(No Model.)

R. M. HUNTER.

ELECTRIC RAILWAY.

No. 414,049. Patented Oct. 29, 1889.

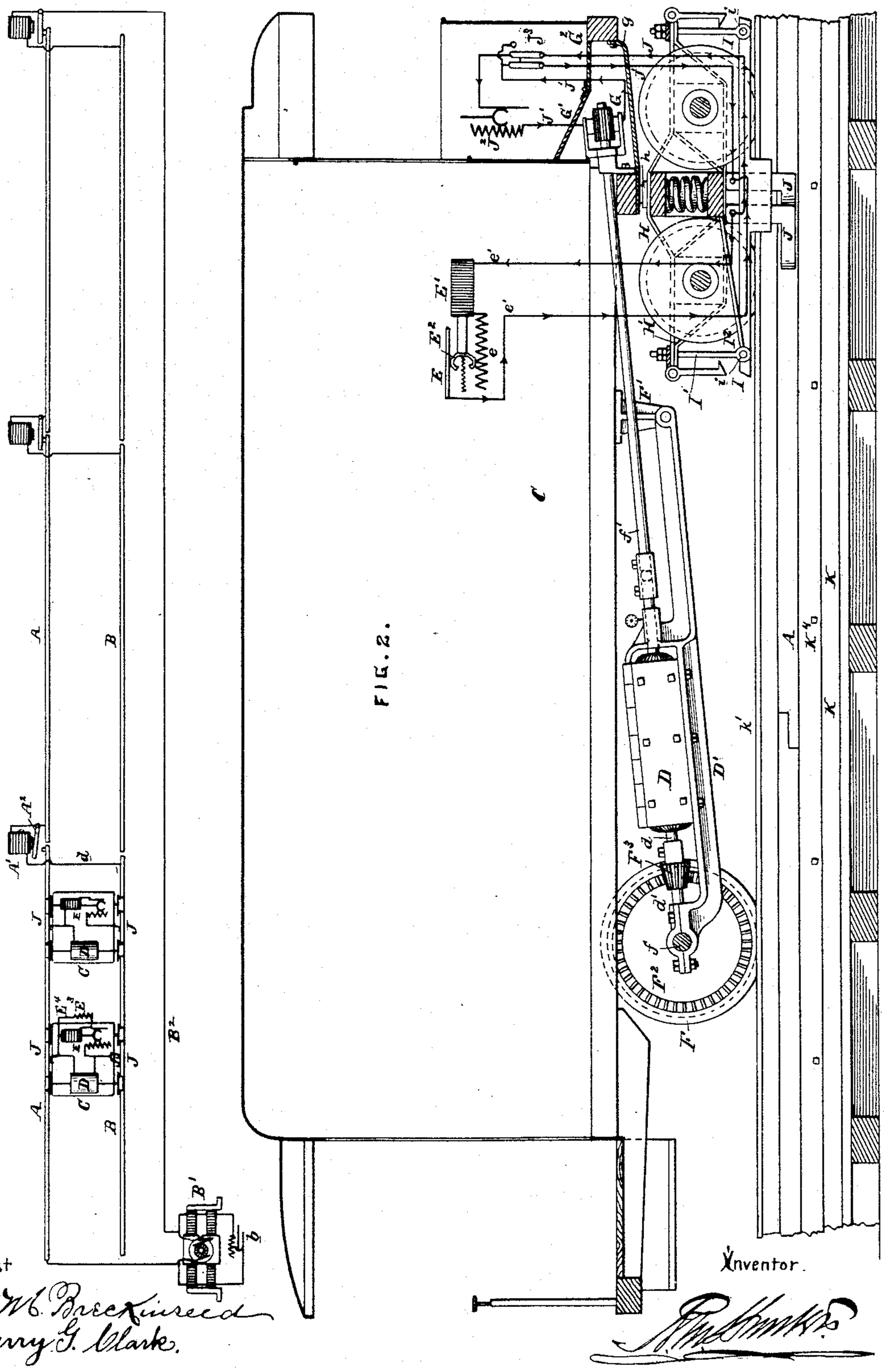

FIG. 1.

FIG. 2.

Attest

C. W. Breckinridge
Harry G. Clarke.

Inventor.

R. M. Hunter

UNITED STATES PATENT OFFICE.

RUDOLPH M. HUNTER, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE THOMSON-HOUSTON ELECTRIC COMPANY, OF BOSTON, MASSACHUSETTS.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 414,049, dated October 29, 1889.

Original application filed November 30, 1886, Serial No. 220,240. Divided and this application filed April 2, 1889. Serial No. 305,771. (No model.)

To all whom it may concern:

Be it known that I, RUDOLPH M. HUNTER, of the city and county of Philadelphia, and State of Pennsylvania, have invented an Improvement in Electric Railways, (Case 92,) of which the following is a specification.

My invention has reference to electric railways; and it consists of certain improvements fully set forth in the following specification and shown in the accompanying drawings, which form part thereof.

This application, Case 92, is a division of my application, Serial No. 220,240, filed November 30, 1886.

In my application filed February 17, 1886, Serial No. 192,187, is described a system in which the motors are coupled in groups, those of a group being coupled in multiple arc and those of different groups being coupled in series with each other. Each group was supposed to occupy at a given time a section of the conductors and each of such sections of conductors is coupled in series. If a group of motors were intended to be five in number and for some reason two were removed from the section, then the current passing through the three would be the same as should have passed through the five. This would necessitate complications.

My present application comprehends improvements to overcome or prevent complications. All of the current passing down the line is caused to pass through the cars on a section of conductors; but all the current over and above that which properly should pass through the motors is shunted around the motors automatically, the regulation being independent of manual exercise of judgment.

It is immaterial to my invention how the means for shunting the excess of current around the motor may be made or operated, and, while I prefer to cause the regulation to take place automatically, the spirit of the invention may be carried out even when the operator on the car is required to control the devices. The generator for supplying the current to the line or working conductors is a shunt or compound wound machine for generating a varying current with a constant potential. Aside from the automatic switches for shunting the excess of current around the motor there are variable resistances on the cars for controlling the speed and power of the motor or for stopping the car, which variable resistances are operated by hand. Where the railway is short and the number of cars comparatively few, the automatic shunting devices on the cars could be dispensed with.

In operating electric railways on constant-potential circuits there are several important results taking place automatically and dependent upon hand-regulation in certain other parts of the system. The line-conductors supply current to the motors on the various cars, which are connected in parallel or multiple with each other, each drawing its supply of current from the same conductors and source of electrical energy. The generator at the central station is a self-regulating shunt or compound wound dynamo-electric machine and feeds the line-conductors with more or less current in volume or ampères while maintaining the constant potential. It is evident that we have here a number of traveling or moving resistances in the motors and regulators on the cars, and it is also evident that these resistances are constantly varying not only from variations in their speed and stoppages, but also from the fact that as the motor moves farther from the generator the increased line-resistance is to be added to the motor-circuit on the car. The resistances, which are thus constantly shifting as to position and amount, cause a varying demand upon the generator in the central station, and this demand is met by the use of a self-regulating constant-potential generator. The varying demand is complex and must be met, for if on a railway employing twenty-five cars twenty were suddenly stopped the large ampèrage for the twenty-five cars would have to go through the remaining five cars if the source of supply were not automatically cut

down to that necessary for five cars. It is true that resistances on the cars might be resorted to; but the motors on the cars might be burned out before the operator realized the danger.

In the drawings, Figure 1 is a plan view of an electric railway embodying my invention, and Fig. 2 is an enlarged sectional elevation of one of the motor-cars.

A and B are two lines of working-conductors, which are made in sections. The conductors may be either the rails or auxiliary conductors suspended exposed on the surface of the road-bed or placed in a slotted conduit. One end of conductor A is connected with one terminal of the generator B′, and the opposite end of the corresponding section of conductor B is connected by wire *a* with the adjacent end of the next section of conductor A, and so on. In these conductors *a* are located magnets A′, which operate switches A^2, so that when no motors are in circuit with a section B the switch A′ will operate to close the break between two succeeding sections A, and vice versa. The distant end of the A conductor is connected with the other terminal of the generator B. It is evident that if we were to only consider one section of the railway, which might be five miles long, the conductor *a* from B would connect directly with the return-wire B^2, and this would form an equal-resistance circuit, as set out in my patent, No. 381,555, of April 24, 1888.

The generator B′ may be supplied with the regulator *b* or other suitable regulating device, and is shunt or compound wound, so as to be self-regulating and give a varying current in ampères, while maintaining a substantially constant potential.

C are electrically-propelled vehicles, cars, or locomotives, which may be constructed in any manner desired. These cars maintain electrical connection with the conductors A B by suitable current-collecting brushes J.

D are the electric motors on said cars, and J′ is the motor-circuit, which may have a resistance-changer J^2, under the control of the operator to vary the speed or power of the motor or stop the car, and a current-reversing switch J^3, for reversing the current passing to the motor.

E is a shunting device for shunting more or less of the line-current around the motors on each car. It consists of a shunt-circuit *e′* in multiple-arc connection with the motor D and having a variable resistance *e*, more or less of which is put into or out of circuit by a switch E^2, operated by an electro helix and core E′, which helix is in the shunt-circuit and directly controlled by the current therein. To reduce the amount of current passing through the helix, an additional shunt E^3 (see Fig. 1) might be placed in the shunt *e* around the helix. It is immaterial to my invention how this regulator is made, so long as it accomplishes the objects sought to be covered.

It will now be understood that if a section of conductors be supposed to hold in multiple-arc connection five cars one-fifth of all the current will pass through each motor or car. If now two cars are from any cause taken off the section, the remaining three cars will still only receive three-fifths of the entire current, as their shunting devices E respond to shunt two-fifths of the current around the motors on the cars; hence the total normal resistance to the line is constant and the current passing down the line is in no wise diminished. This regulation is automatic; but it is evident that the result might be accomplished by operating the shunting devices by hand. This description has been given with particular reference to a system employing series and multiple-arc connection of cars combined; but it is also evident that it is applicable where the entire line is operated on the multiple-arc system, (which corresponds to one section of the above-described system,) as the regulator shunt device would operate to increase or reduce the current flowing through the motor to compensate for the change in the resistance of the line, according as the motor is near to or very far from the generation-station. It is my object to use comparatively high tension currents and working-conductors of small sectional area. In long lines and where a large number of cars are on circuit this line-resistance is an important factor in automatic regulation.

The car shown in Fig. 2 is well adapted to city railways, and consists of the long body supported at its forward end upon a four-wheeled truck H by a pivot *h*. The truck has a small wheel-base, and hence can turn sharp curves, and may be made in any well-known manner, having suitable springs. The rear end of the car-body is supported on two wheels F, secured to their axle *f*, which is journaled in boxes, and support the car-body through springs in the usual way. By this construction of supporting wheels the car is maintained from jumping or swinging up and down, as is now so frequently seen on horse and cable railways. In those systems it is not so objectionable; but in an electric railway the wheel-base should under no circumstances be subjected to jar, owing to the necessity of using the current-collectors. By placing the four-wheeled truck forward a rapid travel can be maintained without the least tendency of jumping the track at quick curves.

D is the electric motor, which is supported on the frame D′, hinged upon the rear axle *f*, and at its forward end is connected at F′ to the car-body between the forward truck and axle *f*, but preferably close to the former. By this means the car-body may rise and fall on its springs without changing the distance between the motor and axle *f*. The motor-shaft *d* is supported in the journal *d′* close to the axle *f*, and is provided with the bevel-pinion

F^3, adjustable to and from the axle *f* and adapted to mesh with the wheel F^2, secured to the axle *f*.

The motor proper is located close to the rear axle *f* and increases the traction of the driving-wheels by throwing its weight mainly upon the rear axle, while the commutator O of the motor is brought forward to the front platform G^2, and its sections are connected with the armature by a long flexible tubular shaft *f'*. As shown, the commutator is located immediately below the front platform, and may be inspected or adjusted by a door G' and protected below from dust and dirt by a case or covering *g*. By this construction I am enabled to locate the weight of the motor where it is most needed and the commutator where it can be inspected and adjusted.

The collectors J are carried by the pivoted truck through the mediation of a collector-frame I, hung by bolts I' from the truck-frame H'. These bolts have screws and nuts *i'*, by which the height of the frame I may be adjusted to bring the collectors J in line with the conductors. These bolts I' are hinged to the frame I at *i*, and this frame is also connected to the truck-frame by a link or drag-bar I^2. This construction will allow all the lateral play required to follow inequalities in a slotted conduit or conductors and in passing around curves. The collector-frame has the lower central portion made to project down through the slot of a conduit, and the collectors are made flat and pass up through the same, (being insulated from it.) By putting the collectors on the truck they may follow the curves more readily and irrespective of the position of the car-body.

When the switches on the car are operated by hand, the resistance between the two conductors A and B of the railway varies proportionally, and likewise the resistance at the terminals of the generating-dynamo varies, and thereby causes the instant automatic regulation of the volume of current to suit the demand, maintaining the same potential and voltage.

I have described the general features of my improvements; but it is to be understood that I do not limit myself to the details, as they may be modified in various ways without departing from my invention.

Any matters set out in this application but not claimed are not dedicated to the public, but form subject-matter of my application of which this is a division.

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

1. In an electric railway, two working-conductors, a source of electrical energy, two or more electrically-propelled vehicles in multiple-arc connection and receiving current from said conductors, and shunt-circuits upon said vehicles to shunt a portion of the current around the motors.

2. In an electric railway, two working-conductors, a source of electrical energy, two or more electrically-propelled vehicles in multiple-arc connection and receiving current from said conductors, shunt-circuits upon said vehicles to shunt a portion of the current around the motors, and means to increase or decrease the resistance of said shunts.

3. In an electric railway, two working-conductors, a source of electrical energy, two or more electrically-propelled vehicles in multiple-arc connection and receiving current from said conductors, shunt-circuits upon said vehicles to shunt a portion of the current around the motors, and automatic means to increase or decrease the resistance of said shunts.

4. In an electrically-propelled vehicle, the combination of a source of electric supply, an electric motor, a shunt-circuit around the motor, a resistance-changer in said shunt-circuit, and an electrically-actuated regulator to control the resistance-changer to reduce the resistance of the shunt if the current in the motor-circuit increases above the normal, or vice versa.

5. In an electric railway, two or more sections of working-conductors, one or more electrically-propelled vehicles on each section, connections for coupling up said conductors, so as to put all the vehicles on the different sections in series connection and those upon the same section in multiple-arc connection, shunt-circuits around the motors on each of the vehicles, and a resistance-changer in each of the shunt-circuits.

6. In an electric railway, two working-conductors, a source of electricity of constant potential, two or more electrically-propelled vehicles receiving electricity from said conductors and coupled in multiple-arc connection with each other, a shunt-circuit around the motor on each of said vehicles, and a resistance-changer in said shunt-circuits.

7. In an electric railway, two working-conductors, a source of electricity of constant potential, two or more electrically-propelled vehicles receiving electricity from said conductors and coupled in multiple-arc connection with each other, a shunt-circuit around the motor on each of said vehicles, and an electrically-actuated resistance-changer in said shunt-circuit.

8. In an electric railway, two working-conductors, a source of electrical energy, two or more electrically-propelled vehicles in multiple-arc connection and receiving current from said conductors, shunt-circuits upon said vehicles to shunt a portion of the current around the motors, means to increase or decrease the resistance of said shunts, and a resistance-changer on the vehicles to control the current flowing through the motors at the will of the operator.

9. In an electric railway, two working-conductors, a source of electricity of constant potential, two or more electrically-propelled vehicles receiving electricity from said conductors and coupled in multiple-arc connec-

tion with each other, a shunt-circuit around the motor on each of said vehicles, an electrically-actuated resistance-changer in said shunt-circuits, and a resistance-changer on the vehicles to control the current flowing through the motors at the will of the operator.

10. The combination of sectional conductors extending along an electric railway, two opposite conductors in succeeding sections being connected as described, electric locomotives in circuit between opposite sections and in series with one another, an electric switch at the end of each section for breaking connection between two successive sections, and shunting-circuits carried by the locomotives to shunt more or less of the current around the motors to prevent an excessive current passing through the motors.

11. The combination of two sectional conductors extending along an electric railway, two opposite conductors in succeeding sections being connected as described, electric locomotives in series making connection therewith, and an electric switch at the end of each section for controlling the connection between successive sections of one conductor, and shunting-circuits carried by the locomotives to shunt more or less of the current around the motors to prevent an excessive current passing through the motors.

12. The combination of a vehicle, a propelling electric motor therefor in series with other motors on the same road, bared conductors adapted for conveying the main current extending along the said road, a constant connection between said conductors and the motors, electrically-operated switches for shunting the main current through said motors, and shunting-circuits carried by the locomotives to shunt more or less of the current around the motors to prevent an excessive current passing through the motors.

13. The combination of a vehicle, a propelling electric motor therefor in series with other motors on the same road, bared conductors adapted for conveying the main current extending along said road, switches operated electrically for shunting the main current through said motor, means for preserving the continuity of the main line during the operation of said switches, and shunting-circuits carried by the locomotives to shunt more or less of the current around the motors to prevent an excessive current passing through the motors.

14. The combination of a vehicle, a propelling-motor in series with other motors on the same road, bared conductors extending along said road and adapted for carrying the main current, electric switches operated from a distance for directing the course of the main current over said conductors, electrical devices for operating said switches controlled by the current which passes over said conductors between said motor and the adjacent switch, and shunting-circuits carried by the locomotives to shunt more or less of the current around the motors to prevent an excessive current passing through the motors.

15. The combination of two conductors parallel with the line of an electric railway, electric locomotives in electrical connection with said conductors, said conductors being divided into insulated sections, each section of one conductor being connected with the opposite succeeding section of the other conductor, cross-connections containing electrical devices which control a connection between successive sections of the other conductor, and shunting-circuits carried by the locomotives to shunt more or less of the current around the motors to prevent an excessive current passing through the motors.

16. The combination of two or more electric motors in series, a vehicle supporting each motor and propelled thereby, a sectional electric conducting-path extending along the line of progress of said vehicles, conductors extending from each motor and making continuous connection with said conducting-path, the main current normally passing through the motors in succession, an automatic circuit-closer for each motor acting to preserve the continuity of the main line in the case of rupture of any motor-circuit, and shunting-circuits carried by the locomotives to shunt more or less of the current around the motors to prevent an excessive current passing through the motors.

17. The combination, in an electric railway, of two conductors extending along the line of the road and divided into sections longer than the ordinary locomotives or trains on the road, electric locomotives having their motor-terminals constantly in connection with the two conductors, respectively, switches operated by the progress of the train or locomotive for sending the main current through the motors in succession, and shunting-circuits carried by the locomotives to shunt more or less of the current around the motors to prevent an excessive current passing through the motors.

18. The combination, with the two main conductors of an electric railway, of an electric locomotive having its terminals in connection with said conductors, respectively, a connection between said conductors, a circuit-breaker in said connection controlled by the progress of said locomotive, and shunting-circuits carried by the locomotives to shunt more or less of the current around the motors to prevent an excessive current passing through the motors.

19. The combination of two sectional conductors extending along an electric railway, each section of one conductor being electrically connected with the preceding section of the other conductor, locomotives in series in traveling connection with said conductors, circuit-controllers between the successive sections of one of the conductors, and shunting-circuits carried by the locomotives to shunt more or less of the current around the

motors to prevent an excessive current passing through the motors.

20. The combination of sectional conductors extending along an electric railway, two opposite conductors in succeeding sections being connected as described, electric locomotives in circuit between corresponding sections of opposite conductors and in series with one another, an electric switch at the end of each section for breaking connection between two successive sections, and a shunt-circuit around the electric-switch magnet to reduce the current passing through the switch-magnet.

21. The combination of two sectional conductors extending along an electric railway, two opposite conductors in succeeding sections being connected as described, electric locomotives in series making connection therewith, an electric switch at the end of each section for controlling the connection between successive sections of one conductor, and a shunt-circuit around the electric-switch magnet to reduce the current passing through the switch-magnet.

22. The combination of a vehicle, a propelling electric motor therefor in series with other motors on the same road, bared conductors adapted for conveying the main current extending along the said road, a constant connection between said conductors and the motor, electrically-operated switches for shunting the main current through said motors, and a shunt-circuit around the electric-switch magnet to reduce the current passing through the switch-magnet.

23. In an electric railway, two conductors to supply current to the motors on the cars, a constant-potential and varying-current dynamo or generating-machine for supplying current to the conductors, two or more electrically-propelled vehicles receiving current from said conductors, and variable resistances or regulating devices on the car to vary the current passing through the motor.

In testimony of which invention I hereunto set my hand.

RUDOLPH M. HUNTER.

Witnesses:
ERNEST HOWARD HUNTER,
MADDIE L. FISS.