(No Model.) 3 Sheets—Sheet 1.

H. F. GRAY.

RAILWAY SUPPLY SYSTEM.

No. 534,642. Patented Feb. 26, 1895.

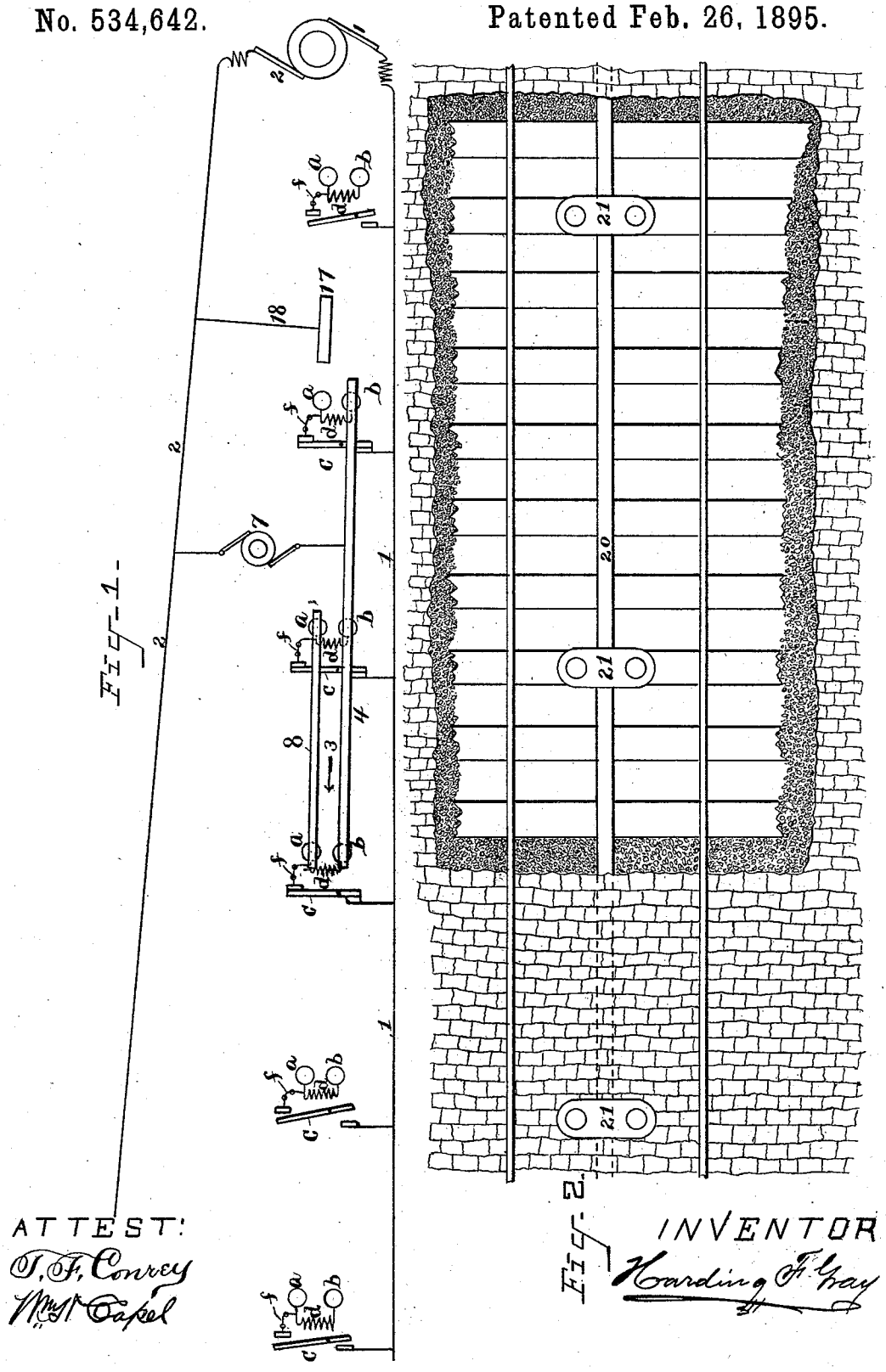


Fig. 1.

Fig. 2.

ATTEST:
T. F. Conroy
Wm. F. Capel

INVENTOR
Harding F. Gray

(No Model.) 3 Sheets—Sheet 2.

H. F. GRAY.

RAILWAY SUPPLY SYSTEM.

No. 534,642. Patented Feb. 26, 1895.

Fig. 3.

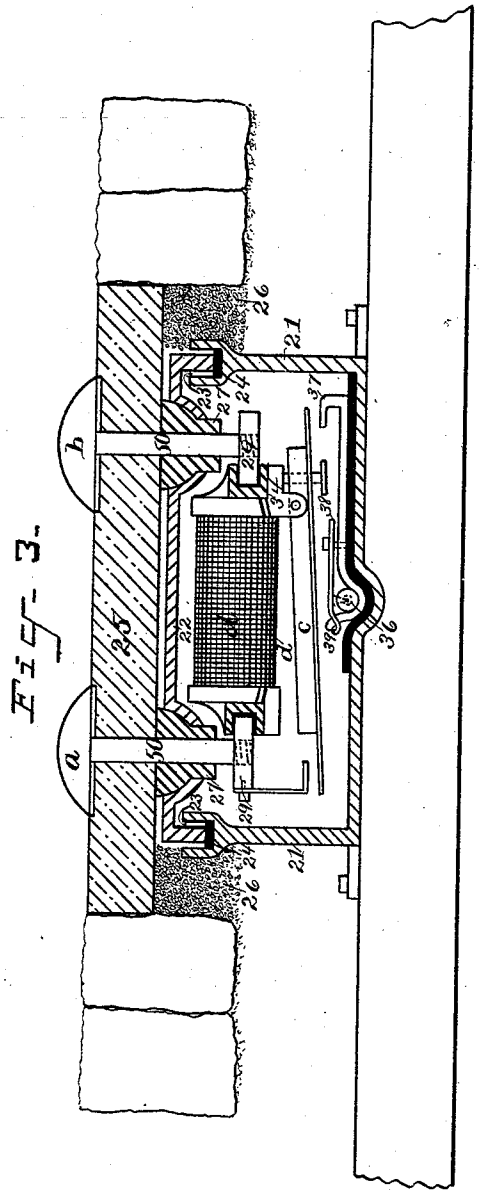


Fig. 5.

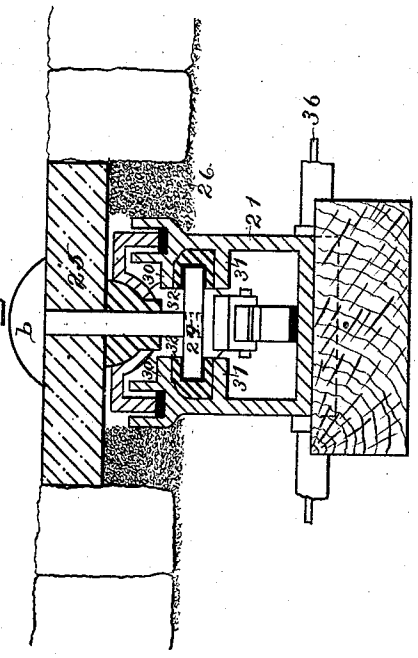
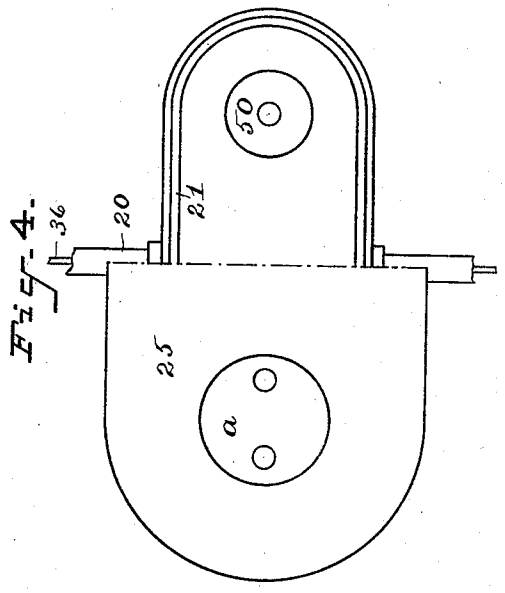


Fig. 4.



ATTEST:
T. F. Conroy.
Wm. H. Capel

INVENTOR:
Harding F. Gray

(No Model.) 3 Sheets—Sheet 3.

H. F. GRAY.

RAILWAY SUPPLY SYSTEM.

No. 534,642. Patented Feb. 26, 1895.

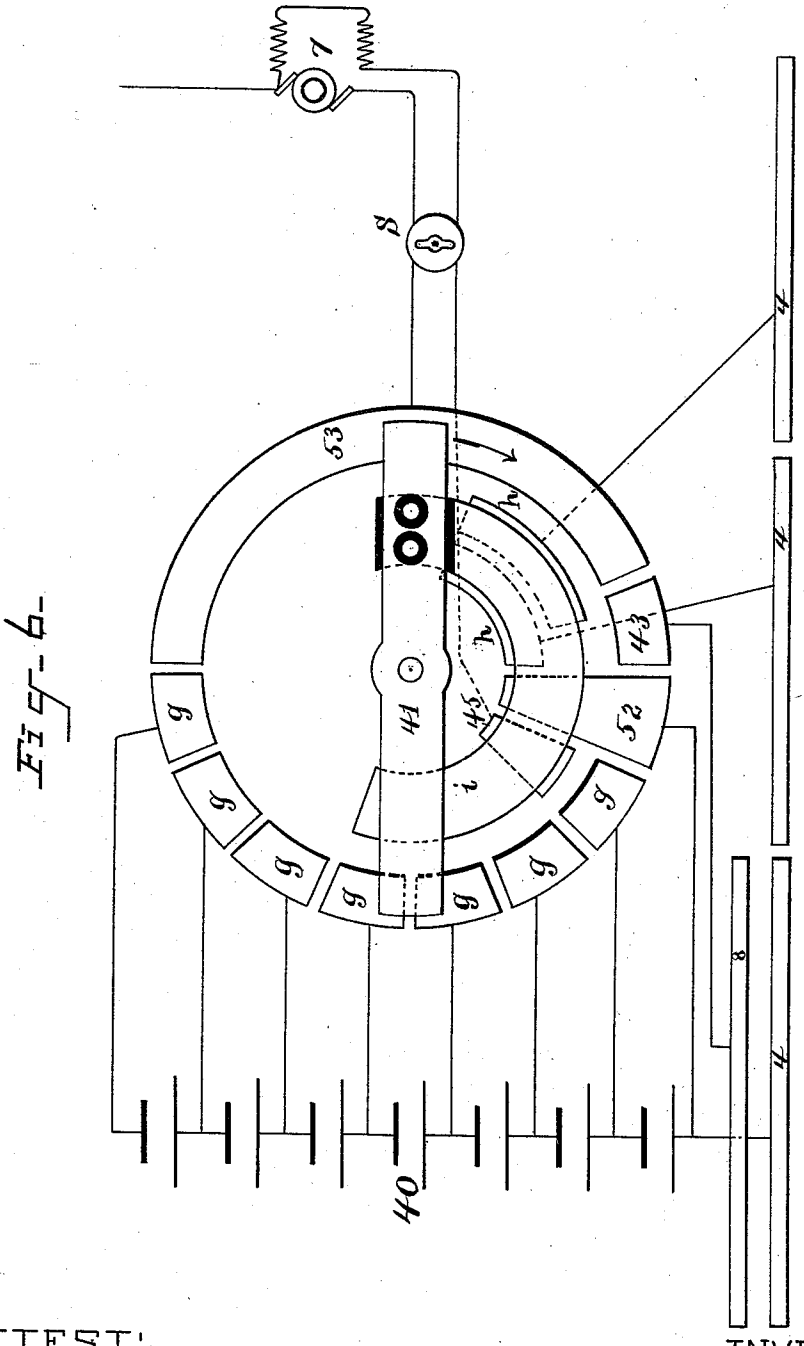


Fig. 6.

ATTEST:
T. F. Conroy.
Wm. A. Capel.

INVENTOR:
Harding F. Gray

UNITED STATES PATENT OFFICE.

HARDING F. GRAY, OF PASSAIC, NEW JERSEY, ASSIGNOR TO THE GRAY ELECTRICAL TRANSIT COMPANY, OF NEW JERSEY.

RAILWAY SUPPLY SYSTEM.

SPECIFICATION forming part of Letters Patent No. 534,642, dated February 26, 1895.

Application filed August 8, 1893. Serial No. 482,700. (No model.)

To all whom it may concern:

Be it known that I, HARDING F. GRAY, a citizen of the United States, and a resident of Passaic, in the county of Passaic and State of New Jersey, have invented certain new and useful Improvements in Electrical Railways, of which the following is a specification.

My invention relates to that class of electric railways wherein the moving vehicle takes up current from the working contact or conductor that is normally disconnected from a well insulated supply wire or conductor leading from a suitable source of electric energy, and provision is made for automatically completing the connection between the said supply conductor and the working contacts or conductor when the passing car is over the said working contact or conductor from which the current used for driving the car is drawn.

As well understood in the art such a system has heretofore been operated by the use of electrically actuated switches in suitable switch boxes along the line of track, said switches being brought into action to connect the working contact or conductor with the supply conductor when the car reaches a section and to be automatically disconnected when the car passes beyond it.

My invention is designed more particularly for electrically operated railways wherein the working contact or conductor is fixed in the road bed with its contact surface slightly elevated above the surface of the road bed but in such way as not to constitute an obstruction to passing traffic.

I prefer in carrying out my invention to use working contacts consisting simply of contact points but I do not limit myself to the linear extent of said contacts in the direction of travel of the vehicle. In fact they might extend to such a distance or even in such proximity to one another as to constitute sections of rail without departing from my present invention.

My invention consists more particularly in means whereby the electrically operated switches may be brought into action. Heretofore such switching devices have been operated in several ways,—either by means of electro or permanent magnets attached to the passing vehicle by their passing influence causing the switches to operate and close the circuits to the working contacts from whence by suitable current-collecting devices the current is collected for use on the vehicle. Other ways have also been invented, such as passing current down from the top of contact points or conductors on the road bed through coils into the ground or return conductors. These plans have generally involved the use of a high resistance coil to throw the switch into operation, when said coil is cut out by a suitable mechanism, the current thereafter passing up through a series coil. The circuit is broken by the car leaving the said contact point or conductor when, the series coil becoming demagnetized, a disconnection from main feeding conductor ensues.

Another plan designed to do away with the high resistance coil involves the use of two sets of contacts or conductors on the road bed, one constituting working contacts or conductors and the other supplemental contacts or conductors by the agency of which the switch devices are brought into operation through the action of a battery carried on the car.

Certain defects belong to the above mentioned system which in their practical operation are insurmountable.

The difficulty arising in the operation of the first named plan is, that fast speed will not give the magnetic influence on the passing vehicle sufficient time to operate the switching devices as described. The difficulty in the second plan is that when snow, ice, dirt and other like débris has collected upon the top of the conductor in the road bed (if it be used with high resistance shunt coil), the accumulation will so increase the resistance between it and the current collecting device or brush as designed with the said system that the leakage which would ensue makes it improbable that sufficient current would pass down through the accumulation on top the conductor on the road bed, thence through the high resistance shunt coil to the ground to operate the switching devices.

When a low resistance shunt coil is used in place of the high resistance coil as described, the tremendous amount of current necessary for the operation of the switching devices becomes an objection which makes its use impracticable. Again an objection which has

arisen is the breaking of the shunt coil in the interior of the switch boxes, and the consequent arcing, the continuance of which causes the destruction of the switching devices and makes the probability of a weld ensuing between the contact points on the interior of the switch boxes, between the switch and main feeding wire, which would cause the conductors or plates rising above the street to remain in a charged condition, the palpable danger of this being easily understood.

The objection arising in the case of the two sets of conductors in connection with the storage battery heretofore mentioned is that the close proximity of a grounded contact point to the positive contact point from which the car collects the current is a great source of leakage at all times.

In my invention I overcome the above defects described in other systems, to which end my invention consists, first, in the combination of two sets of conductors or contact points on the road bed one constituting the working contact or conductor and the other a supplemental conductor, both normally insulated or disconnected from the line and from the ground, an operating switch coil in a connection from one conductor or contact to the other, and a connection from one of said conductors to the contact of the switch that is operated by said magnet to connect said contact with the line.

In conjunction with the working and supplemental conductors on the road-bed, suitable current collecting or contact devices are carried by the car for engagement with them. In this organization the switch magnet is charged when the car reaches it by a part of the main line current which passes from the supplemental contact device carried by the car to one of said conductors or contacts on the road bed back to the other through the coils of the magnet and thence through the current collecting contact on the car to ground by way of the motor.

My invention consists further in the combination with a traveling test contact carried by the vehicle, of means controlled by the abnormal current flowing over the same for breaking the connection between the main line and the working contact or conductor upon the line of way.

My invention relates further to the construction of the switch boxes and contacts or conductors which are located on the road bed and connected with the said switch devices, and also to the combination with the apparatus, of a storage battery upon the car used both as a resistance for the motor and as a means for operating the switch magnets in emergency.

My invention consists further in the details of construction and combinations of parts, as hereinafter more particularly described and then specified in the claims.

In the accompanying drawings:—Figure 1, is a general diagram of a system embodying the arrangement of switch magnets and circuits constituting my invention. Fig. 2, is a plan of a section of railroad equipped according to my invention, a part of the filling and paving for the paved way having been removed. Fig. 3, is a longitudinal cross section through the box containing the electro magnetic switch. Fig. 4, is a plan view of the top of the same showing the protecting slab which forms the surface of the road way partially cut away. Fig. 5, is a lateral cross sectional view taken at right angles to Fig. 3. Fig. 6, shows one of my plans of apparatus upon the car for controlling the current and operating the circuit closing devices.

In the diagram 1, indicates the positive side of a feeding or supply circuit from which, when the working conductors or contacts are properly connected therewith, the car takes its current.

2, is the negative or return side of the circuit for which I prefer to use the rails on which the car rests, as well understood in the art.

b, indicates a series of working contacts or conductors from which, by a suitable current collecting device indicated at 4, the car may take up current for operating the motor. The set of working contacts or conductors *b*, is here represented as in the shape of studs more clearly shown in Fig. 3, as rounded at their top. These studs or working conductors may be of any desired linear extent, but I prefer to make them short as shown and correspondingly lengthen the current collector on the vehicle so that the latter may be always in connection with one or more of said working conductors.

Another series of conductors or contacts similar to *b*, is indicated at *a*. These may be termed for convenience the supplemental conductors and may, like the first named set, be extended in both directions parallel to the line of movement of the car.

8 is any contact device on the car for preserving connection with conductors *a*.

4, typifies any current collecting device carried by the vehicle and adapted to rub upon or make connection with the conductors *b*. The current collecting device 4, may be made in one or more sections, as hereinafter described, and is of sufficient linear extent to be always in connection with one or more of the conductors *b*, as well understood in the art. The current taken up by the collector 4, is passed through the motor 7, to the return in the well known manner.

The switch levers of the electro-magnetic switches are typified at *c*. These switches serve to close the connection between the positive side of the system and the conductors *a*, and they are operated by means of electro-magnets whose coils are indicated at *d*. The coils of the magnets are, as shown, in the connection between the conductors *a* and *b*. When the switches *c*, are opened both conductors *a*, *b*, are, as will be seen, normally

disconnected both from the ground or return and from the main or supply conductor. The current collector 4, and the contact 8, carried by the vehicle are here indicated as bars, but, as will be well understood in the art, any other device suitable for making connection as the car moves along and carried by said car, might be employed.

When any switch is closed the current flows from the main supply to the conductor *a*, through the coils *d*, to the conductor *b*, thence by the current collector to the motor and the return. As the parts are so proportioned that one or more of said switches will be always closed, it will be seen that the contact 8, will be always charged, being in constant connection with the conductors *a*. Hence as the car moves along in the direction of the arrow 3, the contact 8, carried by the vehicle when it engages a new conductor *a*, will cause current to pass to said conductor *a*, to the switch magnet *d*, working conductor *b*, and current collector 4. When this occurs the magnet operates on the switch *c*, in the usual manner and closes the circuit between the positive feed 1, and the contact or conductor *a*, from which current now flows, through the coils of the magnet and through the current collector and motor, the switch being now sustained or held in circuit closing position by a current passing direct from the supply wire, through the switch *c*, to the conductor *a*, and by way of the magnet to the car motor. When the current collecting device 4, however, passes off any section or point of working conductor *b*, then the magnet will lose its power and the connection will be broken with the supply conductor. As the car passes along the action described is repeated at all of the supplemental and working contacts or conductors *a*, *b*.

As there is a possibility of the switch remaining closed after the car has passed, thus keeping the conductors *a*, *b*, alive even after the car has passed beyond the point where it takes up current from such conductors, I provide in connection with the apparatus on the car a supplemental test contact indicated at 17, which automatically tests the condition of the conductors *a*, *b*. This supplemental contact 17, may ride in connection with either of the conductors *a*, *b*, and is placed either in advance of or at the rear of the main traveling contacts or collectors 8, 4. It is here shown as placed behind them.

The test contact 17, is connected by wire 18, directly to the return so that, as will be seen, if it finds one of the contact conductors *a*, alive, an abnormally large current will pass over the connection from the test contact 17. From this abnormally large current the condition of the conductor *a*, will be indicated. The connection 18, is made in any of the usual ways as, for instance, by the car wheel. I prefer to so organize the apparatus that this abnormally large current shall automatically disconnect the conductor *a*, from the main supply which may be done by means of a fuse or any other automatic disconnecting device placed in position to be operated by the abnormally large current flowing over the test or detector contact 17. I have shown a fuse indicated at *f*, which will be operated by the short circuit thus formed and will free the contact point or conductor *a*, from any possible connection with the positive supply conductor.

In the practical construction of a system embodying my invention, the several automatic switches are each placed in a switch box indicated at 21, and the said boxes are connected by a pipe 20, through which the positive supply wire is drawn. Suitable connection with each switch from said supply wire is made in each box 21. The box 21, is hermetically sealed with a detachable top 22, resting in the channel 23, and sealed by some suitable material, as indicated at 24. On the top of said box rests a slab of some suitable insulating material 25, preferably strong artificial stone of the required thickness to sustain traffic passing over it. Slab 25, is flush with the surface of the road bed and rests primarily upon the filling or paving at 26, as indicated, and partially upon the stoppers or blocks of semi-vulcanized rubber or other suitable material 27, in the cover 22. Through these stoppers or blocks seated in the openings in the cover, pass the bolts or rods 50, which, within the box 21, are attached by screwing or otherwise into the bridge pieces 29. The latter are held between lips 30, 31, on the sides of the box 21, as clearly shown in Fig. 5, and are insulated from the box by means of suitable interposed insulation at 32.

It will be seen that when the bolts 50, are screwed down firmly, the stoppers 27, will be forced firmly into the orifice in the lid of the box containing circuit closing devices, and a good seal will be made at such point.

Within the box, the electro-magnet carrying the coils *d*, is preferably one solid piece and is provided at its ends with lips 34, to sustain it in position on the bridge pieces 29. The bolts or rods 50 are connected with the ends of the coils *d*, by attachment of the coil ends to pieces secured on the bridge-pieces, as clearly shown.

The switch indicated at *c*, constitutes the armature of the electro-magnet and its opposite ends close circuit upon a contact indicated at 37, which is in connection with the supply cable 36, and upon a contact depending from the bridge piece 29, that connects with the conductor or contact *a*, on the road bed.

The contact 37, is a part of a connecting device attached to the cable as follows:—This connecting device consists of a plate resting on insulation in the bottom of the box and has a seat for the cable 36, as shown, in immediate proximity to which seat is a hook adapted for insertion into a hole or a hook on the end of the piece 38, which may

be closed down over the cable 36, and fastened by a screw as shown. When so forced down and fastened suitable points as indicated carried by the piece 38, are forced through the insulation of the cable between the strands composing the same and thus make thorough connection with the conductor within the cable without admitting air thereto. To prevent condensation in the interior of the conduit and switch boxes, dry hot air may be forced in from one end of the conduit at the generating station and permitted to escape at a vent or vents at outlying points farthest from the station; or, if a double track road is used and it be found preferable, one conduit can be used for the return of the hot air circulation. By this means a desirable pressure of air can be sustained at all times in the conduit. As will be seen this construction gives ready access to the boxes for repairs since all that it is necessary to do is to unscrew the bolts 50, and lift off the slab 25, and cover 22. When the parts are replaced the bolts are screwed down into place thus forcing the slab down upon the blocks and making a seal while at the same time putting the contact conductors *a*, *b*, into connection with the proper parts of the switch devices within the box.

Fig. 6, shows diagrammatically the manner in which I propose to use a storage battery for regulating the flow of current through the motor and also the use of a sectional current collector, sections of which may be thrown out of action when the current controller is operated in a manner to tend to decrease the current.

41, is the arm of the current controller consisting of a bar or plate pivoted and bearing at one end on a segment 53, of conducting material, and at its other end riding over a number of segments marked *g*. The parts of the sectional current collector are indicated at 4. Two of them which it might be desired to throw out of action are connected to segments *h*, forming switch contacts and normally kept in connection with a segment 52, by means of a contact *i*, which may move with or independently of the controller 41, but is preferably attached thereto and properly insulated therefrom. The movement of the controller arm which tends to decrease the current through the motor 7, connected to segment 53, is in the direction of the arrow. The current is controlled by the engagement of one end of the arm 41, with segments *g*, respectively, thereby throwing in resistance. As will be presently described, I prefer to employ a storage battery as resistance.

It will be seen that a movement of the controller in a direction to reduce the quantity of current to any great extent in the three or four contact points on the road bed from which the car is drawing current, would tend to decrease the magnetism in the several switch magnets to such an extent as to tend to release the armatures of said magnets and open the switches. To avoid this difficulty I divide the current collector or contact device through which circuit is made to the car from said magnets into sections as shown. By this means I am enabled, when the current controller is turning in a direction to decrease the current, to throw out the sections of said current collector thereby concentrating the total current flowing to the motor in a less number of switch magnets which are thereby enabled to hold up their switches.

I provide for the throwing out of sections of the current collector automatically by attachment of the contact *i*, to the current collector as shown. The segments *h*, are of such extent that when the current controller is turned as described, the sections 4, 4, will be thrown out of action successively as the current goes on diminishing. The length of the segments *h*, would be determined by the particular conditions of each case. In practice they should be somewhat shortened over what is shown so that the first section 4, at the right, would be thrown out earlier in the movement of the current controller.

The segment 52, connects as shown to the section 4, of current controller which is supposed to be always in operation and which is always connected to the current controlling devices through the resistance or other apparatus, here typified however at 40, as a storage battery. The sections of storage battery 40, connect to the segments *g*, of the current controller in the well known manner, so that as the arm 41, turns, it will throw more or less of the storage battery into circuit with the motor. The battery operates therefore as a resistance to the flow of current.

When the car is disconnected from the source of supply so as to stop the flow of current through the electro-magnets, it is obvious that the armatures will drop back. To provide for picking them up again when it is desired to again start the car, I utilize the secondary battery 40. This is done by turning the current controller arm 41, to position to engage with a segment 43, of the switch, and the diametrically opposite segment *g*, connected to one pole of the battery. The segment 43, connects with the auxiliary contact device 8, which, as before described, rides on the supplemental conductors *a*. The current of the battery will then pass into the current collecting device 4, through the working conductor points *b*, a series coil of the electromagnet to the conductor point *a*, contact 8, segment 43, arm 41, and back to the opposite pole of the battery, thus energizing the switch magnets and closing the connections with the supply source. After the current has been picked up the arm 41, may be manipulated in the usual way to decrease the resistance in the circuit of the motor on the car.

The motor 7, is shown as provided with a shunt field coil connected with a segment 45, which is kept in connection with segment 52,

by the contact *i*. This puts the field in shunt around the current controlling device and armature in the well known manner.

S, is a suitable switch for interrupting the circuit to the motor on the car.

I do not limit myself to the particular construction of circuit controlling device here shown, nor to the particular arrangement of switch contacts and segments, since, as well understood by electricians, many other arrangements might be used in connection with the sectional current collector.

I do not limit myself to throwing the sections of current collector out of action by an electric switch as any other means of rendering them inoperative might be employed without departing from my invention.

What I claim as my invention is—

1. In an electric railway, the combination of two sets of conductors or contact points on the road bed arranged in two distinct lines one set constituting the working contact or conductor and the other a supplemental conductor both normally insulated or disconnected from the line and from the ground, an operating switch coil in a connection from one conductor or contact in one set to one in the other, a connection from one of said conductors to the contact of the switch that is operated by said magnet to connect said contact with the line and means for transmitting the power current from one supplemental contact to another.

2. The combination, substantially as described, of a set of supplemental conductors, studs or contacts upon the road bed, a contact device carried by the vehicle in constant connection with one or more of them, a series of working contacts or conductors upon the road bed, a current collecting device carried by the car and moving in constant connection with them, switch magnets each energized by current taken from main line and having its coil in a connection between a supplemental contact and a working contact, and a magnetically actuated switch in the connection between the main line conductor and the supplemental conductor or contact.

3. The combination, substantially as described, of a set of contacts or conductors normally disconnected from the source of supply, switches for placing said contacts in connection with a source of supply as the car or vehicle moves along its path, a supplemental test contact carried by the vehicle, and means controlled by the abnormal current flowing over the same for breaking the connection between the source and the said contact or conductor when the test conductor finds it connected.

4. The combination, substantially as described, with the contacts or conductors on the road bed normally disconnected from the supply source, of automatic switches, suitable fuses in the connections to said contacts, and a supplemental test contact carried by the vehicle and connected directly to the return.

5. The combination with the switch box and connected contacts on the street surface, of a protecting slab of insulating material sustained in part by the street filling or paving, as and for the purpose described.

6. The combination with the switch box hermetically sealed and sunk beneath the street level, of the pair of surface conductors or contacts *a*, *b* forming terminals of connecting rods or plates 50, a slab of insulating material through which both of said rods pass, and by which they are insulated from one another and means within the box for attachment of said bolts or rods.

7. The combination, substantially as described, of a switch box, the electrical connecting bolts, bridge pieces to which the same are secured within the box, the contact conductors on the road bed, and the blocks or stoppers of compressible material in the openings in the box cover, as and for the purpose described.

8. The combination, substantially as described, of a switch box 21, having the removable hermetically sealed cover, slab 25, the plugs or stoppers 27, on which the slab rests, the bolts 50, and the contact conductors *a*, *b*, as and for the purpose described.

9. The combination, substantially as described, of the connecting bolts screwing into the box and having contact heads, plugs or stoppers of insulating material through which said bolts pass, and a surface slab resting on said stoppers and extending beyond and insulating said contacts from each other and from surrounding objects.

10. The combination, substantially as described, of an electric railway car motor, a storage battery forming a resistance in the circuit of the same, a sectional working conductor, electro-magnetic switches for connecting the same with a supply source, and means for putting the storage battery on short circuit through the magnets of said switches.

11. The combination, substantially as described, in an electric railway system, of a sectional contact conductor, electro-magnetic switches controlling the connection of the same with a supply source, a sectional contact device carried by the vehicle, and means for varying the number of sections of said contact device in circuit.

12. The combination, substantially as described, with the sectional contact device carried by the car, of a current controller for varying the current on the car, and means governed by said current controller for throwing sections of the contact device out of action as the current controller is operated to decrease the current.

Signed at New York, in the county of New York and State of New York, this 1st day of August, A. D. 1893.

HARDING F. GRAY.

Witnesses:
WM. H. CAPEL,
T. F. CONREY.