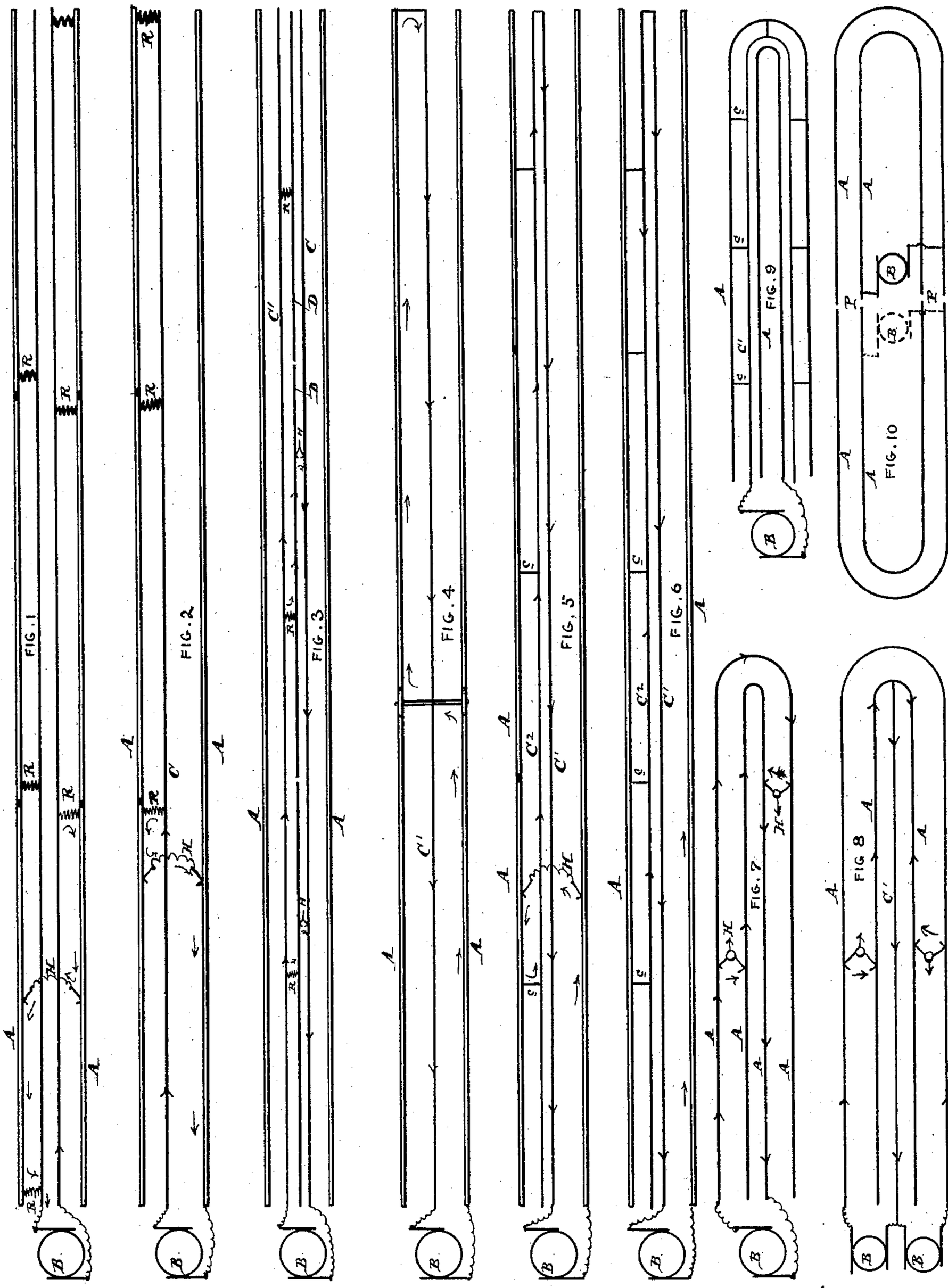
(No Model.)

R. M. HUNTER.

ELECTRIC RAILWAY.

No. 381,555. Patented Apr. 24, 1888.



Attest.

Inventor.

UNITED STATES PATENT OFFICE.

RUDOLPH M. HUNTER, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO THE ELECTRIC CAR COMPANY OF AMERICA, OF SAME PLACE.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 381,555, dated April 24, 1888.

Original application filed October 4, 1886, Serial No. 215,200. Divided and th's application filed August 4, 1887. Serial No. 246,111. (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, of which the following is a specification.

My invention has reference to electric railways; and it consists in a system of electrical conductors whereby the total resistance offered to the current in completing its circuit through the motor, be it close to or a long distance from the generator or source of electric supply, is constant and fixed, or substantially so, and in many improvements in the construction of electric railways, as are fully set forth in the following specification, and shown in the accompanying drawings, which form part thereof.

This application is a division of my application of October 4, 1886, Serial No. 215,200, and also shows certain improvements illustrated and claimed in my application of July 14, 1885, Serial No. 171,625; hence in this application, while I claim the equal-resistance system of operating electric railways, broadly, I wish it to be understood that all matters shown and not claimed form subject-matters of other pending applications—that is to say, the specific application of resistances, as shown in Figures 1, 2, and 3 of this application, are not herein claimed, but form part of the above-specified applications. Likewise the employing of sectional working-conductors is not here claimed, but forms subject-matter of applications, Serial No. 195,742, of 1886, Serial No. 205,770, of 1886, and Serial No. 214,309, of 1886, and also the specific forms of return-railways illustrated in Figs. 7 to 10, in which both railways or sections of railways receive current from the same station are not herein specifically claimed, but form subject-matter of my applications, Serial No. 214,309, of 1886, Serial No. 241,729, of 1887, and 256,915, of 1887.

Heretofore it has been customary to use the rails as the main and working conductors, or to use auxiliary rails therefor, arranged upon the road-bed and between the track-rails; but in all of the systems proposed the resistance due to the length of the main conductors was ignored, and though on very short lines they may be made large enough to make this provision of but little moment, yet on long lines it is of great importance, particularly when a large number of cars or motors are to be operated at given speed to work on time, as in our street-railways, when the resistance is not positively and automatically provided for, the driver will be required to be constantly throwing in or out auxiliary resistance as the car travels from one end of the line to the other.

The object of this invention is, therefore, primarily, to so arrange the electric-railway system that the resistance to the current at any point on the line is equal, or substantially equal, whether the said current is required to travel over one or fifty miles. This will enable the use of only one generator-station with its expensive plant, where with other systems several such stations would be required. From the fact that the resistance is uniform all along the track or line, I am enabled to use small main or supply conductors, and employ high potential currents, as the main or supply conductor or conductors may be insulated, or supported on poles or incased and embedded in the earth, while one or both of the working-conductors may be made in sections and connected to the supply or main conductors, as heretofore set out. There are a large number of ways in which these conductors may be arranged, several such arrangements being set out in the accompanying drawings. I do not limit myself to any means of accomplishing the equal resistance in the line-circuit, as the principle, broadly, is new. It is equally clear that my improvement may be applied to multiple-arc circuits when arranged in sections and the sections coupled so as to work the motors on each section in series with the motors on the other sections, as is set out in my application, Serial No. 208,418, filed July 19, 1886, on my application, Serial No. 192,187, filed February 17, 1886. Again, the equal-resistance system may be applied to an electric railway when all of the motors are working on a single-line conductor, as set out in my application, Serial No. 204,583, filed June 9, 1886. It will there-

fore be seen that the principal of the system is applicable to any construction of electric railway in the drawings.

In the operation of this system a notable fact will be the passage of the current over both working-conductors in the same directions. While this is not an absolute requirement in all cases, yet it is, as a rule, the result in carrying out this system in most of its modifications.

The method involved in operating cars on an electric railway under this system is novel in every particular, and enables not only a uniform speed being maintained with a car on all portions of the line under normal circumstances, but enables the controlling from one point on the line of all of the cars on the line, reducing the skill required of the operator on the car. Under this system the tension or electro-motive force of the current passing through the car under normal conditions will be constant for all positions of said car upon the circuit.

In the drawings, Figs. 1 to 10, inclusive, show several arrangements of constructions and tracks for my equal-resistance system as applied to electric railways.

A are the rails, which may be used as the working-conductors or not, as desired, though in most cases, particularly in street-railways, I prefer that they shall form no part of the electric circuit.

B represents the electric generator or source of electric supply.

C is the positive and C′ the negative conductors.

R represents resistance, which may be used in some form of construction. These resistances may be used as shown in Figs. 1, 2, 3, or may be merged with the line or supply conductors, as shown in Figs. 4, 5, 6, 8, 9, or said resistances may be formed by a suitable arrangement in the working-conductors themselves, be they the rails or separate conductors, as shown in Figs. 7 and 10.

Now, referring to Fig. 1 more specifically, the rails are shown as formed in sections and as constituting the working-conductors. The main or supply conductors are arranged between them, and are connected with these sections by the resistances R, which are as numerous as the working-sections, and these resistances increase regularly by the resistances of the length of the main or supply conductors equal to one of the working-sections. It is evident, however, that these resistances may vary irregularly, as the lengths of the sections might be varied, and such change would require a change in the relation between the resistances. If we take a motor at the two extreme positions, or at the ends of the lines, the current at the farther end would have to pass simply through the supply-conductors and motor, while the current at the nearest end would have to pass through the resistances and motor and such portions of the supply-conductors as might be in circuit, and these resistances would be equal to the resistance of the supply or line conductors between the two positions of the motor. Wherefrom it is seen that with this system carried out a motor will receive the same or practically the same current, be it near or far from the generating-station, and consequently the cars may be run at uniform speed without the trouble or necessity of regulation for variations in the line-resistance. Again, it will seen that if two cars or trains get upon the one section they will automatically slow down, as the current between the two working-conductors would not be sufficient to run both motors at the normal high speed. This will prevent collision, and will be particularly useful in cities.

Now, referring to Fig. 2, we have one of the rails used as the working and main return working conductor and the other rail used as a sectional working-conductor. The principle involved in this is precisely the same as that last mentioned, as in this case the resistances would be simply proportioned to suit the change.

In the system shown in Fig. 3 the rails are not used as the working-conductors, but separate distinct working-conductors are used, and of these C is the continuous return, while D is the sectional working-conductor, the sections of which are connected to the main or supply conductor C′ by resistances R. This is the preferred construction of any so far described, as the conductors C and D may be arranged within a small conduit located between the rails, while the supply or main conductor may be supported on poles or insulated and embedded in the earth.

In Fig. 4 the rails A A are shown as the working conductors. In this case the current is fed to one of the working-conductors, and after passing through the motors to the other working-conductor it is caused to pass the full length of the line and return by the return-conductor C′. In this case the sectional conductor and resistances are merged into the line by the use of the return-conductor C′. It is evident that the working-conductors in this case may be inclosed in a slotted conduit, or otherwise, and need not be the rails.

In Fig. 5 we have the principle shown in Fig. 4 applied to sectional working-conductors which are connected to a conductor, C^2, by branches *c*, the line-conductor C′ being connected at the distant end with the conductor C^2.

In Fig. 6 is shown the same construction as in Fig. 5, except that the working-conductors are not in sections.

In Fig 7 is shown a looped track in which the rails are shown at the conductors, and in which it will be seen that the principle of equal resistance is also carried out. In this arrangement the necessity of the line-conductor C′ of Fig. 4 would not be required, but would theoretically be merged into one of the work-

ing-conductors. Here we have the two poles of the generator B connected with the opposite end of the two working-conductors.

Fig. 8 shows a looped track and two generators, and is the same as if two tracks like that shown in Fig. 4 were arranged side by side with the distant ends of the rails united and with a common conductor, C'.

Fig. 9 shows a construction very similar to that illustrated in Fig. 7; but in this case one of the poles of the generator is connected to a conductor, C', which in turn is connected at intervals apart with the working conductors or rail by branches *c*. It will be observed that the generator is connected to one end of conductor C' and to the opposite end of the working-conductor with which the said conductor C' does not connect.

Fig. 10 shows a construction similar to Fig. 7 duplicated, except so far as the generator-motor is concerned. This would show a continuous or endless track, or one without an end, so that the motor could run continually in the same direction. It is evident that a second generator may be used, as indicated in dotted lines, and in that case the working-conductors could be served as at points marked P, in which case they would be what is shown in Fig. 7, with the end of the conductors arranged end for end.

In any of the foregoing types of my improved system it will be seen that as the motor travels over the line the current supplied to it is caused to pass through the same or practically the same resistances, and as it would be if there were one hundred motors on the line, as there would be in large cities in our street-railways.

It is immaterial as to the particular arrangement of the conductors, as my invention comprehends, broadly, any arrangement of conductors, main or working, or both combined, so that the electricity is supplied to the motors anywhere along the line of railway through a resistance which is equal or substantially equal.

The resistances of a conductor and its mass of metal having fixed relations, it is evident that in this system we might say that the resistances to the current from the generator through the motor and return would be substantially the same for various positions of the motor on the line, because the mass of metal in the conductors through which the current passes increases proportionally as we approach the generator along station. While this proposition is true for those systems where resistances R are in circuit, it would not be true of the construction shown in Figs. 4 and 7, as in these cases the resistances cut out of one working-conductor are added to the other working-conductor, thereby keeping the line-resistance through the motor always the same.

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

1. The combination, in an electric railway, of two working-conductors, a traveling motor receiving electricity from said conductors, one or more auxiliary conductors connecting with said working-conductors, a generator of electricity to supply an electric current to the working-conductors and through the auxiliary conductors, the said auxiliary conductors acting as resistances to the passage of the electric current through the motors and return, and being so connected to the line that the resistance to the passage of the current through the said motor, working and auxiliary conductors shall be substantially the same or constant for various positions of the motor upon the line.

2. The combination, in an electric railway, of two working-conductors, a generator to supply electricity directly to one of said conductors, and an auxiliary resistance-conductor connecting with the generator, and also with the other working-conductor.

3. In an electric railway, the working-conductors, in combination with a traveling motor receiving electricity from said working-conductors, a generator to supply electricity to said working-conductors, and an artificial resistance or resistances varying with the distance from the generator and connecting the generator of electricity with said working-conductor, whereby the resistance from the generator through the motor and return is the same for any position of the motor on the line.

4. In an electric railway, the combination of two working-conductors, an electrically-propelled vehicle receiving electricity therefrom, and a generator of electricity having its poles connected with said working-conductors at relatively different distances from one terminal of the line, whereby the resistances from the generator through the line-motor and return are equal or substantially equal for all positions of the motor on the line between the connections of the generator with the conductors.

5. In an electric railway, the combination of two working-conductors, an electrically-propelled vehicle receiving electricity therefrom, and a generator of electricity having its two poles coupled, respectively, with said working-conductors, one pole being coupled with one conductor near the generator, and the other pole with the other conductor at a relatively greater distance from the generator, whereby the current in passing through the line and the motor shall pass in the same direction over both working-conductors, and in which the resistance to the passage of the current from the generator through the line-motor and return is equal or substantially equal for all positions of the motor on the line.

6. In an electric railway, the combination of two working-conductors, an electrically-propelled vehicle receiving electricity therefrom, an electric generator, and connections between said generator and working-conductors, whereby the current passes over both of said working-conductors in the same directions.

7. In an electric railway, two working-conductors arranged parallel along the track of a railway and having the electric currents flowing over each conductor in the same direction, and an electrically-propelled vehicle receiving electricity from said working-conductors.

8. In an electric-railway system, the combination of a traveling electric motor with two working-conductors from which the electric motor receives current, and with an electric generator whose terminals are connected, respectively, to one of the alternate ends of each of the aforesaid working-conductors.

In testimony of which invention I hereunto set my hand.

RUDOLPH M. HUNTER.

Witnesses:
E. M. BRECKINREED,
R. S. CHILD, Jr.