(No Model.) 4 Sheets—Sheet 1.

B. C. TILGHMAN, Jr.

APPARATUS FOR PREVENTING COLLISIONS ON ELECTRIC RAILWAYS.

No. 573,496. Patented Dec. 22, 1896.

FIG. 1.

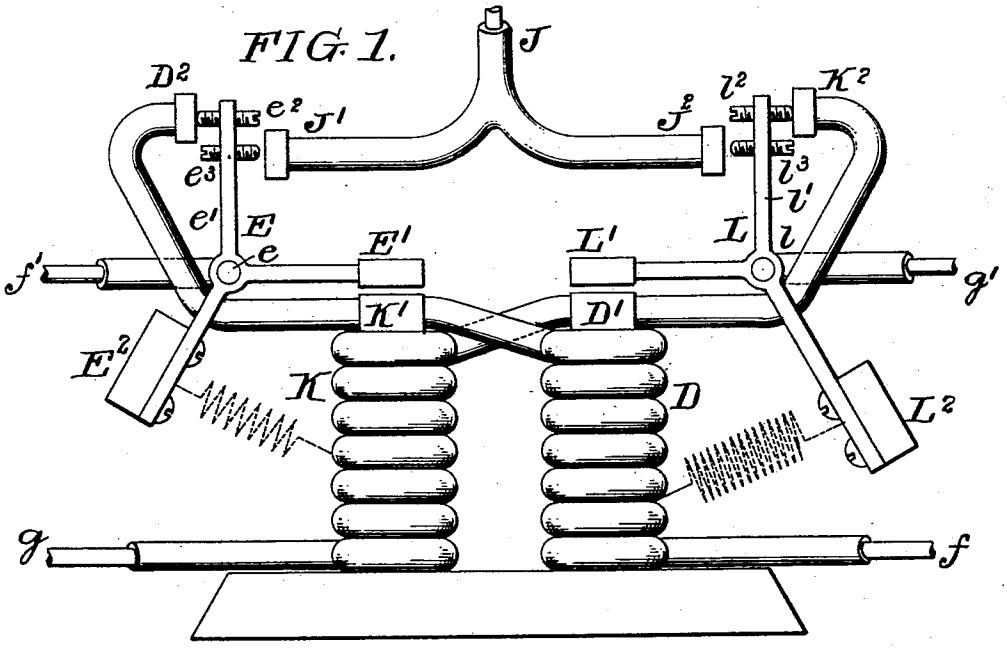
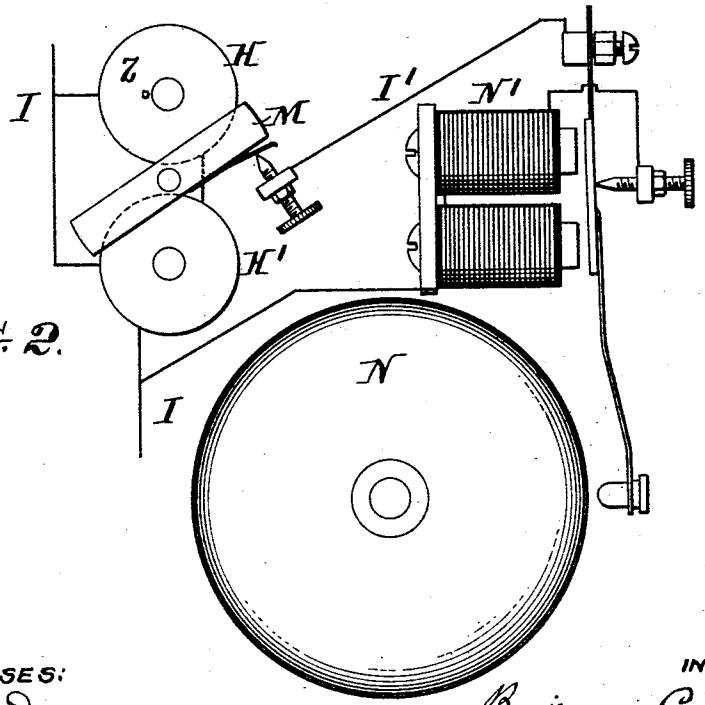


FIG. 2.



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(No Model.) 4 Sheets—Sheet 2.

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FIG. 4.

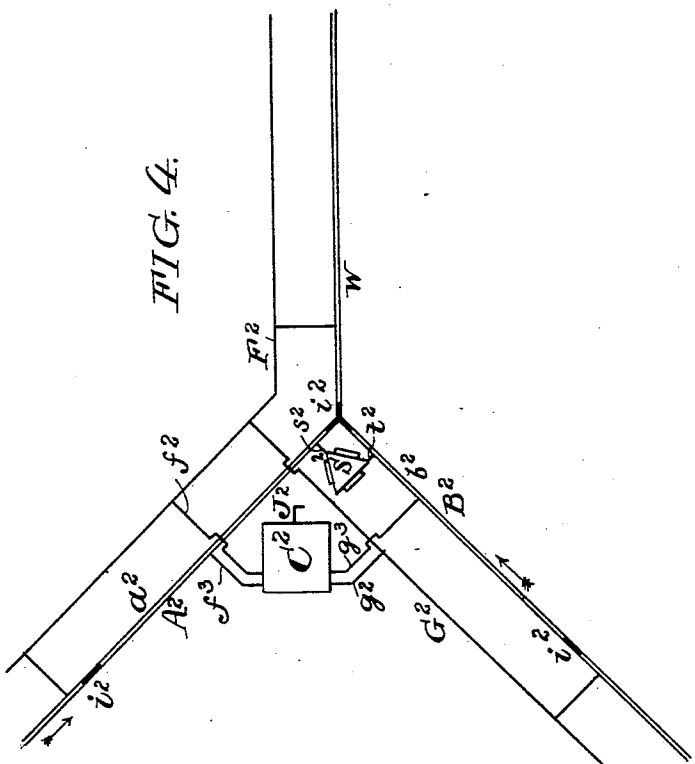

FIG. 3.

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APPARATUS FOR PREVENTING COLLISIONS ON ELECTRIC RAILWAYS.

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FIG. 5.

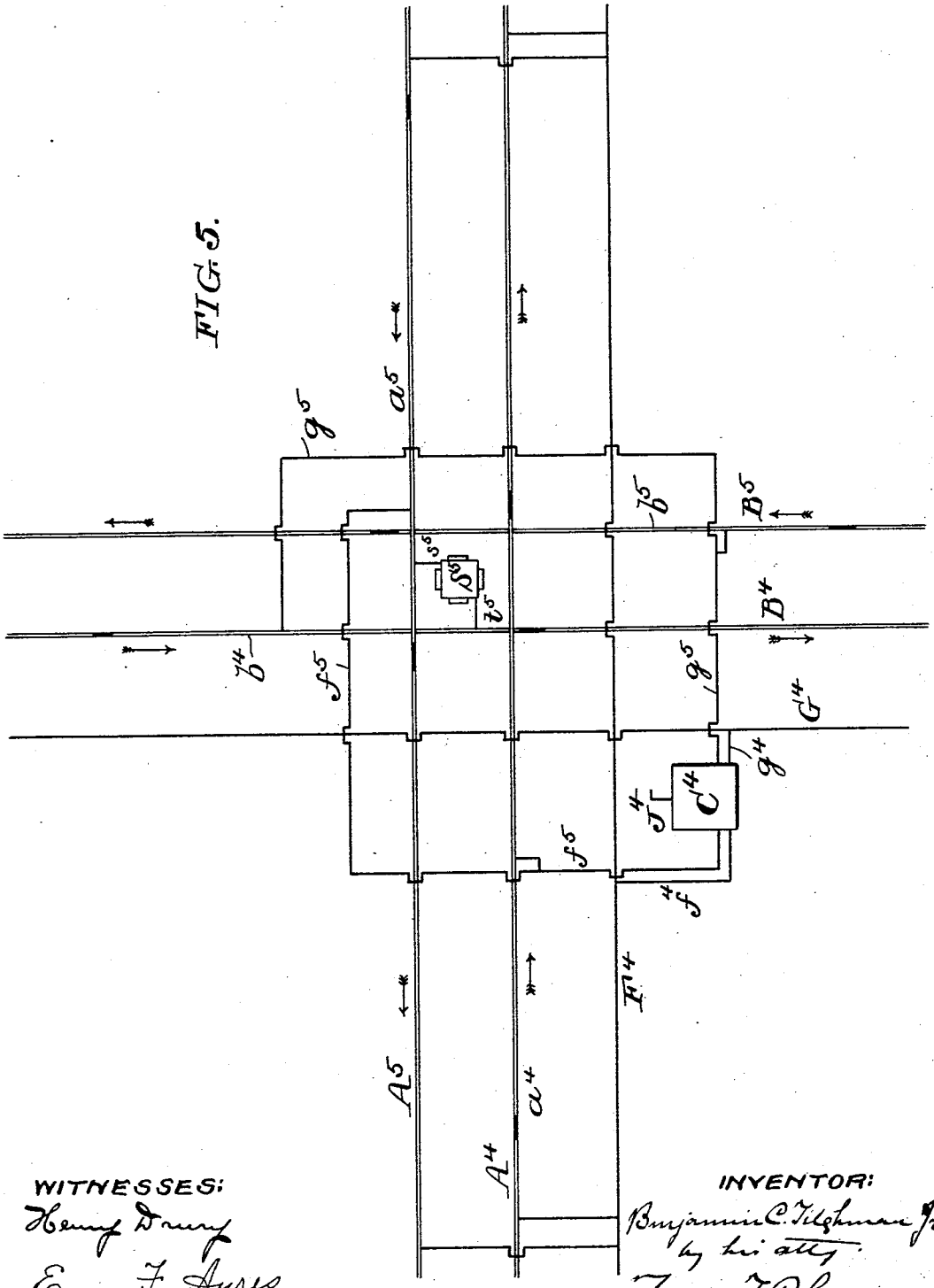

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FIG. 6.

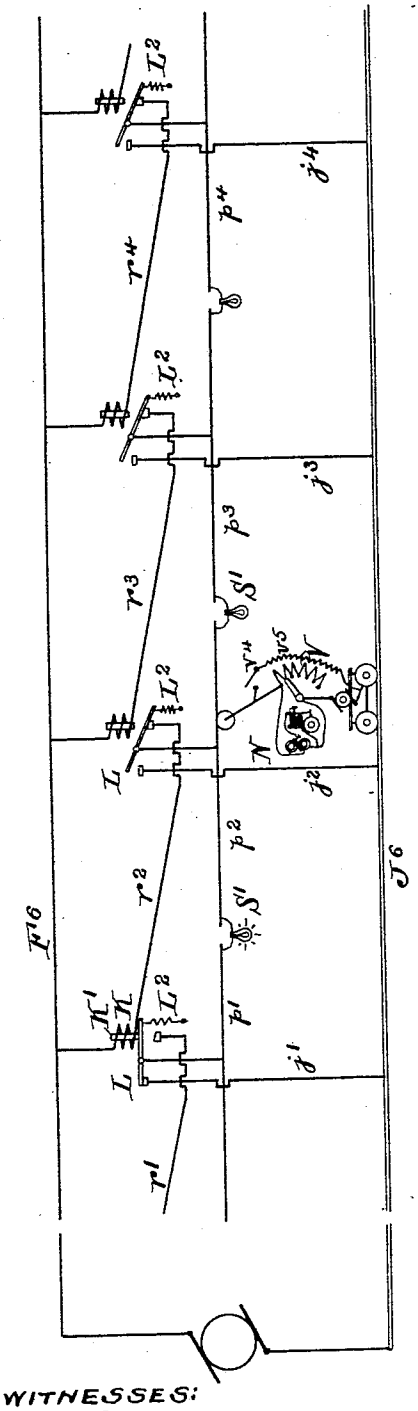
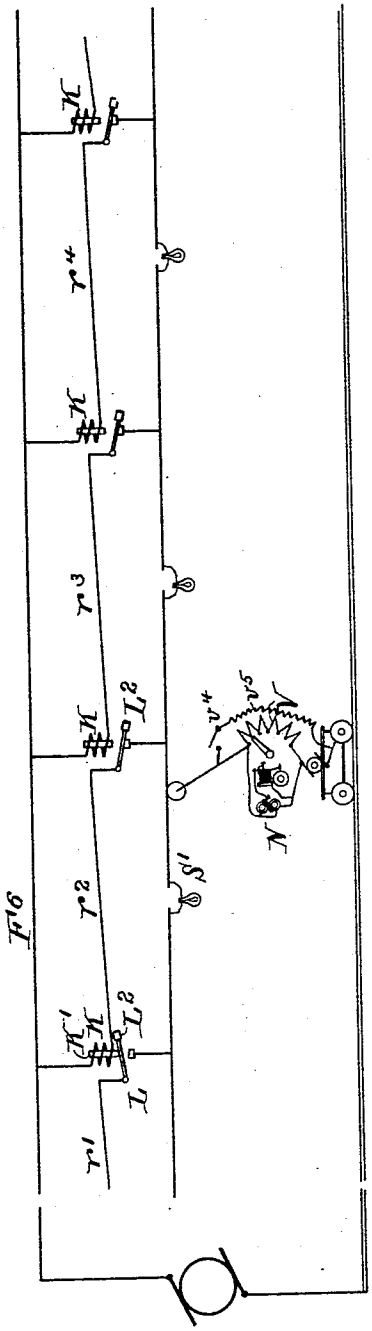


FIG. 7.



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR PREVENTING COLLISIONS ON ELECTRIC RAILWAYS.

SPECIFICATION forming part of Letters Patent No. 573,496, dated December 22, 1896.

Application filed April 13, 1894. Serial No. 507,367. (No model.)

To all whom it may concern:

Be it known that I, BENJAMIN C. TILGHMAN, Jr., a citizen of the United States, residing in the city of Philadelphia, in the county of Philadelphia, in the State of Pennsylvania, have invented a new and useful Improvement in Apparatus for Preventing Collisions on Electric Railways, of which the following is a true and exact description, reference being had to the accompanying drawings, which form a part thereof.

My invention relates to apparatus for preventing collisions on electrically-actuated railways, and has for its objects, first, to prevent collisions, particularly where one road crosses or meets another, and also to prevent collisions on the same road; also, to provide a suitable signal when a car is on a portion of the road where a collision might occur, and also to provide an alarm on and to check the speed of the car which has not the right of way. To accomplish these objects, I provide insulated feed-sections on the crossing roads, extending for suitable distances on each side of the place of crossing, and provide means for cutting off the current on the section of one road when a car is on the corresponding section of the other, and I also prefer to ground the section from which the current is cut off and operate an alarm by means of a current which passes, preferably, through a high-resistance connection from the live to the grounded section. I also provide an improved connection in block-sections on the same road, whereby an improved operation is obtained with much less wiring.

My improvements will be best understood as explained in connection with the accompanying drawings, in which—

Figure 1 is a side view of a cut-out instrument which can conveniently be employed to open and close the circuits in the desired manner. Fig. 2 is a plan view of a polarized relay adapted to operate an electric bell. Fig. 3 is a diagrammatic view showing the wiring of two single-track roads which cross each other. Fig. 4 is a similar view showing the wiring of two meeting roads. Fig. 5 is a diagrammatic view showing the wiring of two double-track roads which cross each other. Fig. 6 is a conventional view of a block system arranged according to my invention and applied to a trolley-road; and Fig. 7 is a view similar to that shown in Fig. 6, but showing a modification.

Referring first to Fig. 3, A B are two crossing roads, the cars on which run in the direction indicated by the arrows. Each of the roads is shown provided with an insulated sectional feed-supply conductor *a b*, extending back from the crossing-point for any desired distance, insulation being provided at *i*, as shown.

F G are feed-conductors (shown as heavy solid lines) for the roads A B, respectively, and are normally connected to the insulated sections by means of circuits *f f''* and *g g'*, respectively. I provide means, however, for opening either of these connecting-circuits when a car is taking current from the sectional feed-conductor to which that connecting-circuit does not lead. A convenient apparatus for doing this is shown in Fig. 1.

The essential features of this apparatus are magnets, as D K, the coils of which are energized by or form part of the two circuits leading from the feed-conductors to the sectional power-supply conductors and means operated by each of said magnets when energized for opening the circuit which operates the other. As shown, the circuits *f g* pass around similar cores D' K', thus forming electromagnets D K, and pass from there to contact-plates D^2 K^2. Armature-levers E L, which are substantially similar and only referred to by different reference-letters for purposes of identification, are pivoted at *e l*, respectively, and are provided with armatures E' L'. Contact-points e^2 l^2 engage with the contacts D^2 K^2 and form part of the circuits *f f' g g'*, the connections *f' g'*, leading to the insulated sections *a b*, being shown connected to the lever-arms *e' l'*, on which said contacts e^2 l^2 are situated. Positively-actuated non-magnetic means, as a weight or spring, as indicated at E^2 L^2, serve to hold the contact-points e^2 D^2 and l^2 K^2 normally in engagement. These positively-actuating means are arranged to operate with different force on the levers for a purpose to be hereinafter explained. As shown, the weight at L^2 is placed farther out on its arm than the weight E on its arm, so as to act with different force than said weight. I also prefer to ground the section *a* or *b* from which the current has

been cut off, and, as shown, contacts e^3 l^3 are adapted to be engaged with contacts J' J^2 of the ground-wire J by the same movement that disengages the said section from its feed-wire. In operation it will be noted that if a current passes through the circuit $f f'$ and around the magnet D the armature L' will be operated and the lever L so turned on its pivot l that the contact l^2 K^2 will be broken, thus opening the circuit $g g'$, while contact of l^3 J^3 will be made, grounding the conductor connected to the line g'.

S is a signal of any desired form which is adapted to be operated or displayed when one section is grounded and the other section in connection with the feed-conductor. A circuit $s t$, preferably of very high resistance, so that any current which passes will not be sufficient to operate a car-motor, connects the two sections $a b$, and so, when one section is grounded, a current passes through this circuit from the live to the grounded section, thus operating the signal. It will be noted that the signal will not be operated between two dead or between two live sections having the same voltage. The signal S is of course so placed that it can be clearly seen from both roads.

The arrangement shown in Fig. 4 is substantially the same as that shown in Fig. 3, the two roads A^2 and B^2 meeting at W instead of crossing each other. Parts similar to those shown in Fig. 3 are indicated by the same reference-letter with the index 2 added.

In Fig. 5 a double-track road A^4 A^5 crosses another double-track road B^4 B^5, the cars thereon traveling in the directions indicated by the arrows. The insulated sections a^4 a^5 are shown fed from the same feed-wire F^4 and the insulated sections b^4 b^5 from a feed-wire G^4. A car on one of the sections a^4 a^5 will cut off the current from and ground the other sections b^4 b^5 and set the signal S in the manner before described, a car on the sections b^4 b^5 acting in the same way as to the sections a^4 a^5. I also preferably provide an alarm on the cars, so arranged that if any car attempts while running to take power from a cut-out and grounded section a local alarm will be given on that car. Such an alarm is shown in Fig. 2, and consists of an electric bell N, operated by magnets N'. In the circuit of these magnets N' are contact-points controlled by an apparatus in the nature of a polarized relay. This relay conveniently consists of a permanent magnet M, pivoted, as shown, between the poles of the magnets H H'. When the current passes in one direction through these magnets, the permanent magnet is attracted and breaks the alarm-circuit. This is the condition when the current is passing normally from the power-supply conductor to the motor, the alarm and magnetic circuits around the magnets H H' being arranged as shunts upon the rheostat controlling the speed of the car. If now the car runs onto a grounded insulated sectional conductor and attempts to take power from said conductor, it is evident that there will be a counter electromotive force generated by the motor, which of course is moving with the car, and this will not only act to brake the car, but will also send a current through the magnets H H' in an opposite direction to that previously directed through them. The polarity of these magnets will be reversed and the magnet-armature M will be repelled, assuming the position shown in Fig. 2, closing the alarm-circuit and ringing the bell or operating any other alarm for the information of the motorman, who can then easily stop the car. In this connection it will be noted that when a vehicle is on one of the danger-sections of one road it not only cuts out but also grounds another section through the wire J. (See Fig. 1.) This of course makes a ground for the motor, connected to the cut-out section by way of the trolley-arm, and permits the counter electromotive force of the motor to actuate the bell.

In cases where one road always has the right of way it will of course be practicable to provide but one insulated section and cut it out by the action of a car on the dominant road.

It will be noted that if two cars arrive on the insulated sections at exactly the same instant both will first momentarily receive current. This will result in both cutting out the other. Both being cut out, the magnets will be deënergized and the armatures free to move into the position shown in Fig. 1 under the influence of the weights E^2 L^2 or other operating mechanism. One of these mechanisms, however, operates, as has been said, with greater force than its neighbor, and therefore its armature will first close the circuit which it governs, and which, operating the magnet which it surrounds, will immediately and permanently cut out the other section, the car whose circuit is first closed having, therefore, the right of way. Substantially the same principle can be employed to prevent collision on a single-track road, and by my arrangement I save a great deal of the wiring which is necessary in setting up prior systems to accomplish the same purpose. I also provide an alarm which will indicate to any one entering on a block whether there is any car on the next block.

In Fig. 6 I have indicated in diagram an arrangement for preventing collisions on the same road. $p' p^2$, &c., are insulated sectional feed-conductors; F^6, a feed-wire; $r' r^2$, connections from the feed-wire to the different sections $p' p^2$, &c. K is a magnet having a core K' exactly similar to the magnet shown in Fig. 1. L is an armature-lever having a weight or spring L^2 adapted to keep the armature-lever L in the position, as shown, above the vehicle V, so as to connect a section, as p^2, with the feed-wire through the connection r^2. When a current is passing through this connection r^2, it energizes the magnet K, as shown at the left of said figure, and connects

the said section to earth through the ground-wire j'. After the vehicle V has passed from the section p the weight or other mechanism L^2 moves the armature to put the said section in connection with its feed-wire. I also prefer to arrange an alarm S' between the sections, which alarm will operate when a current passes from one section to another, as when the preceding section is grounded.

In Fig. 7 the construction is substantially the same, except that the ground-wires are omitted. In this case the alarm S' will not be operated until a car comes on the insulated section, which will then be grounded through the motor-circuit and the alarm will be operated. This arrangement of an alarm between two sections, one of which may be provided with a current in excess of the other and so that the alarm will be given if the relative amount of currents on the two sections varies, enables me to dispense with considerable wiring and makes the alarm perfectly automatic.

The operation is believed to be perfectly understood. If a car runs on an insulated section, it immediately cuts off the current from the section on the crossing road, grounds said section, and sets the alarm. A car subsequently attempting to obtain power from said cut-out section is not only deprived of power, but a braking action is set up by the counter electromotive force of the motor, and a local alarm is operated. In the case of the block-sections the same thing happens if a car runs on a cut-out section, preferably the section immediately preceding the one on which the first car is running.

In a road composed of a number of insulated sections or blocks provided with the cut-out apparatus, as above described, it is evident that should a car or other vehicle running on any given block break down or be there stopped by some cause which prevents it from taking current from its section in this case the cut-out section in the rear of that upon which the car was traveling would then be restored to the circuit, and thus the safeguard provided be withdrawn at just the time that it was needed. To prevent this action, I provide a circuit around the motor on the car or vehicle traveling on the said road of such suitable resistance and so controlled by a suitable and convenient switch that when the same is closed there will be drawn through the said circuit from the section upon which the car has stopped a sufficient amount of current to maintain the section in the rear of the said car cut out from the source of electric supply. Such an apparatus is indicated in Figs. 6 and 7, where v^5 is a suitable conductor, preferably of considerable resistance, which is adapted when the switch v^4 is closed to permit such a flow of current around the motor that the previous section or desired section will remain cut out.

It will of course be noted that when I refer to "grounding" a wire I mean connecting it to the other side of the circuit or to the other pole of the electric generator. This, while usually the ground, may of course be a metallic return-conductor.

The section and feed conductors may of course be the ordinary arrangement of trolley and feed wires or any other manner of installations by which cars or vehicles of any sort are driven by electrical energy supplied from outside the car or vehicle, and while I prefer to operate the vehicles by a unidirectional current it is of course evident that by properly laminating the cores of the electromagnets D K and designing the helices so as not to have an objectionable self-indirection the apparatus shown in Fig. 1 can be operated with an alternating current in the same way as with one constant in direction. Indeed everything but the local car-alarm will operate in exactly the same way with alternating as with unidirectional currents.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination with the crossing tracks and an electric conductor extending along one track for supplying electricity as a motive power, of means under the control of a train moving along the other track for temporarily cutting the electricity off from a portion of said conductor along the first-named track.

2. The combination with two electrically-operated roads which meet or cross each other, of a source of electrical supply, an insulated sectional conductor connected to said source of electrical supply and adapted to furnish power to a vehicle traveling on a portion of one road, and means operated by one vehicle traveling on a predetermined portion of the other road for cutting off the current from the insulated conductor of the first road.

3. The combination with two electrically-operated roads which meet or cross each other, of a source or sources of electrical supply, two insulated sectional conductors, each connected to a source of electrical supply and adapted, one to furnish power to a vehicle traveling on a portion of one road, and the other to furnish power to a vehicle traveling on a portion of the other and means operated by a vehicle receiving power from either of the insulated sections for cutting off the current flowing to the other section.

4. The combination with two electrically-operated roads which meet or cross each other, of a source or sources of electrical supply, two insulated sectional conductors, each connected to a source of electrical supply and each adapted to furnish power to a vehicle traveling on a portion of one road and means operated by a vehicle receiving power from either sectional conductor for setting an alarm as S.

5. The combination with two electrically-operated roads which meet or cross each other, of a source or sources of electrical supply, two insulated sectional conductors, each connected to a source of electrical supply and

each adapted to furnish power to a vehicle traveling on a portion of one road and means operated by a vehicle receiving power from either of the insulated sectional conductors for cutting out the circuit from the other section and simultaneously setting an alarm as S.

6. In an electric railway the combination with a number of sectional power-supply conductors, of a feed-conductor, connections between the feed-conductor and the sectional conductors, a circuit-controller for governing said connection, positive-acting non-magnetic means for normally holding said connections closed, and means operated by the passage of a current from the feed-conductor to one sectional conductor for operating the circuit-controller so as to open the circuit leading to another section whereby rear-end collisions can be prevented.

7. In an electric railway the combination with a number of sectional power-supply conductors of a feed-conductor normally-closed connections between the feed-conductor and the sectional conductors, circuit-controllers consisting of electromagnets the coils of which form part of the connections between the feed-conductor and the sectional power-supply conductor, and armatures operated by each electromagnet for opening a connection leading to another section so as to prevent collisions.

8. In an electrically-actuated road, a sectional power-supply conductor, a feed-conductor normally connected to said sectional conductor, a motor adapted to receive power from said sectional conductor, an alarm in the motor-circuit adapted to remain inoperative during the normal flow of the current and means for cutting out the sectional conductor and grounding it whereby a reverse current will be set up and the alarm operated by the counter electromotive force of the motor while it is in motion.

9. The combination with two electrically-operated roads which meet or cross each other, a source or sources of electrical supply, two insulated sectional conductors, each connected to a source of electrical supply and adapted one to furnish power to a vehicle traveling on a portion of one road and the other to furnish power to a vehicle traveling on a portion of the other, and means operated by a vehicle receiving power from either of the insulated sections for cutting off the current flowing to the other section, and grounding that section.

10. The combination with two independent circuits, of electromagnets D K, each forming part of one of said circuits, an armature actuated by each magnet and serving to open the circuit passing around the other magnet and positively-actuated means for closing the circuits after the current which operated to open them has ceased flowing, said means acting with different force so that if both circuits were opened simultaneously one will be closed before the other.

11. The combination with two electrically-actuated roads which meet or cross each other, of a feed conductor or conductors, sectional power-supply conductors, each adapted to supply energy to a vehicle on different roads, connections leading from a feed conductor or conductors to each of the sectional conductors, a magnet forming part of each of these connections and an armature operated by each magnet and adapted when operated to open the circuit of which the coils of the other magnet form a part.

12. The combination in an electrically-actuated railway of a number of insulated sectional power-supply conductors arranged one behind the other, a feed-conductor normally connected to each sectional conductor, an alarm arranged in a high-resistance circuit which connects the otherwise-insulated sectional conductors, means operated by a vehicle on one section for cutting out another section whereby a current will pass to the cut-out section from the adjoining sections if said section be grounded and operate the alarm.

13. The combination in an electrically-actuated railway of a number of insulated sectional power-supply conductors arranged one behind the other, a feed-conductor normally connected to each sectional conductor, an alarm arranged in a high-resistance circuit which connects the otherwise-insulated sectional conductors, means operated by a vehicle on one section for cutting out and grounding another section whereby a current will pass to the cut-out section from the adjoining sections and operate the alarm.

14. The combination with two independent circuit-magnets D K one in each circuit, a ground-wire J, two armatures, one operated by each magnet and contact-points on each armature so arranged that when an armature is operated by its magnet it breaks the circuit around the other magnet and connects said circuit to the ground-wire.

15. The combination with two independent circuits of magnets D K, one in each circuit, two armatures, one operated by each magnet and each provided with contact-points normally forming part of the circuit around the other magnet and positively-acting means for holding the armatures away from the magnets.

16. The combination with two independent circuits, of magnets D K one in each circuit, two armatures, one operated by each magnet and each provided with contact-points normally forming part of the circuit around the other magnet and positively-acting means acting with different force on each armature for holding said armatures away from the magnets.

17. The combination in an electrically-actuated railway of a number of sectional power-supply conductors arranged one behind the other, a feed-conductor normally connected to each sectional conductor, positively-acting

non-magnetic means for normally holding said feed-conductors in circuit with each sectional conductor, means operated by a vehicle while it is receiving energy from one section for cutting out another section, and a conductor for permitting a flow of current when the motor is cut out or disabled whereby the cut-out section may be kept cut out as long as necessary.

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