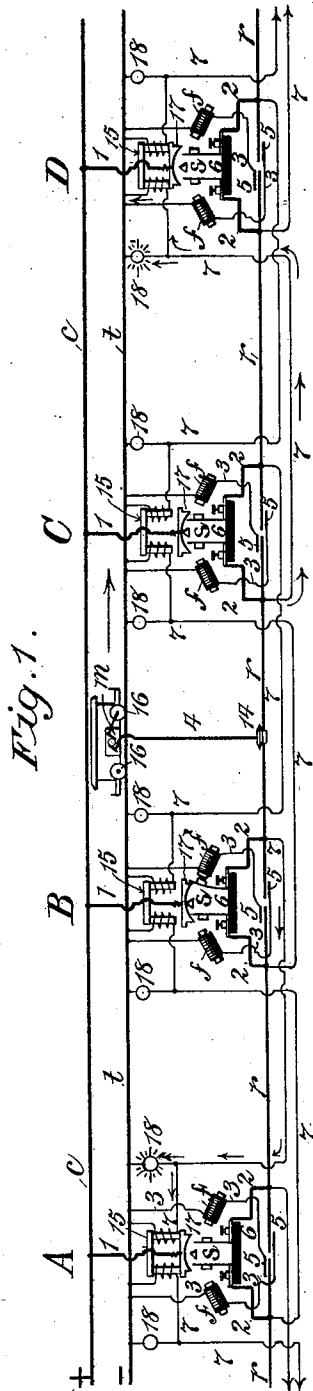


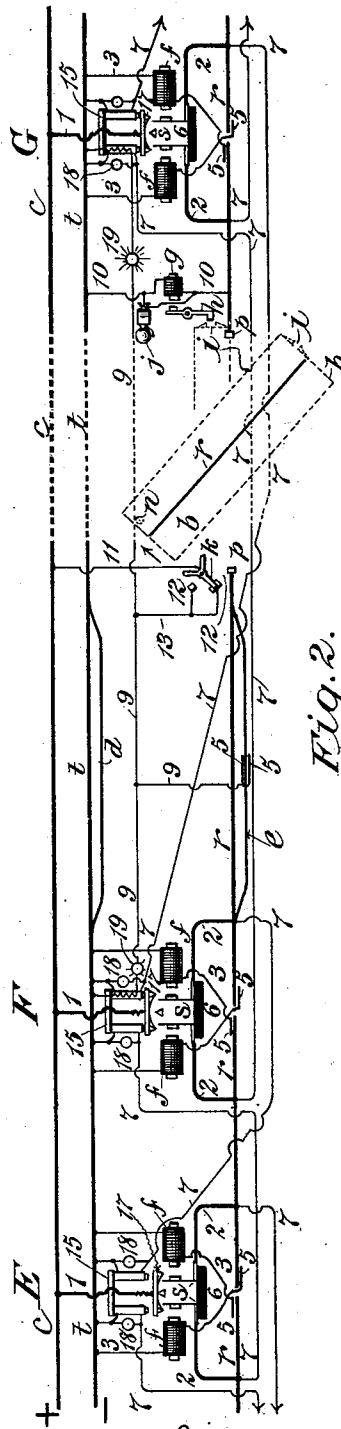
C. J. KINTNER.
ELECTRIC RAILWAY.
(Application filed May 6, 1901.)

(No Model.)

5 Sheets—Sheet 1.



Witnesses
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C. J. KINTNER.
ELECTRIC RAILWAY.
(Application filed May 6, 1901.)

(No Model.)

5 Sheets—Sheet 2.

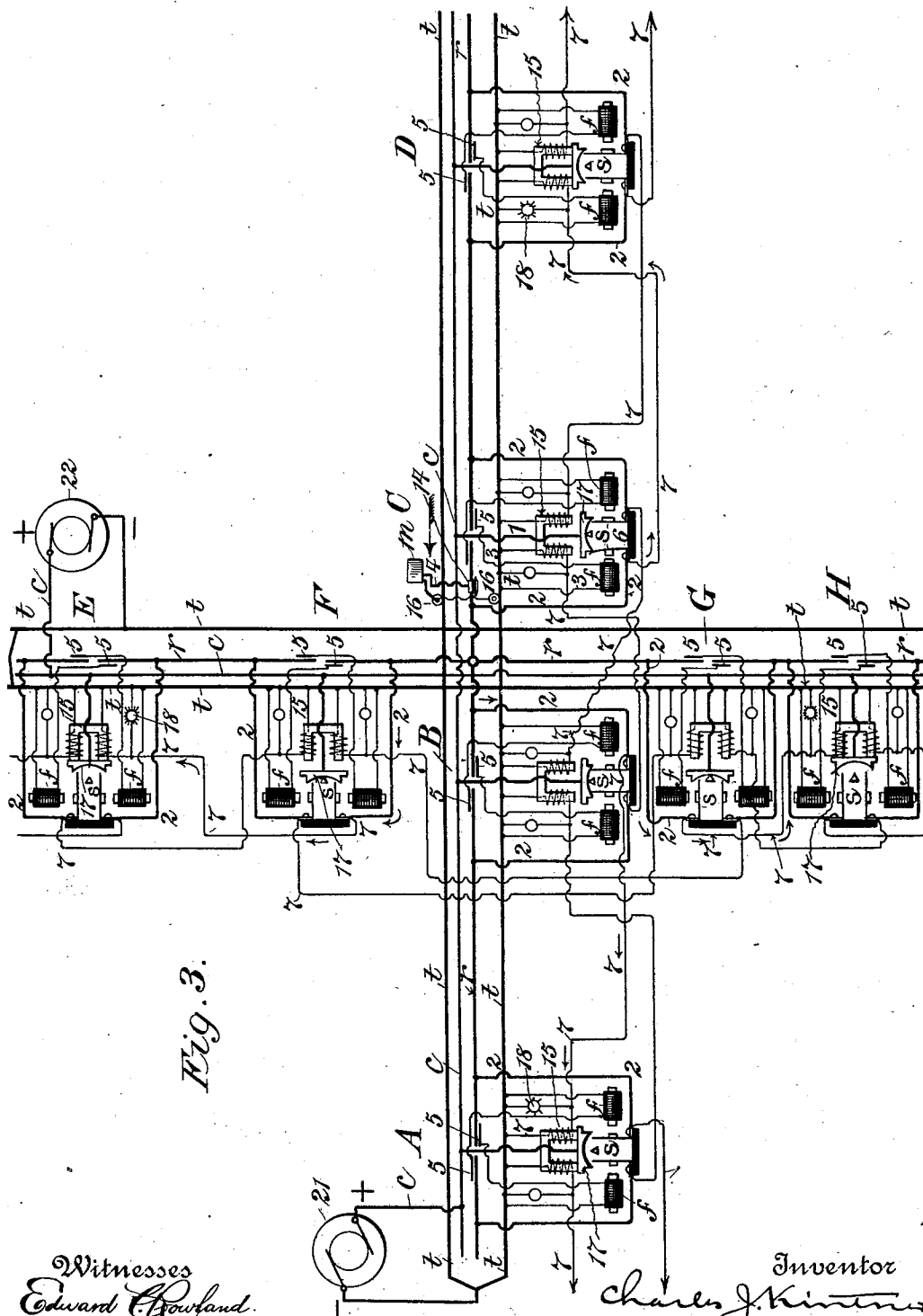


Fig. 3.

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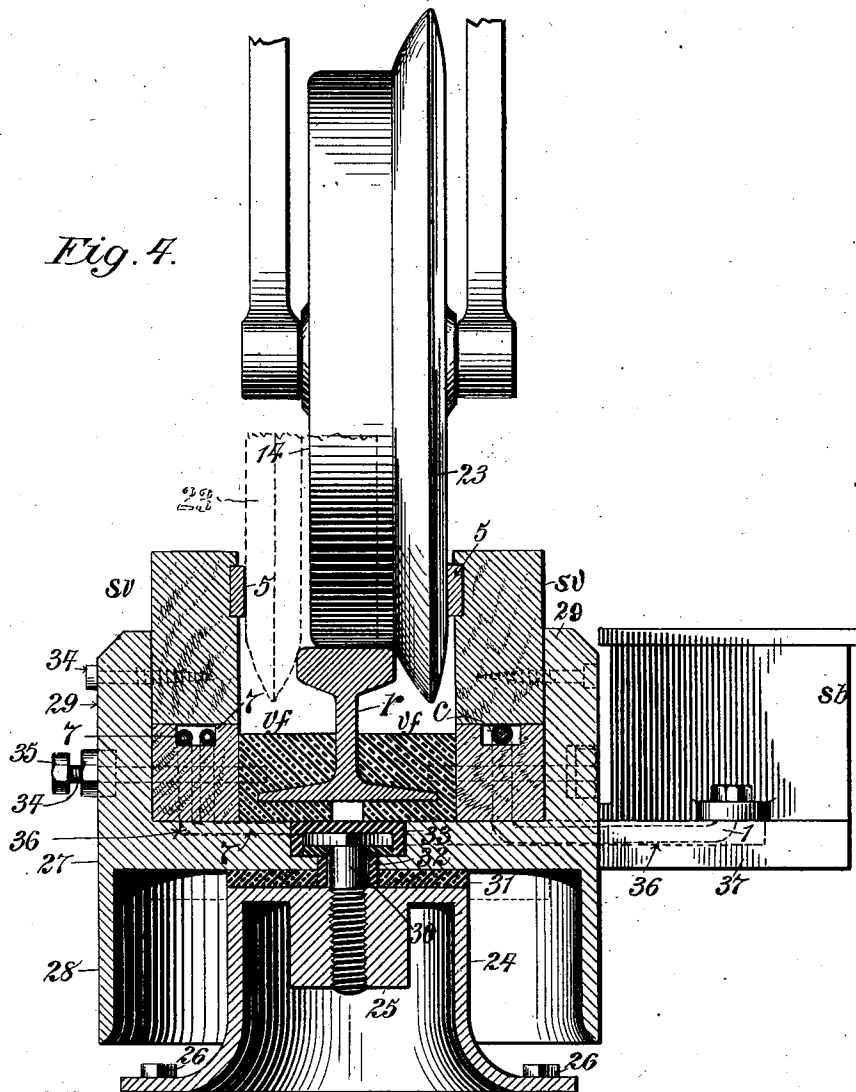
No. 700,128.

Patented May 13, 1902.

C. J. KINTNER.
ELECTRIC RAILWAY.
(Application filed May 6, 1901.)

(No Model.)

5 Sheets—Sheet 3.



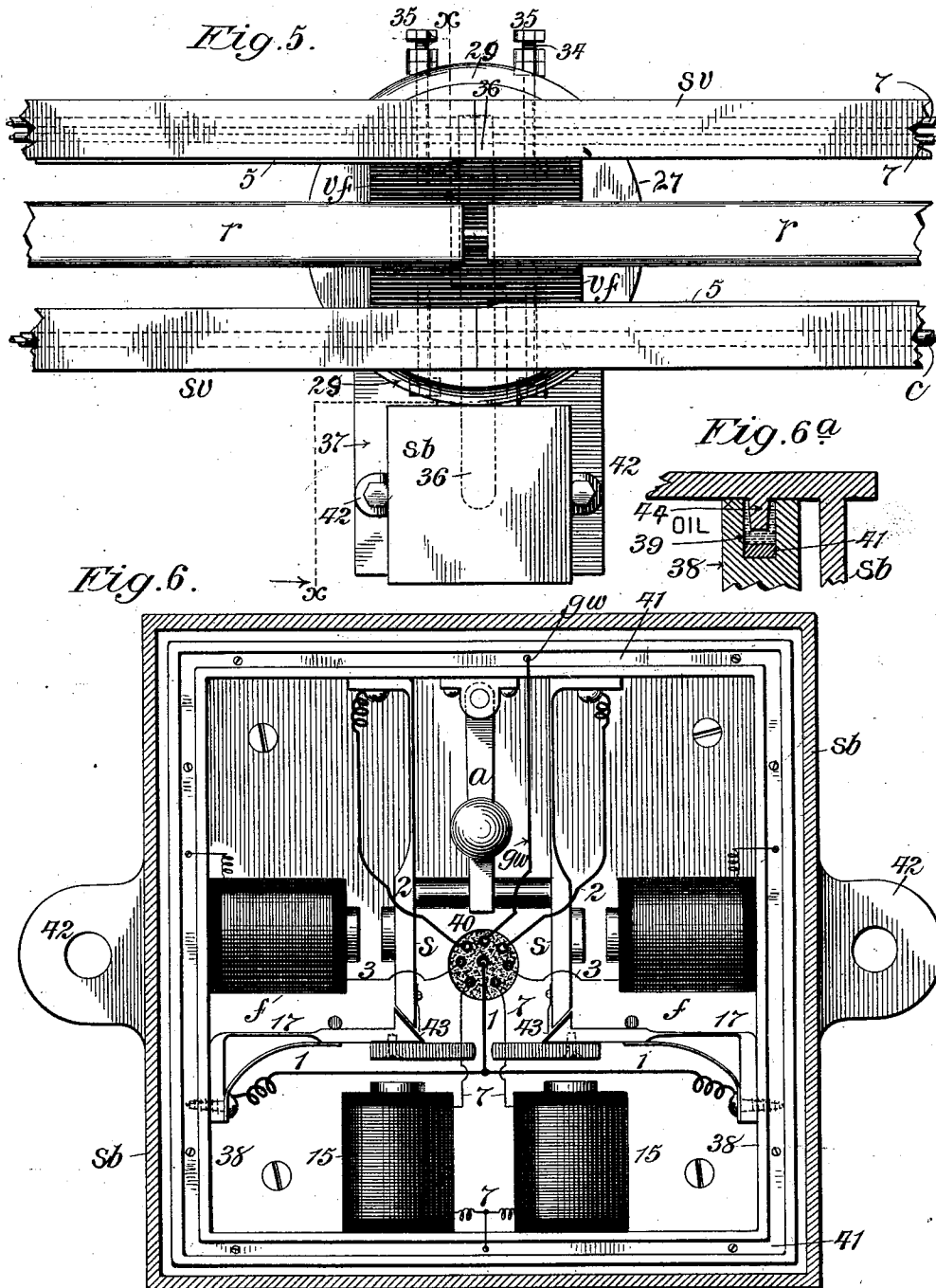
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C. J. KINTNER.
ELECTRIC RAILWAY.
(Application filed May 6, 1901.)

(No Model.)

5 Sheets—Sheet 4.



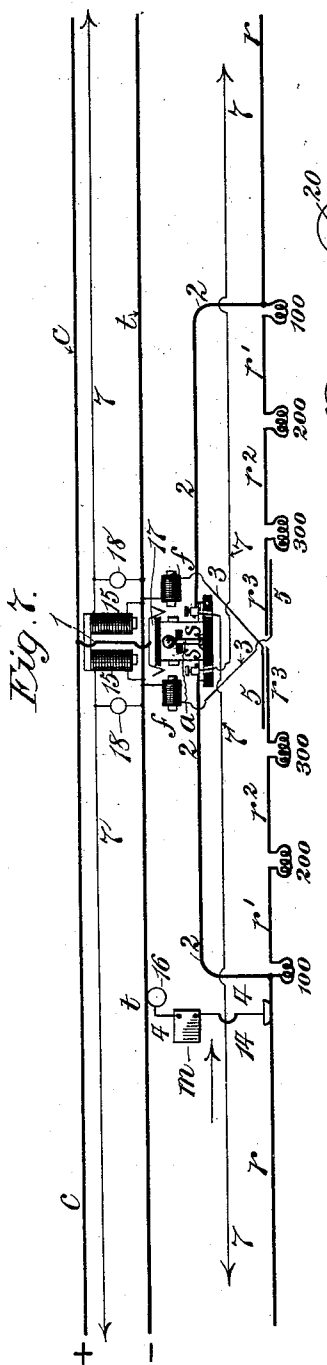
Witnesses
Edward Howland
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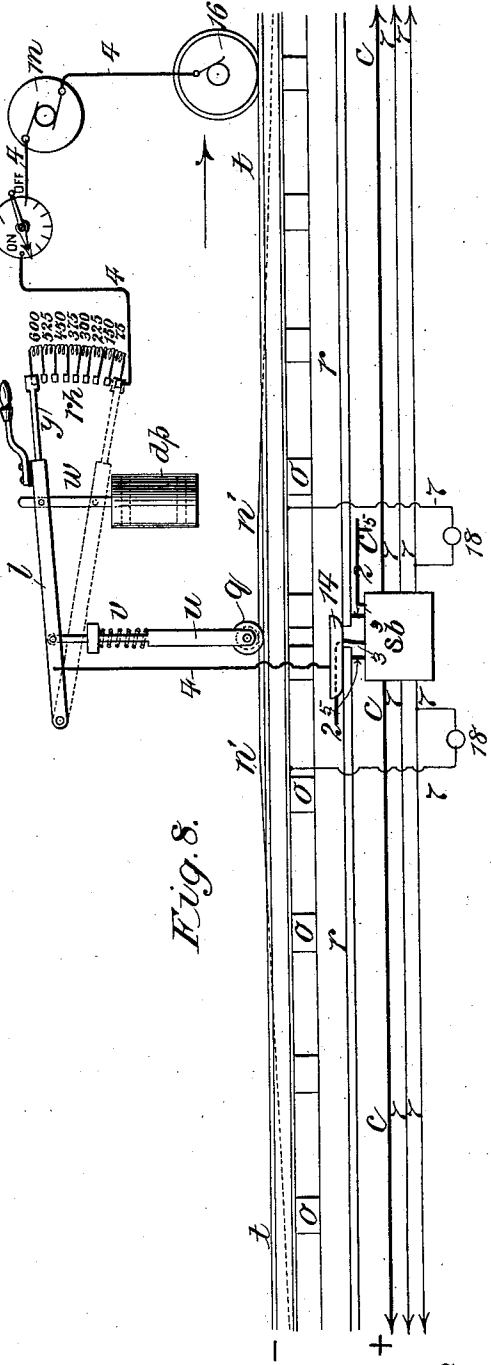
C. J. KINTNER.
ELECTRIC RAILWAY.
(Application filed May 6, 1901.)

(No Model.)

5 Sheets—Sheet 5.



Witnesses
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Inventor
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UNITED STATES PATENT OFFICE.

CHARLES J. KINTNER, OF NEW YORK, N. Y.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 700,128, dated May 13, 1902.

Application filed May 6, 1901. Serial No. 58,923. (No model.)

To all whom it may concern:

Be it known that I, CHARLES J. KINTNER, a citizen of the United States, residing at New York, borough of Manhattan, county and State of New York, have made a new and useful Invention in Electric Railways, of which the following is a specification.

My invention is directed particularly to improvements in sectional-third-rail systems of electric railways, and has for its objects, first, to provide a system of this type in which the sectional third rails or conductors normally disconnected from the current feeder or main are automatically connected to and disconnected from the same as a car passes over the route and in such manner that either rear or front end collisions are avoided; second, to provide an electric-railway system with means for avoiding collisions at switches or side tracks where trains pass each other; third, to provide an electric-railway system with means for preventing a car from approaching within a definite distance from either end of a draw or turn bridge when the latter is moved from its normal or closed position; fourth, to provide an electric-railway system with means for preventing a draw or turn bridge from being moved from its normal or closed position after a car has approached within a definite distance from either end thereof; fifth, to provide an electric-railway system with means for preventing collisions at the crossing-point of intersecting tracks and in such manner that when a car approaches within a definite distance of the crossing no other car can approach the same crossing upon either track in any direction until the first-named car has passed a definite distance beyond the crossing; sixth, to provide an electric-railway system of the sectional-third-rail type with circuit-closing rails or contacts located at the adjoining ends of the sectional third rails or conductors and on opposite sides thereof, together with circuit connections running therefrom to switching-electromagnets and a reversible trolley roller or shoe adapted to automatically effect the proper circuit connections for the sectional third rails or conductors when running in either direction; seventh, to provide novel means for preventing abnormal arcing at the ends of the rails of a sectional-third-rail system and in

the switch-boxes at the terminals where the third rails are connected to and disconnected from the current feeder or main; eighth, to provide the sectional third rails of a third-rail system of electric railways with insulators and side timbers, carried also by the insulators and located on opposite sides of the third rails and having channels or grooves for concealing the conductors of the system.

For a full and clear understanding of the invention, such as will enable others skilled in the art to construct and use the same, reference is had to the accompanying drawings, in which—

Figure 1 is a diagrammatic view of my novel system, showing also a car passing thereover from left to right. Fig. 2 is a similar diagrammatic view illustrating also the novel manner of avoiding collisions at a siding from the main track where trains pass each other and of avoiding accidents at a draw or turn bridge, said bridge being shown in dotted lines in partial open position, all of the conductors passing under the river being also illustrated in dotted lines, that part of the third rail carried by the bridge being shown in a full line. Fig. 3 is a diagrammatic view illustrating two crossing tracks of tram-rails and two powerhouse generators or sources of electrical energy therefor, illustrating also the manner of preventing collisions at the point of intersection of the tracks. Fig. 4 is a sectional view through one of the third rails, the body of one of the insulators which support the third rails, the guard-rails therefor, the conductors of the system, and all of the switch-boxes, one of the latter and its supporting-bracket being also shown in end elevational view, this view being taken on the broken line *x x*, Fig. 5, and as seen looking thereat from left to right in the direction of the arrows. Fig. 5 is a plan view of all of the features illustrated in Fig. 4, except the trolley. Fig. 6 is an enlarged horizontal sectional view of the switch-box and its box-like cover, illustrating in plan view the yielding conducting-terminals, the switch operating and releasing electromagnets and circuit connections within the switch-box, together with a hand switch-operating lever for manually connecting the current feeder or main to either of the corresponding third rails. Fig. 6^a is a detail sec-

tional view of a part of the top of the switch-box and the box-like cover therefor, illustrating also the manner of effectually sealing the switch-box against the admission of water thereto. Fig. 7 is a diagrammatic view illustrating my novel manner of preventing abnormal arcing at the ends of adjoining third rails of a sectional-third-rail system and also at the switching-terminals in one of the switch-boxes thereof, a car being shown in diagrammatic view passing from left to right; and Fig. 8 is a similar diagrammatic view of a modified form of this part of my invention in which the major portion of the current-varying apparatus is carried by the car.

It is to be noted that I have illustrated the tram-rails and all of the conductors of the system which convey the working current to the motors on board the cars in heavy black lines and all of the switch operating and signaling circuits which convey the current to the switch-controlling magnets and to the signals in light black lines.

Referring now to the drawings in detail, in all of which like letters and numerals of reference represent like or equivalent parts wherever used, and first to Fig. 1, *c* represents the current feeder or main connected to the positive pole of the power-house generator, (not shown,) and *t* one of the tram-rails connected to the other or negative pole thereof. *r r*, &c., represent the sectional third rails or conductors of the system normally disconnected from the current feeder or main and connected at each end by conductors 2 2 to yielding conducting-terminals *s s*, &c., of the switches, *f f f f*, &c., being switch-operating magnets for causing the yielding terminals *s* to be connected directly with the current feeder or main through locking-armatures 17 17, &c., by short branch conductors 1 1, &c. The electromagnets *f f*, &c., are included in branch circuits 3 3, connected each at one end to a short circuit-closing rail or contact 5, located near the ends of the adjoining third rails *r r* and on opposite sides thereof, the other ends of said circuits being connected directly to the tram-rail or return-conductor *t*. 7 7 7 7 are pairs of signaling and releasing conductors, connected each at one end directly to one of the third rails *r* and at the other end to a coil around one core of a releasing-magnet 15, said magnet being located at the distant ends of the adjacent third rails. 18 in each instance is a signal or lamp in a multiple branch circuit. *m* represents the motor on board the car. 16 16 represent the tram-wheels of the car, and 4 a conductor running from the motor to a reversible trolley 14, provided with a single flange 23. (See Fig. 4.)

The operation of the system is as follows: Suppose the car to be traveling from left to right in the direction of the arrow and the system to be divided into sections between the points A, B, C, and D, equal in length to the corresponding sectional third rails *r r r*. Un-

der this condition of affairs current is flowing from the current feeder or main at the point B by the branch conductor 1, locking-armature 17, yielding conducting-terminals, branch conductor 2, third rail *r* to the trolley 14, by conductor 4 to the motor, thence through the wheels 16 of the car to the tram-rail *t* and to the negative pole of the generator, thus furnishing current to move the car in the direction shown. At the same time current flows by the signaling and releasing conductor 7 to the rear in the direction of the arrows to the releasing-electromagnet 15 at the point A at the distant end of the adjoining third-rail section, thence to the tram-rail *t* and to the negative pole of the generator. Current is also flowing through the lamp 18, thus indicating danger at that point. An additional circuit is also closed from the right-hand end of the third rail *r*, over which the trolley 14 is moving, by the signaling and releasing conductor 7 in the direction of the arrows to the distant end of the next section in advance, through the releasing-magnet 15 at the point D, and also through the lamp 18, indicating danger at that point. It will thus be apparent, therefore, that during the time the car is passing over the section upon which the trolley 14 is now seen, between the points B and C, no car can receive current from the section in the rear nor can any car coming in the opposite direction receive current from the section in advance, owing to the fact that both of the locking-armatures 17 at the points A and D are held in their upper or released positions, as shown, and out of the paths of the free ends of the yielding conducting-terminals *s*. It will also be apparent that danger-signals 18 will be displayed, as shown. As the car advances to the beginning of the next section the flange 23 of the trolley 14 closes the circuit between the third rail *r* and the corresponding circuit-closing rail or contact 5, thereby conveying current through the right-hand conductor 3, magnet *f*, to the tram-rail or return-conductor *t*, thus operating the right-hand yielding conducting-terminal *s* at the point C and causing it to be drawn into its hooked or locked position at the right-hand end of locking-armature 17. At the same time circuits are closed through the signaling and releasing conductors 7, connected with the third rail *r* between the points C and D in each direction, releasing the terminals *s* from behind the armature 17 at the point B and displaying the danger-signals in the rear and advance, as before. As the car advances, therefore, each sectional third rail in the rear and in advance of that over which it is passing will be rendered dead or inert so long as said car remains upon the section, and danger-signals will be displayed at the opposite ends of the adjacent sections. It will also be noted that all of the conductors of the system, except the current feeder or main, are normally without electrical current potential and that

only those conductors have electrical current potential which are connected to the current feeder or main through some one of the conducting-terminals *s*, and also that should any sectional third rail be left connected to the current feeder or main through one of the yielding conducting-terminals *s* the locking-armatures 17 of the switches at the distant ends of the adjacent sectional third rails or conductors will both be held in their upper position, and the corresponding signals or lamps 18 included in circuit, so that cars cannot approach said section until its spring-terminal has been released.

15 In order to run cars in a reverse direction over the same track, it is only required to reverse the reversible trolley 14, so that the flange 23, shown in its reversed position in dotted lines, (see Fig. 4,) will pass between the circuit-closing rails or contacts 5 on the other side of the third rails *r*, (see Fig. 1,) so as to thereby close the circuit through the switching-magnet *f*. It will also be apparent that because of the fact of the switch-releasing magnets 15 being energized by independent coils connected with signaling and releasing conductors 7 running in opposite directions no sectional conductor can ever be left closed after a car has passed into the next section, either in advance or in the rear, it being understood that each individual coil has the capacity to effectually saturate the entire core of the magnet.

In Fig. 2 I have illustrated a continuation of the system shown in Fig. 1, embracing three more sections between the points E, F, and G, and in this figure I have also illustrated in the section between the points F and G the application of my invention in connection with a side track, where cars may pass each other, and also in connection with a draw or turn bridge, showing how collisions and accidents are avoided at these places. *d* represents a single side-track rail, corresponding to the tram-rail *t*, and *e* the side-track third rail, only one tram-rail being shown both in Figs. 1 and 2 for the purpose of avoiding unnecessary complication of the drawings. In this figure of the drawings, which is in effect a continuation of the system shown in Fig. 1, only three sections are shown, there being three sets of spring-terminals *s s*, three pairs of switch-operating magnets *f f*, and three releasing magnets 15 and signals or lamps 18, corresponding thereto, the side track and the draw or turn bridge being included in the third section between the points F and G. The circuit connections to the switching-magnets, the yielding conducting-terminals, releasing-magnets, and the signals 18 are the same as illustrated in Fig. 1, except that I provide additional circuit connections for that section between the points F and G, embracing the side track and draw or turn bridge, as will now be described. Referring now to the section between F and G, *d* represents, as before stated, the tram-rail for

the siding, and *e* the corresponding third rail therefor. 5 5 are circuit-closing rails or contacts near the center of the siding and similar to the corresponding circuit-closing rails or contacts 5 5, referred to in connection with Fig. 1, except that both of said circuit-closing rails or contacts are connected directly to a single safety and signaling conductor 9, running in opposite directions to independent coils around one leg of the core of each of the releasing-electromagnets 15 and thence to the tram-rail or return-conductor *t*, 19 19 being special electric lamps or signaling devices included in the circuit or conductor 9. *b* represents in dotted lines a draw or turn bridge, and *r* in full lines that section of the third rail between the points F and G which is carried or sustained by the bridge, the opposite ends of said rail being adapted to make good electrical contact with contact-plates *pp* when the bridge is closed, so that there is one continuous third-rail section between F and G. It will be understood, of course, that corresponding tram-rails are carried by the bridge and that the ends of the tram-rails *t* on opposite sides of the river or spaces to be bridged, together with the current feeder or main *c*, the signaling and releasing conductors 7, 7, and 9, are connected together by corresponding conductors and all included in a cable located in the bed of the river, the parts of said conductors so located being all indicated in dotted lines. *k* is a two-armed snap-switch having its pivot-point connected by a conductor 11 directly to the current feeder or main *c* and its free end adapted to make contact with either of two contacting plates 12, connected directly to a conductor 13, which in turn is connected to the safety and signaling conductor 9, the arrangement being such that when the bridge is closed the contacting part of the switch *k* rests in a central position with relation to the two contacts 12 and out of contact with both. *n* represents a switch-operating pin carried at one end of the bridge, and *i* is a locking notch or catch in the other end thereof, adapted to receive the hooked end of an armature-lever *h* when the bridge is closed, said armature-lever being under the control of an electromagnet *g*, included in a branch circuit 10 between the third rail *r* and the tram-rail or return-conductor *t*. *j* is an alarm or signal, here shown as a tap-bell located in a derived circuit to the magnet *g*, adapted to ring or be displayed continuously when the third-rail section between the points F and G is connected to the current feeder or main. If the bridge is operated by any source of power other than hand-power—as, for instance, by an electric motor or by a steam-engine—the armature-lever *h* of the electromagnet *g* might obviously be utilized to control the application of power in such manner as to prevent the movement thereof when a car is passing over the section between the points F and G. The operation of these features of the invention is

as follows, referring first to the draw or turn bridge: Suppose the bridge attendant to be turning the bridge from left to right in the direction of the hands of a watch, as shown by the arrow. At the instant that the ends of that part of the sectional third rail *r* carried by the bridge left the contact-plates *pp* the pin *n*, carried at the left-hand end of the bridge, acted upon the upper or left-hand arm of the two-armed switch *k*, causing it to be snapped into the position shown with its free or contacting end upon the lower contact-plate 12. Consequently the circuit was closed from the current feeder or main *c* by the branch conductor 11, switch *k*, contact-plate 12, branch conductor 13, safety and signaling conductor 9 in opposite directions to the coil around one leg of the core of each of the releasing-electromagnets 15 at the points F and G, thereby causing the locking-armatures 17 at these points to be held in their upper or open positions, as shown, at the same time displaying danger-signals 19 19 of a special character at the points F and G. Consequently should a car advance in either direction toward the points F or G danger-signals will be seen; but should the motorman fail to note the signal no current will be received from either end of the sectional third rail *r* when the car passes the switch at F or G for the reason that the locking-armatures 17 at both points are held out of operative relation with the yielding conducting-terminals *s*. Therefore the car will stop for lack of current. On returning the bridge to its normal or closed position the pin *n* acts upon the lower or right-hand arm of the snap-switch *k* and interrupts the circuit at the point 12 at the instant that part of the sectional third rail *r* carried by the bridge completes the circuit at the plates *pp*, so as to make the third-rail connections. Consequently the locking-armatures 17 between F and G will be restored to their normal positions and the danger-signals 19 will cease to give indication of danger. In the event of a car passing the switch next adjacent to the bridge on either side thereof when the latter is open it will of course be understood that after the bridge is closed it will be necessary to operate in the proper direction the manual circuit-closing switch found in each of the switch-boxes and illustrated in Fig. 7. This will be effected by taking hold of the switch-handle and moving it, say, to the right or the left, dependent upon the direction in which the car is moving, until the proper spring-terminal *s* is hooked up behind its locking-armature 17. The car may then proceed. Should the bridge be rotated in a reverse direction, the switch *k* would obviously close the circuit in a manner already described, its free end then contacting with the upper contact-plate 12. The bridge being closed, suppose now that a car enters the section between F and G in either direction. The flange of the trolley, acting in the manner described, will close the cir-

cuit through the closing rail or contact 5 and conductor 3 to the proper switch-operating magnet *f* and connect the sectional third rail *r* to the current feeder or main. When this is effected, current will flow from the third rail *r* between the points F and G, through the branch conductor 10, electromagnet *g*, to the tram-rail or return-conductor *t*, causing the hooked armature-lever *h* to lock the bridge in its normal position, so that the attendant cannot interfere with it after the car has once entered the section. At the same time the tap-bell *j* will give a continuous warning of the fact that a car has entered within the danger-line and that an attempt should not be made to move the bridge. This tap-bell *j* will obviously continue to ring so long as the sectional third rail *r* between the points F and G is connected with the current feeder or main, and the hooked armature-lever *h* will also hold the bridge in locked position until the car passes out of the section and releases the spring-terminal *s*, through which circuit connection had been effected to the current feeder or main.

Suppose it is desired to have two trains pass each other at the siding *d* between F and G. The first train to arrive upon the section between F and G will of course maintain control of that section and of the sections in the rear and in advance, as already indicated in connection with Fig. 1. When it reaches the siding *d*, it will be switched in the usual way upon said siding, and as it passes the center thereof the flange 23 of the trolley 14, passing in either direction, will momentarily close the circuit between the siding trolley-rail *e* by conductor 9 to the releasing-magnets 15 15 at the points F and G, thereby causing the locking-armatures 17 to release the spring-terminal which had connected the section to the current feeder or main. This will be effected momentarily as the car passes by the circuit-closing rails or contacts 5 by its momentum. It will of course be seen that the danger-signals at the point E and at the point on the right of the point G (not shown) will at once be returned to "safety," and any car at either of these points may now advance and pass the first-mentioned car on the main track.

Referring now to Fig. 3, I will describe how collisions are avoided in my novel system at the crossings of two lines of railways. In this figure of the drawings the two lines of tram-rails *tt* are shown crossing each other, and one set of tram-rails is connected to the pole of the power-house generator 21, the + pole thereof being connected to the current feeder or main *c* for that system. The other line of rails is connected to the - pole of a second power-house generator 22, the + pole of which is connected to a current feeder or main *c* for that system. The wiring of each system with relation to its special power-house generator, current-feeder, switching-magnets, releasing-magnets, third rails, and signaling devices is identically the same as

is shown in Fig. 1 of the drawings. It will be noted, however, that where the tracks cross each other the tram-rails are mechanically and electrically united, as are also the third-rail sections, the arrangement being such that when any car passes into the crossing section the circuit connections in the front and the rear of the car are such that danger-signals will be displayed at the distant ends of the two adjacent sections upon that system and also at the distant ends of the two adjacent sections upon the crossing system. In the first system, connected to the power-house generator 21, I have lettered the sections A, B, C, and D, and in the second system, connected to the power-house generator 22, the corresponding sections are lettered E, F, G, and H. A car is shown diagrammatically on the right in the first system, with its motor *m* connected to the car-wheels 16, the trolley 14 resting upon the right-hand end of the crossing third-rail sectional conductor *r*, which is united, as will be seen, with the other crossing sectional third-rail conductor *r*, as illustrated by a circle at the center of the crossing tracks. When the car passed the point C, moving in the direction of the arrow from right to left, the flange 23 of the trolley 14 closed the circuit between the third rail *r* of the section between C and D and the circuit-closing rail or contact 5 by conductor 3 through switch-operating magnet *f*, thus causing the yielding terminal *s* to be drawn into its locked position, as shown, with its free end behind the locking-armature 17. Consequently a circuit was closed from the power-house generator 21 by the current feeder or main *c* to the point C by the branch conductor 1, through the locking-armature 17, yielding terminal *s*, branch conductor 2 to the sectional third rail *r*, between the points B and C, thence through the trolley 14, conductor 4, to the motor *m*, car-wheels 16, and tram-rails *t* to the power-house generator. At the same time the circuit was closed to the rear from the yielding terminal *s* by a conductor 7 in the direction of the arrows to the releasing-electromagnet 15 at the point D and also to the lamp or signal 18 at that point, thereby causing the locking-armature to be held up so that the motorman of a car following in the rear is warned by the danger-signal, and should he pass the point D his car would stop on entering the section for lack of current. In the same manner the circuit was closed from the distant end of the third rail *r*, over which the trolley 14 is passing in the direction of the arrow, by the branch conductor 2, conductor 7, to the releasing-electromagnet 15, and electric lamp or signal 18 at the point A, thus holding up the locking-armature 17 and displaying a danger-signal at that point, thereby preventing the entrance of a car in that direction. The circuit was also closed over the two branches of the crossing third rail *r* of the second system by the branch conductors 2 and conductors 7 7 to the releasing-

magnets 15 15 and lamps or signals 18 18 at the points E and H, thus displaying danger-signals at these points and preventing the entrance of a car upon the crossing track in either direction. Consequently no car can enter in any direction upon the crossing sections until the car at present passing over that section has passed beyond the point A and closed the circuit to the switch-operating magnet *f* at that point of the section next to the left of the point A, at which time all of the danger-signals will be restored to "safety" and all of the locking-armatures released in the same manner as has been described in connection with the description of the operation of the system illustrated in Fig. 1.

Referring now to Figs. 4 and 5 of the drawings, 24 represents the base, and 27 the chair or support, of one of the insulators for the third rails and attached parts, said parts being made, preferably, of cast-iron and subjected to any vitrifying process which will coat their surfaces so as to give both the best insulating effect. 25 is a downwardly-extending neck in the base 24, screw-threaded interiorly for the purpose of receiving a bolt 30. The chair 27 is provided with vertical sides 29, adapted to support laterally the side timbers *sv sv*, which constitute the protecting-conduit for the third rails *r*, the current feeder or main *c*, and signaling and releasing conductors 7 7. The lower portion of the chair is provided with a petticoat 28, adapted to entirely surround the supporting-base 24, and thereby prevent water from reaching the insulating-joint between the base and the chair. 31 and 32 are washers and sleeves, of vegetable fiber, adapted to effectually insulate the chair and its downwardly-extending petticoat from the base, the arrangement being such that when the bolt 30 is firmly screwed home all of the parts are securely held together and insulated from each other, after which the chamber 33 around the head of the bolt is filled with asphaltum or other insulating material which will harden. These insulators are secured to the ties of the track, preferably outside of the tram-rails, by bolts 26 26, and with the inner walls of the lateral sides 29 29, in alinement with each other, so as to receive the side timbers *sv sv*, each of which is composed of two parts, the lower portion being grooved, as shown, to receive in one instance the signaling and releasing conductors 7 7 and in the other the current feeder or main *c*. *vf vf* are vegetable fiber or other insulating-blocks having notches in their inner faces corresponding to the cross-section of the base of the third rail *r*, which in the present instance is similar to the ordinary tram-rail. 34 34 are bolts having heads 35 and set-nuts, as shown, their function being to extend inward through the sides 29 and the lower portion of the side timbers *sv* into openings in the insulating-blocks *vf vf* in such manner as to grip or clamp the blocks firmly against the lateral faces and lower flange of the rail, after

which the set-nuts are secured so as to hold all of the parts. Additional bolts 34 are provided for the upper portions of the side timbers *sv*. 5 5 are the circuit-closing rails or contacts hereinbefore referred to, said rails or contacts being secured to the inner faces of the side timbers *sv* and in such manner that when the trolley 14 is in the position shown in the drawings the flange 23 thereof will bridge the space between the particular circuit-closing rail or contact 5 and the third rail *r*, dependent upon the direction in which the same is moving, it being apparent that if the trolley is lifted out of the conduit and reversed and lowered again into position the flange 23 will make connection on the other side, as shown in dotted lines. (See Fig. 4.)

Referring again to Figs. 4 and 5 and also to Figs. 6 and 6^a, I will describe the manner of supporting and insulating the switch-boxes and of forming the circuit connections between the switching apparatus therein and the circuits of the system and in such manner as to arrive at the best possible insulating effects for all of the parts. 37 is a rectangular-shaped bracket cast integral with the chair 27, said bracket having sufficient area to support the switch-box 38 and its box-like protecting-cover *sb*. In the upper face of the supporting-base of the chair and in the corresponding face of the bracket 37 is cast a channel or groove 36 of proper width and depth to hold the inleading ends of the signaling and releasing conductors 7 7, the branch conductor 1, all of the other short conductors running to the switch-box, and the third rails and return-conductor, a hole or opening having been drilled or formed through the side 29 in alinement with the channel or groove for conveying said conductors there-through. 38 represents the switch-box, which is made, preferably, wholly of treated wood or other insulating material, such as vegetable fiber, and is open at its upper side, a groove 39 being formed around the upper edge, in the bottom of which is located a metal bus-bar or wire 41, constituting a part of the earth or return-conductor of all of those conductors which run to earth or to the tram-rails *gw*, being the common return-wire from the bus-bar of the tram-rails. (See Fig. 6.) This box 38 is provided with a hole or opening in its bottom, which is located directly over the outer end of the channel or groove 36, when the box is finally secured in position upon the bracket 37 by screws, as shown. The switch-operating magnets *ff*, of horseshoe type, are secured directly to the inner wall of the switch-box 38, with their poles facing each other, the yielding conducting-terminals *s s* being secured directly to the inner wall of the box also, so that their operating-armatures face the free poles of the magnets *ff*. The single switch-releasing magnet 15, also of horseshoe type, is secured within the inner wall of the switch-box and with its free poles directly opposite the lock-

ing-armatures 17, having hooks or notches, as shown, and leaf-springs for normally holding said armatures against back stops. The yielding conducting-terminals *s s* are provided at their free or contacting ends with a number of flexible fingers adapted to make yielding contact with the conducting part of the locking-armatures 17. 43 43 are sheets of insulating material secured to the faces of the hooked part of the armatures 17, so as to prevent any electrical contact between the terminals *s* and the armatures 17 until the former are secured in their locked positions. It will be noticed that there are two independent armatures 17, one for each pole of the releasing-magnet 15, instead of a single armature, as disclosed in Figs. 1, 2, and 3; but it will be understood that both of these armatures will be operated simultaneously by this magnet when either leg of the horseshoe-core thereof is energized by a current flowing from either one of the signaling and releasing conductors 7, connected in multiple thereto, as illustrated in Figs. 1, 2, and 3 of the drawings, said coils each having sufficient magnetizing capacity to effectually saturate the entire core, as before stated in connection with Fig. 1. *a* is the manual switch, also illustrated in Fig. 7, said switch being wholly within the switch-box and adapted to enable a motorman or other person on opening the box to manually operate either of the yielding conducting-terminals *s*, dependent upon the direction in which the switch is moved. This switch is used for connecting a third rail when a car has been inadvertently run by a switch-box and upon the next sectional third rail when the latter is dead, because of the presence of a car on a preceding section, and may only be used after said preceding car has passed the next switch-box in advance. In putting this part of the system together the adjacent ends of the insulated signaling and releasing conductors 7 7, running in opposite directions from each switch, as shown in Figs. 1, 2, 3, 7, and 8, are conveyed downward through the lower part of their supporting-timbers to the channel or groove 36 and thence to the opening 40 in the bottom of the switch-box. In a similar manner the branch conductor 1, connected to the current feeder or main *c*, is conveyed downward in a groove in its supporting side timber to the same channel or groove, thence upward through the opening 40 in the bottom of the box. In like manner the conductors 2 3 and ground-wire *gw* are conveyed through the same channel or groove into the switch-box through the opening 40 in the bottom thereof and the proper connections made at their outer ends, after which the box is secured in place upon the bracket 37 by the screws extending through the bottom thereof, the heads of said screws being countersunk. Then the countersunk openings, the hole or opening 40, and the channel or groove 36 are all filled with hot liquid asphalt, which

is allowed to cool, so as to effectually insulate all of the conductors and the bottom of the switch-box. Finally the proper connections are made to the magnets, terminals, and locking-armatures in the box. The removable cover *sb*, of box-like form, is provided at its opposite sides with lugs or ears 42, having bolt-holes or other means for detachably securing it directly to the bracket 37, there being provided within the inner surface of said cover a downwardly-extending ledge 44, adapted to fit loosely within a groove 39, the arrangement being such that when said groove is filled with oil and the cover *sb* secured in position it (the cover) will act after the manner of a diving-bell and prevent any moisture from reaching any of the switch connections in the switch-box, all of said connections, together with the electromagnets and terminals, being preferably secured as near as possible to the upper or open edge of the box 38.

In Figs. 7 and 8 of the drawings I have illustrated my novel manner of preventing abnormal arcing at the ends of adjoining sectional third rails and at the switching-terminals in the switch-boxes and also of avoiding injury to the motors on board the cars, by reason of sudden changes of current potential, such as would ordinarily occur in connection with third-rail systems using enormous current volumes, where violent changes of current potential and quantity would naturally result.

In Fig. 7 I have illustrated two adjoining sectional third rails *r*, a current feeder or main *c*, and tram-rails *t*, together with switching-electromagnets *ff*, releasing-magnet 15, and other circuit connections similar in all respects to those disclosed in Figs. 1 to 3, inclusive, the circuit relations not being essentially different, except that in the present instance I have included between the ends of the adjacent sectional third rails *r* three short sectional rails on each side of the break—namely, $r^1 r^2 r^3$ and $r^3 r^2 r^1$ —said short sectional rails $r^1 r^2 r^3$ being connected together successively by resistances of, respectively, one hundred, two hundred, and three hundred ohms in the first instance and three hundred, two hundred, and one hundred ohms in the second instance. I have illustrated also a diagrammatic view of a car traveling from left to right in the direction of the arrow and provided with a motor *m* and trolley-shoe 14, 16 representing one of the car-wheels moving upon the tram-rail *t*. The circuit connections, in so far as they relate to the system embracing the switches, &c., are identically, as already indicated, the same as hereinbefore described in connection with Figs. 1, 2, and 3. It will be noted, however, that with the improvement in question when the trolley 14 passes from the third rail *r* to the short third rail r^1 a resistance of one hundred ohms is placed in circuit, and in like manner when it passes from the short rail r^1

to r^2 a resistance of two hundred ohms more is placed in circuit, and when it passes from r^2 to r^3 a resistance of three hundred ohms more is placed in circuit, or a total of six hundred ohms, so that if the voltage of the system be, say, six hundred and the current-generating capacity of the power-house generator six hundred amperes there will be flowing at the time that the trolley 14 passes onto the rail r^3 one ampere, an amount of current which, it will be understood, will not produce damaging arcing between the trolley 14 and the short rail r^3 as the former leaves the latter. It will also be apparent that when the circuit is closed through the short conducting rail or contact 5, conductor 3, and switching-magnet *f* the quantity of current flowing through the system will be such that there will be no damaging arcing in the switch-box at the terminal of the switch located at the other end of the section when the locking-armature 17 at that point is drawn into its upper position and the terminal released. As the trolley passes off section r^3 , therefore, there is little arcing, and in like manner as it enters the next section there can be no damage to the motor, owing to the fact that there is now six hundred ohms resistance between the short rails $r^3 r^2 r^1$ and the sectional third rail *r*, upon which the car is entering. Consequently as the trolley passes from r^3 to r^2 , &c., the current will gradually increase through the motor, this upon the supposition, of course, that the controller on board of the motor was so set as to supply the full current at the time the car was passing the switch.

In the modified form of the invention illustrated in Fig. 8 I have shown the major portion of the non-arcing apparatus as carried by the car, the same consisting of a rheostat *rh* and a vertical sliding bar *u*, provided with a roller *q* at its lower end, said sliding bar being connected at its upper end to a pivoted arm *l*, to the free end of which is secured the contacting arm *y* of the rheostat, said rheostat embracing sectional coils of from seventy-five to six hundred ohms. 4 is the conductor from the trolley 14 to the motor *m*, and 20 the controller; 16, the car-wheels, as before, all of said parts, as before indicated, being carried by the car. In the middle of the road-bed at each switch-box is located a double-inclined plane *n'* of from sixty to one hundred feet in length and of such height as to cause the roller *q* to be gradually lifted when a car is approaching a switch-box in either direction until the free end of the arm *y* is in the upper position, as shown in full lines. *dp* is a dash-pot or retarding device connected by a link *w* with the arm *l* for regulating the return of said arm to its normal position by the action of the spring *v*. With this modified form of the invention suppose a car to be traveling from left to right in the direction of the arrow. At the time it reached the point at the extreme left-hand edge of the drawing the arm *l* was in its lower position

(shown in dotted lines) and the rheostat was entirely cut out, so that on the supposition that the controller was in the position shown with all of the current "on" as the car advanced the inclined plane *n* caused the roller *q* to lift the arm *l* into the upper position, thus gradually cutting in resistance of the rheostat *rh* until the entire amount of resistance was thrown into circuit, which occurred at the time that the car passed the switch-box, so that, as before, a minimum amount of current is flowing, and consequently minimum arcing effects will result both at the adjoining ends of the third rails *r* and at the terminals of the switch at the distant end of the sectional third rail in the switch-box. An operating-handle is also shown connected to the free end of the arm *l* for enabling the motorman to regulate the movements of said arm at will at points between the switch-boxes or when it becomes necessary to cause the current to flow to the motor *m* in less time than would result through the action of the dash-pot *dp* and spring *v*. It will of course be understood that with the apparatus illustrated in Figs. 7 and 8 for preventing abnormal arcing at the ends of adjoining third rails and at the switching-terminals in the switch-boxes it will be necessary that the car shall have sufficient momentum on approaching a switch-box to carry it by the same, so that by preference the switch-boxes should always be located on level ground or at such points as will effectually accomplish this result.

In Fig. 8 of the drawings I have indicated also the fact that the signals or lamps 18 are connected to the signaling and releasing conductors 77 and the tram-rails *t* at points outside of the switch-boxes, it being obvious that these signals may be connected up in such manner without affecting the circuit relations of the conductors in the switch-boxes.

I make no claim in the present application to any of the features hereinbefore described, and shown in the accompanying drawings, when combined with signaling apparatus, as these features constitute the subject-matter of a divisional application filed by me in the United States Patent Office on the 25th of December, 1901, bearing Serial No. 76,564; nor do I claim hereinafter any method of operation attributable to any of the structural apparatus disclosed in this application, as the generic methods of avoiding rear and front end collisions by the practice or use of the apparatus herein disclosed are made the subject-matter of a divisional application filed by me in the United States Patent Office on the 2d day of December, 1901, bearing Serial No. 84,322; nor do I make any claim hereinafter to the method of avoiding abnormal arcing at the terminals where the sectional conductors are connected to and disconnected from the current feeder or main by increasing the resistance to the current or reducing the current-flow through such ter-

minals as the current-collector passes from one sectional conductor to another, as this feature constitutes the subject-matter of a still further divisional application filed by me in the United States Patent Office on the 20th day of March, 1902, bearing Serial No. 99,141.

In still another application filed by me in the United States Patent Office on the 5th day of December, 1900, bearing Serial No. 38,724, I have disclosed means for preventing front and rear end collisions, wherein the sectional conductors are automatically connected to a current feeder or main through the agency of mechanical switches controlled by the movement of a car and disconnected therefrom through the agency of electromagnetic devices included in safety or releasing circuits extending to the front and rear in the same manner as the safety and releasing circuits are disposed in the present application. In that application I have claimed means for preventing either front or rear end collisions, limiting the claims to mechanically-actuated switching devices. In the present application I have claimed, broadly, a safety system in which the sectional conductors are positively connected or locked into connection with the current feeder or main by a local source of power or energy distinct from or independent of the working source of current-supply and releasing devices included in releasing-circuits, all so arranged that the switches are rendered temporarily inoperative either in the front or rear, or both, while a car is passing over a given section.

I have chosen to place the generic claims as to this structural apparatus in the present application, because I deem electromagnetic switching devices like those disclosed in the present application to be preferable to those where the switches are controlled mechanically, and this for the reason that where the electromagnetic switching devices are controlled wholly by the working current as to their closure and as to their release a greater element of safety enters than is possible with mechanically-actuated switching devices, it being apparent that under certain conditions a car might pass a switch by its momentum after the working current had been momentarily or temporarily cut off—as, for instance, by the stoppage of the power-house dynamo—and if the switch were mechanically connected in that instance it would connect the sectional conductor to the working conductor, and thus make it possible to cause a collision, while with electromagnetically-operated switches operating in the manner disclosed in the present application such a condition is practically impossible; nor do I limit myself to all of the details of invention hereinbefore described, and illustrated in the accompanying drawings, as many of said details may be materially departed from and still come within the scope of my claims, hereinafter made, it being obvious that many of

the features of my invention hereinbefore described may be utilized in connection with electric railways in general, and my claims are designed to include all such uses.

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

1. A safety system of electric railways embracing a current feeder or main, a series of
10 sectional third rails or conductors normally disconnected therefrom and switching mechanism for locking said sectional conductors to the current feeder or main as a car or vehicle passes by or over the same; in combination
15 with safety-circuits including devices for releasing the conducting-terminals of the switches, said safety-circuits being permanently connected to the negative pole of the power-house generator so as to be normally
20 without electrical current potential; the entire arrangement being such that when a car is passing by or over a given sectional third rail or conductor the switch at the distant end of the sectional third rail or conductor immediately in the rear thereof is rendered temporarily inoperative until the car passes out of
25 said section, substantially as described.

2. A safety system of electric railways embracing a current feeder or main, a series of
30 sectional third rails or conductors normally disconnected therefrom and switching mechanism for locking said sectional conductors to the current feeder or main as a car or vehicle passes by or over the same; in combination
35 with safety-circuits, two for each sectional third rail or conductor, said safety-circuits including devices for releasing the conducting-terminals of the switches and so connected to the power-house generator as to be normally
40 without electrical current potential, the entire arrangement being such that when a car is passing by or over a given sectional third rail or conductor the switches at the distant ends of the two adjacent sectional third rails
45 or conductors are both rendered temporarily inoperative until the car passes out of the section over which it is traveling, substantially as described.

3. A safety system of electric railways, embracing a current feeder or main, a series of
50 sectional third rails or conductors normally disconnected therefrom and switching mechanism having conducting-terminals for connecting said sectional conductors to the current feeder or main as a car or vehicle passes
55 by or over the same; in combination with releasing-electromagnets for the conducting-terminals of the switches, the individual coils of said releasing-magnets being included in
60 circuit with safety-circuits running in opposite directions and connected to earth and to the adjacent ends of distant sectional third rails or conductors, substantially as described.

4. A system of electric railways embracing
65 a current feeder or main, a series of sectional third rails or conductors normally disconnected therefrom, and a series of electromagnetic

switching devices for connecting said sectional conductors to the current feeder or main as a car passes by or over the same; in
70 combination with additional conductors, two for each sectional third rail or conductor, said additional conductors including electromagnetic devices for releasing the conducting-terminals of the switches, the entire arrangement
75 being such that when a car is passing by or over a given sectional third rail or conductor the switches at the distant ends of the two adjacent sectional third rails or conductors are both rendered temporarily inopera-
80 tive until the car passes out of the section over which it is traveling, substantially as described.

5. A system of electric railways embracing a current feeder or main, a series of sectional
85 third rails or conductors normally disconnected therefrom and electromagnetic switching devices having conducting-terminals for connecting said sectional conductors to the current feeder or main as a car passes by or over
90 the same; in combination with releasing-electromagnets for disconnecting the terminals of the switches, the individual coils of said releasing-magnets being included in circuit with conductors running in opposite direc-
95 tions and connected to earth and to the adjacent ends of distant sectional third rails or conductors, substantially as described.

6. An electric-railway system embracing a current feeder or main; a series of sectional
100 third rails or conductors for a main track normally disconnected from the current feeder or main and a siding having a third rail or conductor adapted to be connected in circuit with the current feeder or main; in combina-
105 tion with switching devices and circuit connections whereby when a car approaches within a definite distance of the siding it obtains control of the operating-current for a section of the main track until it passes upon
110 the siding adjacent thereto; together with additional means for restoring the circuit condition of the sectional conductor of the main track to normal, the arrangement being such that no other car can approach the sid-
115 ing in either direction until the first-named car has been side-tracked and the circuits restored to normal condition, substantially as described.

7. An electric-railway system embracing a
120 current feeder or main; a series of sectional third rails or conductors for a main track normally disconnected from the current feeder or main and a siding having a third rail or conductor adapted to be connected in circuit
125 with the current feeder or main; in combination with switching devices so arranged that when a car approaches within a definite distance of the siding it obtains control of the working current for the section adjacent to
130 the siding and in such manner that no car can approach in either direction until the first-named car has passed upon the siding, substantially as described.

8. In an electric-railway system a current feeder or main, two or more sectional third rails or conductors normally disconnected therefrom and switching mechanism adapted to connect said sectional conductors to and disconnect them from the current feeder or main as a car passes over the route; together with a siding and circuit connections therefor so arranged that when a car passes within a definite distance of the siding it obtains absolute control of the working current for that section until said car has passed upon the siding; and additional means for restoring the electrical conditions of the third rails of the main track to normal after the car has been properly side-tracked, substantially as described.

9. A safety system of electric railways embracing a current feeder or main; a series of sectional third rails or conductors normally disconnected therefrom and switching mechanism for connecting said sectional conductors to the current feeder or main as a car or vehicle passes by or over the same; in combination with a drawbridge carrying a sectional third rail or conductor and circuits and circuit connections relatively so arranged with relation to one of the first-named sectional third rails or conductors that when the drawbridge is moved from its normal or closed position a car is prevented from approaching either end thereof, substantially as described.

10. A safety system of electric railways embracing a current feeder or main; a series of sectional third rails or conductors normally disconnected therefrom and switching mechanism for connecting said sectional conductors to the current feeder or main as a car or vehicle passes by or over the same; in combination with a drawbridge carrying a sectional third rail or conductor and circuits and circuit connections relatively so arranged with relation to one of the first-named sectional third rails or conductors that when the drawbridge is moved from its normal or closed position no working current can be supplied to an approaching car for a definite distance from either end of the bridge, substantially as described.

11. A safety system of electric railways embracing a current feeder or main; a series of sectional third rails or conductors normally disconnected therefrom and switching mechanism for connecting said sectional conductors to the current feeder or main as a car or vehicle passes by or over the same; in combination with a drawbridge carrying a sectional third rail or conductor, circuits and circuit connections and locking mechanism, all so arranged that when a car approaches either end of said bridge within a definite distance the latter is locked or held so that it cannot be disturbed until after the car has crossed the bridge or passed out of the section which includes the bridge, substantially as described.

12. In a safety system of electric railways

a current feeder or main; a series of sectional third rails or conductors normally disconnected therefrom; switching devices for connecting said sectional conductors to and disconnecting them from the current feeder or main as a car or vehicle passes over the route; in combination with a similar system crossing the first-named system; together with switching devices, circuits and circuit connections for both systems, so arranged that when a car reaches a definite point from the crossing in either direction it prevents any other car, approaching in any direction on either of the four intersecting branches, from advancing toward the crossing beyond a definite distance until the first-named car has crossed, substantially as described.

13. Two systems of electric railways embracing each a current feeder or main; a series of sectional third rails or conductors normally disconnected therefrom; switching devices for connecting said sectional third rails or conductors to and disconnecting them from the current feeders or mains; in combination with electrical circuits and circuit connections for the two systems so interconnected and arranged that when a car reaches a definite point from the crossing in either direction it obtains absolute control of the working current of both systems and prevents any car from approaching the crossing upon any of the four intersecting branches by depriving it of working current at definite points from the crossing until the first-named car has crossed, substantially as described.

14. A system of electric railways of the sectional-third-rail type embracing a current feeder or main and switching devices for connecting the third-rail sections to the current feeder or main; in combination with circuit-closing rails or contacts located at the adjoining ends of the sectional third rails or conductors and on opposite sides thereof; together with a reversible trolley, the arrangement being such that the sectional third rails are connected to the current feeder or main in advance of the trolley no matter in which direction the latter may be moving, substantially as described.

15. In a sectional-third-rail system of electric railways a series of insulators; in combination with a series of sectional third rails or conductors and a series of water-tight switch-boxes including electromagnetic switching mechanism; together with a current feeder or main, all of said parts being supported or sustained by said insulators, the switch-boxes being constructed of insulating material and each provided with an opening at its bottom through which all of the circuit connections are effected; together with a removable water-tight cover adapted to prevent the admission of water after the manner of a diving-bell, substantially as described.

16. Means for preventing arcing at the ends of adjacent sectional-third-rail sections of a third-rail system of electric railways and at

the terminals in the switch-boxes thereof, consisting of a variable resistance and circuit connections so arranged that as a car approaches the adjacent ends of two third rails the current supplied to the motor is reduced to a minimum and again restored to normal conditions after the switch is operated, substantially as described.

17. An electric-railway system embracing a current feeder or main; a series of sectional third rails or conductors normally disconnected therefrom; switching devices for connecting said sectional third rails or conductors to and disconnecting them from the current feeder or main; in combination with a car provided with a trolley or contact-shoe for conveying current to a motor on board thereof; together with means adapted to automatically lower the current potential at the switch-terminals and at the junction of the third-rail sections or conductors each time the trolley or contact-shoe passes from one sectional third rail or conductor to another, substantially as described.

18. In a sectional-third-rail system of electric railways means for preventing abnormal arcing at the ends of adjacent third rails and at the switching-terminals in the switch-boxes, consisting of a variable resistance carried by a car; in combination with means located in or adjacent to the road-bed for automatically causing said variable resistance to be gradually inserted in circuit with the motor on board the car until a minimum flow results at the time that the junction of the third rails is passed, and to correspondingly increase the current flow from the next adjacent third rail to the motor until a maximum flow is obtained, substantially as described.

19. In a safety system of electric railways a current feeder or main; a drawbridge carrying a sectional conductor constituting a part of the service-conductor for supplying current to the motor on board a car as it passes over the same, when in closed position; in combination with locking mechanism and circuits operatively connected therewith and so arranged that after a car approaches within a definite distance of either

end of the bridge, the latter is locked so that it cannot be moved from its normal position; substantially as described.

20. A sectional-third-rail safety system of electric railways provided with switching mechanism for effecting electrical connection of the third rails to and disconnection thereof from the current feeder or main; in combination with means for securing said third rails adjacent to the road-bed; together with a protecting-conduit for said rails consisting of side timbers located on opposite sides thereof and provided with means for effectually securing and protecting the current feeder or main and other conductors, substantially as described.

21. A safety system of electric railways embracing a current feeder or main, a series of sectional third rails or conductors, a protecting-conduit consisting of side timbers located on opposite sides of said third rails or conductors and having channels or grooves for concealing the conductors of the system; in combination with switch-boxes inclosing switching devices for connecting the sectional conductors to and disconnecting them from the current feeder or main; together with a series of insulators supporting all of said parts, substantially as described.

22. In an electric-railway system a current feeder or main; sectional third rails or conductors normally disconnected therefrom; switching mechanism for connecting said sectional conductors to the current-feeder, and releasing-electromagnets for disconnecting them therefrom; said releasing-electromagnets being included in circuits connected each at one end directly to earth or return and extending in opposite directions to the nearer ends of adjacent sectional conductors, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

CHARLES J. KINTNER.

Witnesses:

JAMES P. J. MORRIS,
M. F. KEATING.