

(No Model.)

R. M. HUNTER.

METHOD OF OPERATING ELECTRIC RAILWAYS.

No. 424,607.

Patented Apr. 1, 1890.

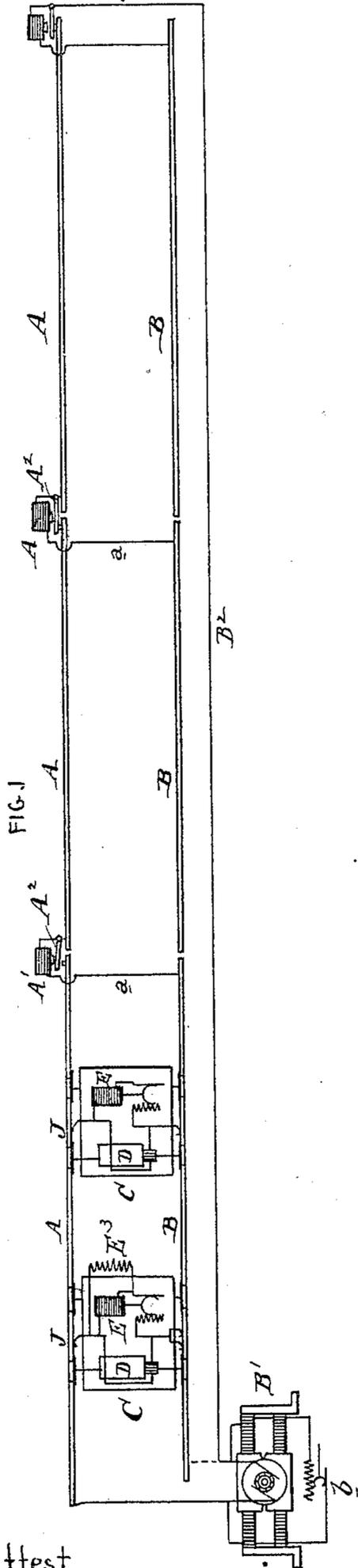
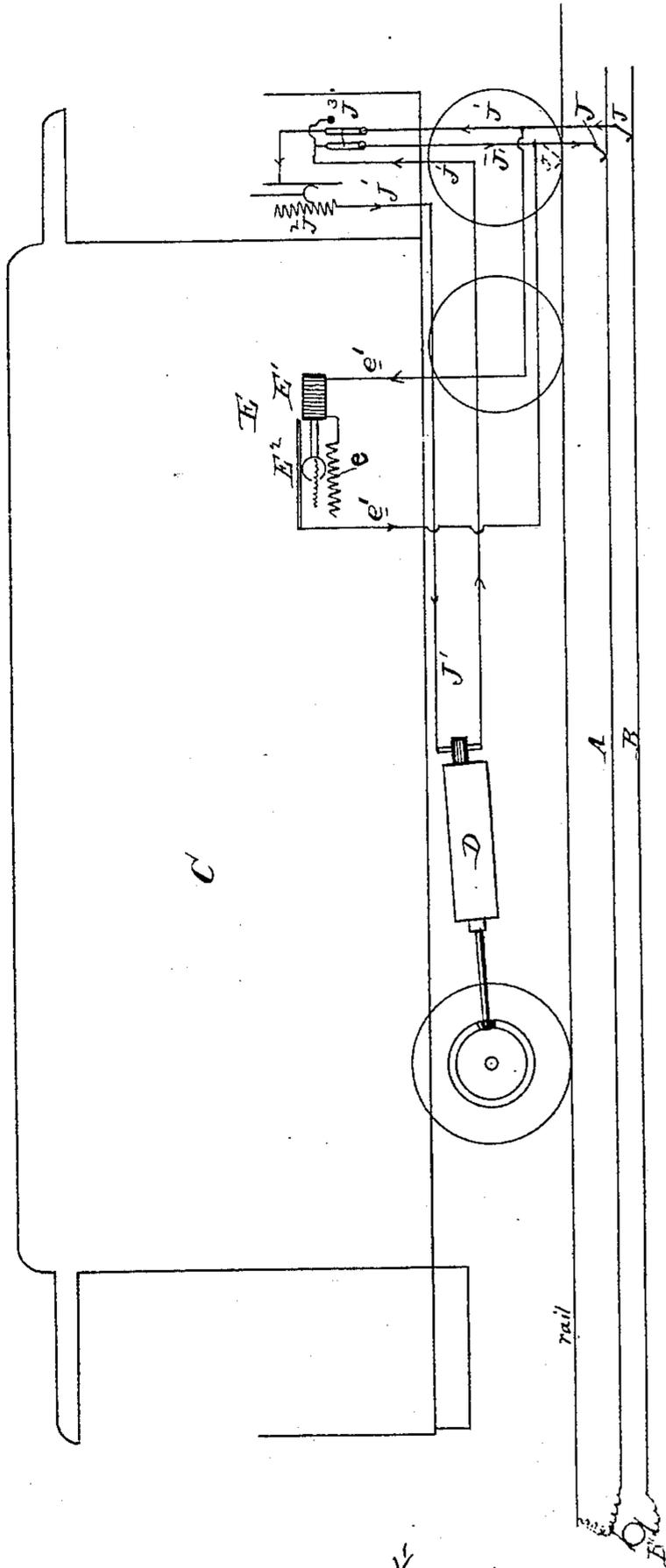


FIG. 1

FIG. 2



Attest

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METHOD OF OPERATING ELECTRIC RAILWAYS.

SPECIFICATION forming part of Letters Patent No. 424,607, dated April 1, 1890.

Original application filed November 30, 1886, Serial No. 220,240. Divided and another application filed April 2, 1889, Serial No. 305,771. Again divided and this application filed October 10, 1889. Serial No. 326,632. (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 the Method of Operating Electric Railways, of which the following is a specification.

My invention has reference to a method of operating electric railways; and it consists of certain improvements, all of which are fully set out in the following specification, and shown in the accompanying drawings, forming a part thereof.

This application (Case 115) is a division of my application, Serial No. 305,771, of April 2, 1889, which in turn was a division of my application, Serial No. 220,240, filed November 30, 1886.

In one portion of my invention 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 should properly 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 arc with each other, and each draws 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 I 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 the 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 varying 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 the 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, and 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 the 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 A², 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 conductors *a* from B would connect directly with the return-wire B², 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 amperes, while maintaining a substantially constant potential.

C are electrically-propelled vehicles, cars, or locomotives, and 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 the said cars, and J' is the motor-circuit, which may have a resistance-changer J², under the control of the operator, to vary the speed or power of the motor or stop the car, and a current-reversing switch J³ 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 E², 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 E³ (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, where a large number of cars are on circuit, this line-resistance is an important factor in automatic regulation. 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.

In this application I do not claim the series multiple system of operating electric railways, as such method and construction form subject-matter of my application, Serial No. 192,187, filed February 17, 1886; nor do I claim the arrangement of supporting-wheels or connection of the motor with the rear wheels, as the same form subject-matter of my applications, Serial Nos. 215,199, of September 23, 1886; 224,150, of January 12, 1887, and 250,842, of September 27, 1887.

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

1. The method of controlling two or more electric motors in multiple-arc connection, consisting in shunting more or less of the current around said motors, according as the numbers of said motors in circuit decrease or increase.

2. The method of controlling an electric motor in passing from a section of conductors of one current strength to another section of another current strength, which consists in shunting more or less of the current around said motors, according as the current is stronger or weaker in the different sections.

3. The method of operating an electric railway, consisting in maintaining two or more electrically-propelled cars in groups and coupled in multiple-arc connection with each other, and two or more such groups of cars coupled in series connection with each other and shunting more or less of the current

around the motor on each car of a group in accordance with the increase or decrease in the number of cars in the group to maintain the current passing through the motors remaining normally constant.

5 4. The method of operating an electric railway, consisting in supplying to a conductor or conductors extending along the railway a current of substantially-constant potential and
10 varying volume, and feeding said current at various places along the conductor or conductors to a series of electric motors on cars traveling on the railway, and which motors are connected in parallel with each other, varying
15 the resistance of the motor-circuits, and thereby the total line-resistance, by hand regulation on the cars to vary the speed or power or stop the travel of the cars, and automatically varying the volume of current supplied
20 to the conductor or conductors by the generator in accordance with said varying demand and at the same time maintaining the potential of the current substantially the same.

25 5. The method of operating an electric rail-

way, consisting in supplying electric current of constant potential to the line, maintaining two or more electrically-propelled cars in groups and coupled in multiple-arc connection with each other, and two or more groups
30 of cars coupled in series connection with each other and shunting more or less of the current around the motor on each car of a group in accordance with the increase or decrease in the number of cars in the group to
35 insure the current passing through the motors remaining normally constant.

6. The method of controlling two or more electric motors in multiple-arc connection, consisting in maintaining a circuit of con-
40 stant potential and in shunting more or less of the current around said motors, according as the number of said motors in circuit decrease or increase.

In testimony of which invention I have
45 hereunto set my hand.

RUDOLPH M. HUNTER.

Witnesses:

ERNEST HOWARD HUNTER,
C. S. CHAMPION.