(No Model.)

F. C. ESMOND.

CLOSED CONDUIT ELECTRIC RAILWAY SYSTEM.

No. 551,534. Patented Dec. 17, 1895.

FIG. 1.

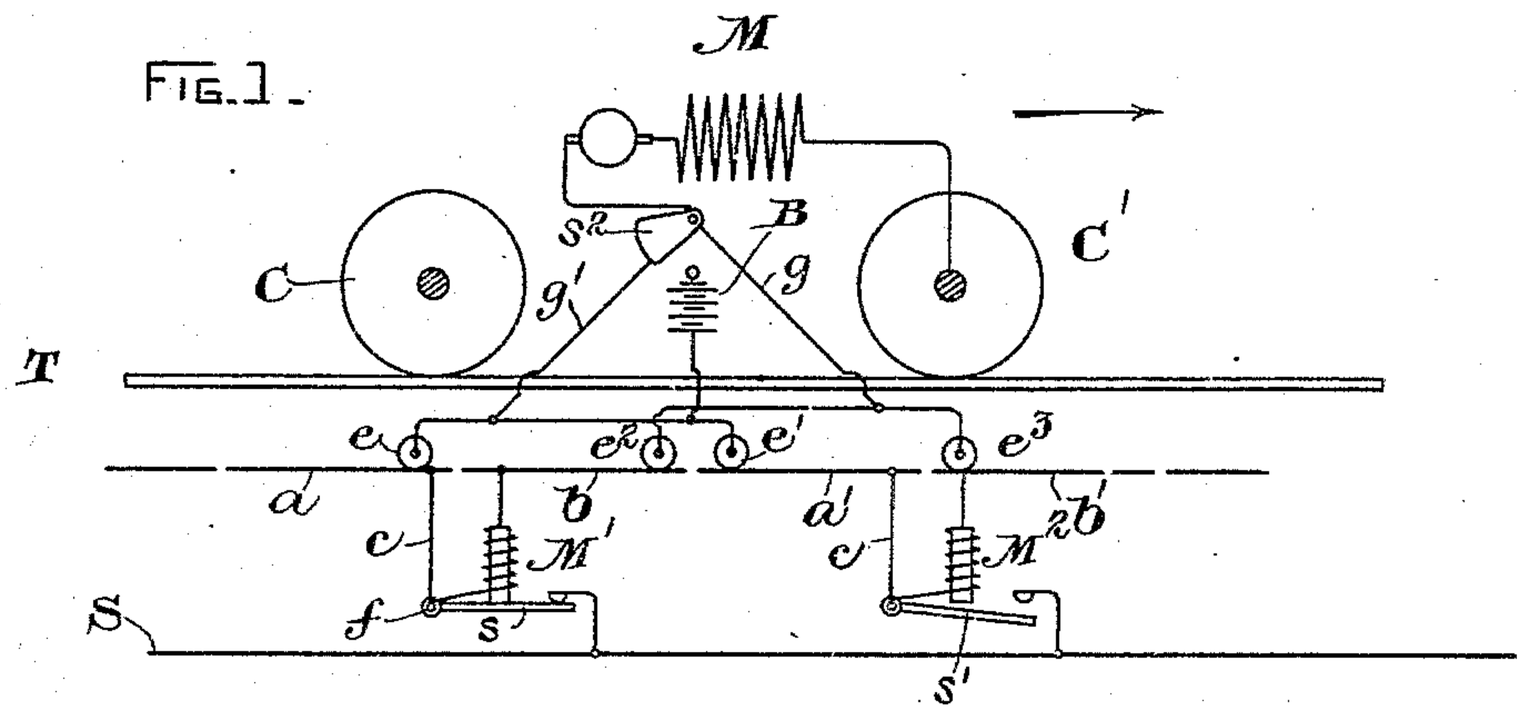


FIG. 2.

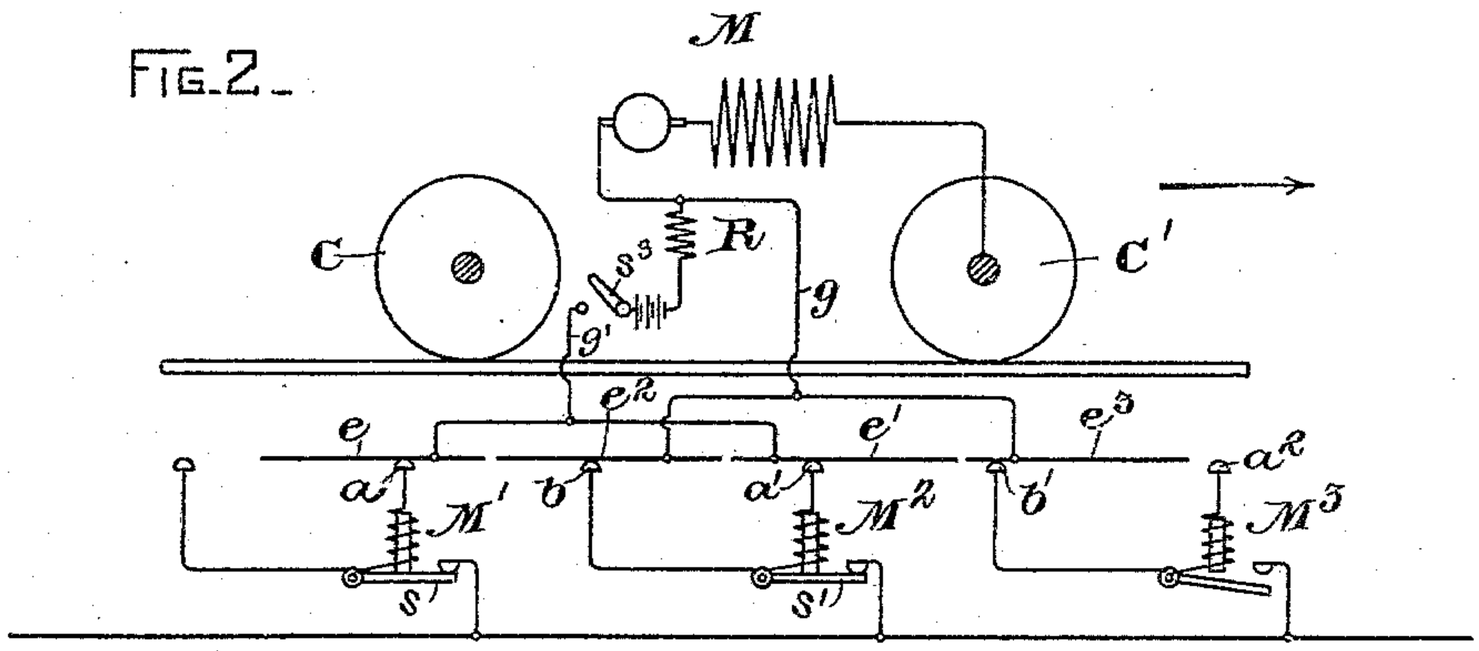
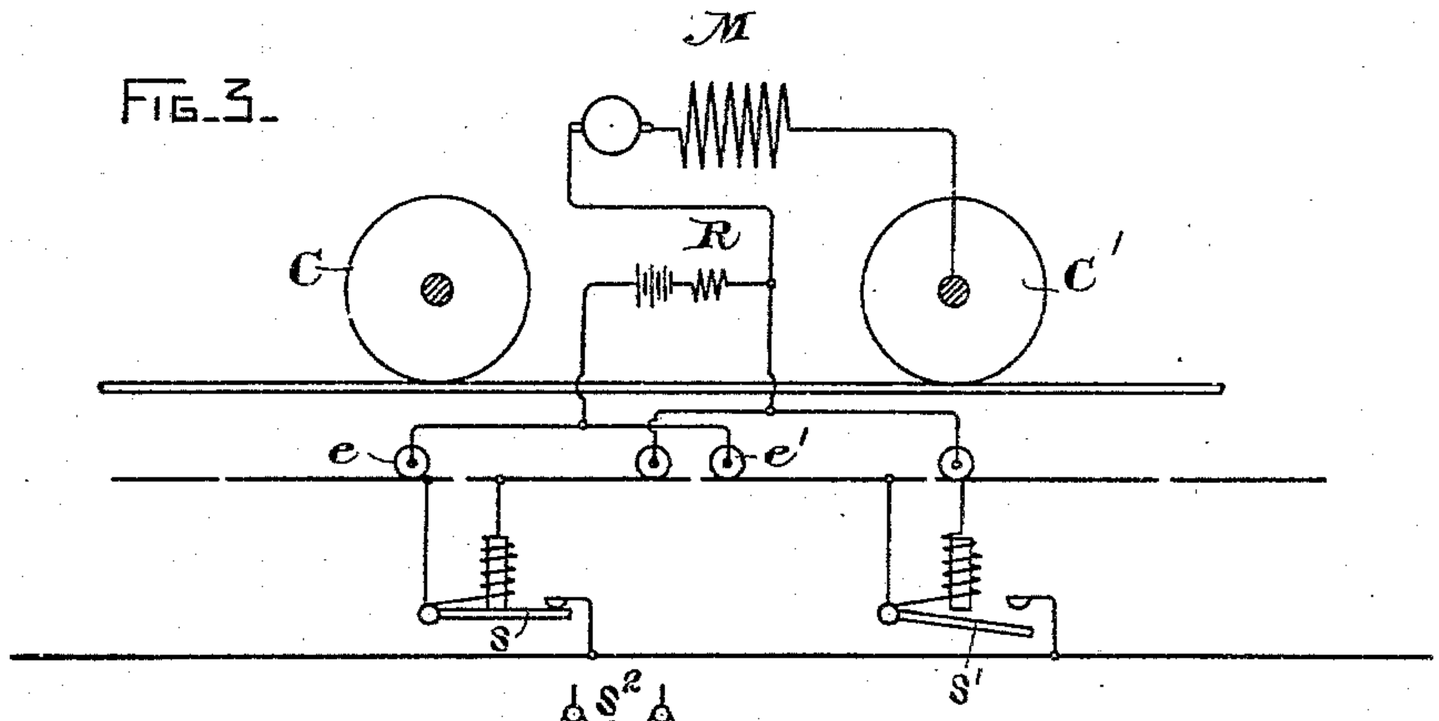


FIG. 3.



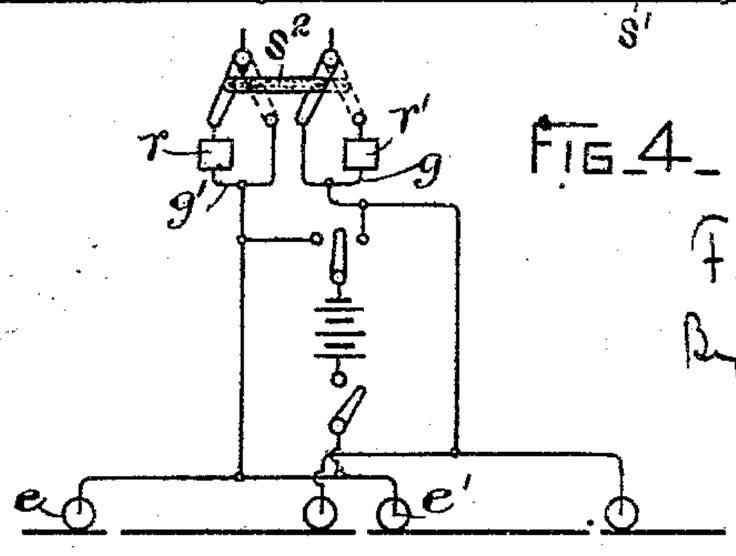


FIG. 4.

WITNESSES.

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UNITED STATES PATENT OFFICE.

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CLOSED-CONDUIT ELECTRIC-RAILWAY SYSTEM.

SPECIFICATION forming part of Letters Patent No. 551,534, dated December 17, 1895.

Application filed April 12, 1895. Serial No. 545,439. (No model.)

To all whom it may concern:

Be it known that I, FREDERICK C. ESMOND, a citizen of the United States, residing at Brooklyn, county of Kings, State of New York, have invented certain new and useful Improvements in Closed-Conduit Electric-Railway Systems, of which the following is a specification.

The present invention relates to a closed-conduit electric-railway system.

Various systems have heretofore been devised, in which current is fed to the propelling-motors from an insulated supply-conductor through working conductor sections or points, which are insulated from one another and normally disconnected from the supply-conductor. Various forms of switching devices have been devised for connecting the working sections or points which are under or near a car to the supply-conductor, so that these are the only live working sections. The difficulty with these systems heretofore, from a practical standpoint, has been chiefly due to the connecting-switches and means for operating them in the manner desired and intended.

My invention aims to overcome these difficulties and to furnish a practically reliable and satisfactory system of the general character described.

In the accompanying drawings, Figures 1, 2 and 3 show in diagram modified forms of the invention, and Fig. 4 shows in detail an accessory arrangement on the car which sometimes will be used.

In the drawings, C C′ represent the wheels of a truck or locomotive driven by one or more electric motors connected to the axles in any desired manner. One such motor is represented at M, having one terminal grounded through the truck and rails T, as is customary in the single-trolley system now in general use, while its other terminal is maintained in circuit with an insulated supply-conductor S by a special arrangement of switches and collectors constituting the principal feature of the invention. It is, however, not necessary that the return branch of the circuit be formed through the rails. The invention is equally applicable to an all-metallic circuit or to one in which the sectional conductor system is used in both branches of the motor-circuit.

In Fig. 1, $a\ b\ a'\ b'$ represent a series of working conductor-sections which are joined electrically in pairs by a series of conductors c. In each such connecting-circuit there is included an electromagnet, and a switch $s\ s'$, &c., is joined to each conductor c, so that current flowing over the switch may pass to sections $b\ b'$, through the magnets, and to sections $a\ a'$ without influencing the magnets. The working conductor-sections are insulated from each other and are disconnected from the supply-conductor at the switches $s\ s'$, except as the latter are closed temporarily by the magnets, as hereinafter described.

If it be assumed that the car is traveling in the direction of the arrow, Fig. 1, and the rear switch s is closed, as shown, it will be evident that if the working sections be connected in alternate pairs, $a\ a'\ b\ b'$, and to the motor, then the motor-circuit will be divided, and the current taken from the supply-conductor S over the switch s will flow to the motor partly through magnet M′ and working section b and partly through magnet M^2, so that the advance switch s' will be thrown before the switch s opens.

In my invention a special arrangement of collectors on the car is used, bringing about this division of the motor-current for operating the pick-up magnets successively. For this purpose I use overlapping sets of collectors, or, as they may otherwise be regarded, a collector with overlapping sets of contact-makers, the purpose of one set being to connect the sections corresponding to $a\ a'$, while the other set connects the sections $b\ b'$, when the proper time comes for closing the circuit of an advance pick-up magnet so as to operate the corresponding switch.

In Fig. 1, $e\ e'$ represent one set of collectors connected electrically, as shown, and $e^2\ e^3$ a second overlapping set. The parts are shown in the position which they occupy just as they close the circuit of the advance magnet M^2. The switch s' is drawn open, to illustrate more clearly the division of the current flowing from the main conductor through the rear switch s. Current passes through the last-

named switch and divides at the point *f*, part flowing through the collectors *e e'*, working section *a'*, magnet M^2, collector e^3, and to the motor. The other branch from the part *f* includes magnet M', contact e^2, and so on to the motor. At this moment, then, the two magnets are in multiple, and each of the motor branches will have a substantially equal resistance. I have assumed that the current passes to the motor over the lead *g*, connected to the collectors e^2 e^3. If desired, however, the collectors *e e'* may be connected directly to the motor, as at *g'*, so that the current flowing from section *a* may again branch, part flowing through the magnet M^2 and part through the direct connection *g'*. If this is done, the resistance of the latter path will be made such as not to short-circuit the pick-up magnet. The conductor-sections and collector-bars will be so proportioned as to connect the sections in the manner described. For example, with a twenty-four-foot car I use conductor-sections substantially four feet long, making eight feet between the switches. The total distance between collectors *e* e^3 would then preferably be ten feet, the space between collectors *e e'* and e^2 e^3 being approximately six feet. In this figure, B represents a secondary battery which may be connected into the motor-circuit by the switch s^2 for charging, and may be used for lighting purposes, or for picking up the switches in case the line-current fails. Assume, for example, that the switch s^2 is thrown so as to close the battery-circuit, then, as the parts are arranged in this figure, the battery would be closed through the magnet M^2.

In Fig. 2 a similar arrangement is shown with some modifications. Here pairs of contact-points *a b a' b'* are used instead of the longer sections of Fig. 1. The collectors *e e'* e^2 e^3 are correspondingly lengthened, so as to bridge the wider spaces between the contact-points. The points are connected in successive pairs by conductors, including the magnet M M' as before, and the collectors are arranged so as to connect the points momentarily in alternate pairs *a a' b b'*, as in Fig. 1, when a new switch is to be thrown. In Fig. 2 the parts are shown in a different position from Fig. 1, with two of the switches closed. Assume that the car has advanced so that the collector e^3 rests on the point a^2, the collector *e* engaging point *b* and collector *e'* the point *b'*. Then there will be the same division of the current from the switch *s'*, as heretofore explained, one branch passing from point *b*, by the collectors *e e'*, to point *b'*, through the magnet M^3 and to the motor. The other path from the switch *s'* passes through the magnet M^2, collector e^2, and to the motor. The advance switch will then be thrown, while that portion of the current which flows through magnet M^2 holds the latter switch closed. In this figure the motor connection corresponding to *g'*, Fig. 1, is shown open at the switch s^3. When closed the circuit is formed through the battery and resistance R.

The arrangement shown in Fig. 3 is similar to that in Fig. 1, except that the battery is located in a different position. It is now connected between the collectors *e e'* and the motor, and preferably has a small resistance in series with it. When the battery-circuit is closed, it therefore forms a shunt to the normal motor line-circuit.

When an arrangement like that of Fig. 1 is used it is desirable that a small resistance be included in that branch of the motor-circuit directly connecting the rear pair of collectors and the motor. In Fig. 4 such an arrangement is shown. Here the motor connections *g g'* each have a double set of contacts, the circuit of one of which includes the necessary resistance. A switch s^2 is arranged as shown, so that when the car is moving to the right the switch will stand in the full-line position, putting the resistance *r* in circuit to balance the resistance of the advance pick-up magnet. When the car travels in the opposite direction, the collectors e^2 e^3 will, of course, be the rear set, and the switch s^2 is thrown to the dotted-line position, so as to cut the resistance out of the lead *g'* and include the resistance *r'* in lead *g*. In this last figure the battery has one terminal connected to the collectors *e e'*, and a switch is provided for connecting the second terminal either to *g* or *g'*, as may be desired.

The relative arrangement of the working sections or points and their switches with the collectors on the car is the principal novel feature of the invention and furnishes an effective and satisfactory means for closing and holding up the necessary switches at all times, no matter where the car may stop. A further advantage of the arrangement is that the current flows through the magnets in the same direction just before and after the switches are closed. For example, in Fig. 1 it will be noticed that the magnetizing-current, applied to the magnet M^2 from the switch *s*, flows through the magnet in the same direction as the flow of the line-current after the switch *s'* is closed. This avoids certain objections characteristic of other systems which have been proposed, in which there is a reversal of the current in a part or the whole of the pick-up magnets.

In using the word "sections" in the claims hereinafter made I mean to cover the short sections shown in Fig. 2, sometimes called "contact-points," as well as the longer rail-sections shown in the other figures.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. The combination of a main supply conductor, working conductor sections normally out of circuit with the supply conductor, electro-magnetically operated switches for

coupling the working sections in circuit with the main conductor, and collectors on the car overlapping one another in a fore and aft direction, for establishing a circuit through the pick-up magnet of an advance conductor section, as set forth.

2. The combination of a main conductor, a single row of working conductor sections normally insulated from the main conductor and from each other, electro-magnetically operated switches for coupling the working conductor sections temporarily into circuit with the main conductor, and collectors on the car overlapping each other in a fore and aft direction, for establishing a circuit through the pick-up magnet of an advanced section, as set forth.

3. The combination of an insulated supply conductor, working conductor sections, switches for connecting the working sections with the supply conductor, magnets for operating the switches whose coils form part of circuits connecting succeeding working sections in pairs, and overlapping sets of collectors on the car, connecting alternate working sections in pairs, for completing a circuit through the pick-up magnet of an advance section before the switch of a rear section is opened, as set forth.

4. The combination of an insulated supply conductor, working conductor sections, switch operating magnets whose coils join the conductor sections in pairs, and sets of collectors on the car, one of which bridges a given working section and the second section in advance, at the time when the switch of an advance section is thrown, while a second set overlapping the first set, bridges under the same conditions, the remaining sections of two successive pairs of sections, as set forth.

5. The combination of an insulated supply conductor, working conductor sections, magnets whose coils connect the sections in pairs, and collectors on the car forming a division of the motor current for actuating the pick-up switches between paths of substantially equal resistance, one of which, starting from a given switch passes from one of a pair of sections through the magnet of an advance section, while the second path passes through the magnet of the first named section, whereby the magnets of successive sections are in multiple at the time the switch of an advance section is thrown, as set forth.

6. The combination of an insulated supply conductor, working conductor sections, magnets whose coils join the working sections in pairs, and collectors having contact-making parts adapted to engage simultaneously four of such conductor sections or points and form multiple circuits between the supply conductor and motor, one branch including the magnet of a given section, and the other the magnet of an advance section, as set forth.

7. The combination of an insulated supply conductor, working conductor sections, switches for connecting the different sections with the supply conductor, conductors joining the working sections in pairs and including an electro-magnet between one such section and the corresponding switch, and collectors forming a division of the motor current and placing the magnet coil of an advance section in multiple with the magnet of a rear section, the connections being so made that current flows in the same direction in the magnets just before and after a given switch is closed, as set forth.

8. The combination of an insulated supply conductor, working conductor sections, switches and magnets for operating the switches, whose coils connect the conductor sections in pairs, overlapping sets of collectors for forming a division of the motor current, and actuating the switch of an advance section by throwing its magnet in multiple with the magnet of a preceding section, a battery connected at one terminal to one such set of collectors, and means for connecting the other terminal of the battery in the motor circuit, or to the second set of collectors, as set forth.

9. The combination of an insulated supply conductor, working conductor sections, switches and magnets for operating the switches, with a double set of overlapping collectors leading to the motor, and a switch for including a resistance in the circuit between the motor and the rear set of collectors in either direction of motion of the car, as set forth.

In witness whereof I have hereunto set my hand this 8th day of April, 1895.

FREDERICK C. ESMOND.

Witnesses:

B. B. HULL,

A. F. MACDONALD.