose set forth.

8. In an electric-railway system, substantially as described, the combination with two series of working contacts or conductors extending along the road and connected respectively with the feeding and return circuits from the source of current, of normally open electromagnetic switches controlling the flow of current through said conductors, a fuse in the circuit through the magnet of each switch, contact-makers carried by the cars for engagement with said conductors, the car-motor connected between two of said contact-makers, and a third contact-maker in circuit with that of the motor which engages with the return-circuit conductor and adapted to engage with the feeding-circuit conductors thereby forming a short circuit between the working conductors, as and for the purpose set forth.

9. The combination with the normally dead surface contacts or conductors, of switches for connecting them to the power-current as a car moves over the road, an auxiliary contact-maker carried by the car, and means controlled by an abnormal current flowing over the same for interrupting the power-current

flowing to a surface conductor when the auxiliary contact-maker finds such conductor still alive.

10. The combination, substantially as described, with the normally dead surface conductors, of automatic switches controlling the flow of current thereto, suitable automatic cut-outs in the circuit to said conductors, and an auxiliary contact-maker carried by the car and directly connected to the return-circuit, as and for the purpose set forth.

11. In an electric-railway system, substantially as described, the combination with the normally dead working contacts or conductors on the surface of the road, of electromagnetic switches controlling the flow of current thereto, a fuse in the circuit of the magnet of each switch, and means upon the cars for causing said fuses to blow and thereby deënergize any switch-magnet that failed to release the switch as soon as the car-motor ceased to take current from the working conductor, controlled by that switch for the purpose set forth.

Signed at New York city, in the county of New York and State of New York, this 31st day of August, A. D. 1892.

GRANVILLE T. WOODS.

Witnesses:
W. S. HANFORD,
LIZZIE WOODS.