

No. 637,119.

Patented Nov. 14, 1899.

R. M. HUNTER.
ELECTRIC RAILWAY.
 (Application filed July 20, 1894.)

(No Model.)

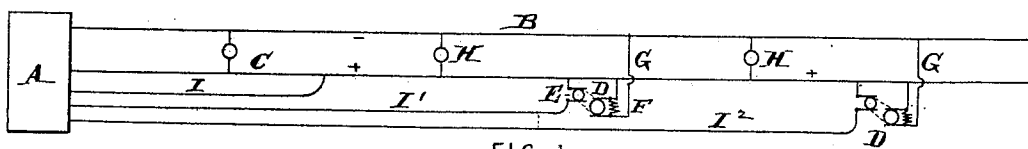


FIG. 1.

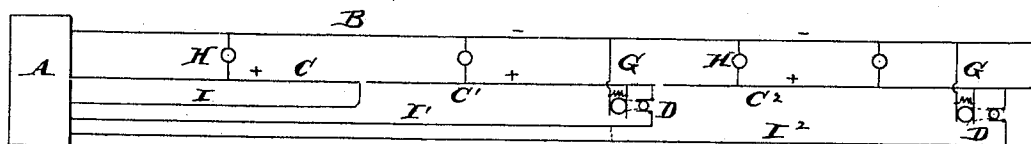


FIG. 2.

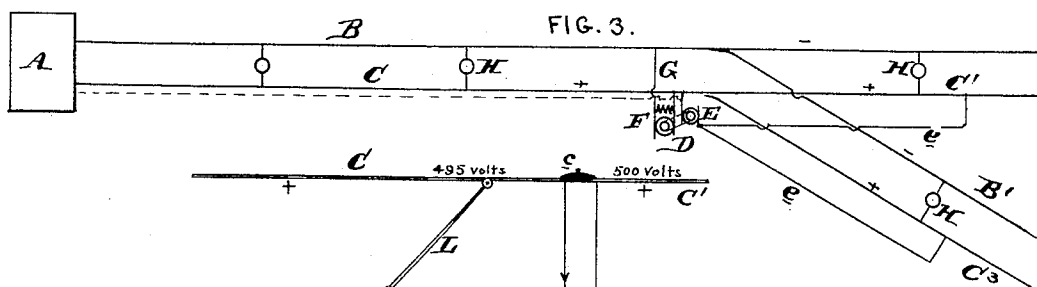


FIG. 3.

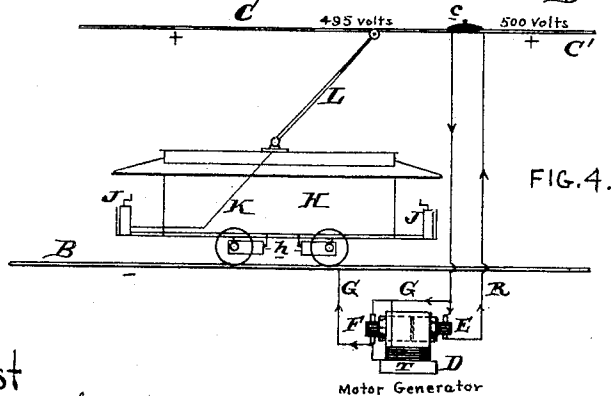


FIG. 4.

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UNITED STATES PATENT OFFICE.

RUDOLPH M. HUNTER, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO
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ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 637,119, dated November 14, 1899.

Application filed July 20, 1894. Serial No. 518,075. (No model.)

To all whom it may concern:

Be it known that I, RUDOLPH M. HUNTER, of the city and county of Philadelphia, in the 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 of certain improvements which are fully set forth in the following specification and shown in the accompanying drawings, which form a part thereof.

This application (Case No. 281) comprehends certain improvements for maintaining the potential on an electric railway or other power-circuits in those parts greatly removed from the primary source of power or generating-station.

It is well known in practice that in long circuits for supplying electric currents to distant places, and especially in connection with the transmission of power where current is to be supplied to moving translating devices, such as in electric railways, considerable difficulty arises from the fact that the potential of the line-circuits decreases very materially where the line is very long or the resistance very great. This has in a great measure been obviated by the use of expansive low-resistance feeding-conductors connecting with the working conductors at intervals in their length. Another method for exceedingly long lines is disclosed in Letters Patent No. 451,154, dated April 28, 1891, granted to me, wherein the railway or circuits are divided into sections and each supplied with current of proper potential from a separate generator and in which the generators of the several sections or portions of the same main circuits are controlled by electrical devices in the preceding section, whereby the potential throughout the entire line may be maintained substantially the same. This construction is objectionable, however, in ways which are apparent to one skilled in the art, as it requires more than one generating-station.

The object of my invention is to overcome these defects by causing the potential in the line at different places to be increased to compensate for what would be normally the loss of said potential at said places in the line adjacent to the said distant places for produc-

ing the electromotive force necessary for that part of the line in which said loss occurs.

My invention may be applied to a system of electrical transmission of power where there are but the two working conductors, or a single outgoing and return conductor, or to those cases where feeding-conductors are employed in connection with said working conductors, and also in those cases where branch working conductors are supplied from main conductors leading from a source of electrical energy. My invention is also applicable to those cases where at any portion of the circuit it is necessary to increase the potential thereof, so that special translating devices may be operated therefrom, or where current is to be sent over a great distance from a given point on the main line and to accomplish which it is necessary to materially increase the potential at this point, so that at the most distant part of the circuit the potential will be only that which is required for the particular translating device.

The importance of maintaining the potential in a system of electric railways is apparent when we consider that the motors are wound for a definite potential and that any variation in this potential materially alters the current which may flow through the motors, and thus render uncertain their speed, and which would be not only inefficient but also undesirable where the cars are run on schedule time.

In carrying out my invention I provide suitable electric-motor generators at one or more places on the line and interpose into the line-circuit in series the armature of the generator portion of the motor-generator, the winding of said armature being of sufficiently low resistance to carry the current which is necessary for the operation of the line beyond said armature. It is only necessary to drive this armature at a moderate speed, so as to generate within it an electromotive force equal to that which it is desired to supply to the line, so that the sum of the electromotive force which is fed to the motor portion of the motor-generator and the electromotive force which is supplied to the line by the armature of the generator portion of the motor-generator is just equal to the maximum po-

tential which it is desired to have in the line at that point. It will be evident that this may be accomplished with but small consumption of energy from the line-circuit. Ordinarily I would arrange the motor portion of the motor-generator in parallel connection with the line, while the generating portion of the motor-generator would be in series with the line, although it is quite evident that the field thereof might be the same field employed in the motor, and thus energized by constant potential, which is more desirable than arranging the generator as a series generator. The generating portion of the motor-generator thus practically constitutes a machine in which the armature is in series with one of the line-circuits and revolves in a separately-excited field, or if we ignore the length of the line-circuits the field may be considered as a shunt. These improvements may be applied to a main circuit without the use of any feeding-conductors, or feeding-conductors may be employed in a variety of ways—for instance, short feeding-conductors may be passed from the motor-generator to different parts or sections of the main line, or feeding-conductors may pass from such motor-generator to portions of the main line or branch conductors, or both, or feeding-conductors may extend from the central station to different portions or sections of same circuits and potential-increasers may be arranged in one or more of said feeding-circuits. This will suffice as examples of the possible employment of my invention.

My invention will be better understood by reference to the accompanying drawings, in which—

Figures 1 and 2 are diagrams illustrating my invention as applied to electric railways with the employment of feeding-conductors from the central station. Fig. 3 is a similar diagram showing my improvement in connection with branch circuits or railways, and Fig. 4 is an elevation illustrating my improvement more in detail.

A is a central-station plant and may be of any construction heretofore well known, comprising a power plant and suitable generating-dynamos for producing a current of the proper potential for the operation of the translating or current-consuming devices in the line-circuit.

B is the return or negative conductor.

C is the positive or outgoing conductor. This positive conductor may have portions, as C^1 C^2 , made as continuations of it, as will be more fully described hereinafter.

H represents electrically-propelled cars or any suitable translating or current-consuming device arranged in parallel in the line-circuit and receiving current from the conductors B C C^1 , &c.

D represents current-potential increasers, which more specifically may be described as motor-generators—that is to say, they comprise a portion F, which may be designated as

an “electric motor,” and a portion E, which may be designated as a “generator.” A good form of this motor-generator is shown in Fig. 4. It will be seen that the field-magnets T include a motor-armature F, connected positively to a generating-armature E. The motor-armature receives current from the circuits B C by conductors G G and has its field-magnets preferably in shunt relation, so that the motor part is essentially a construction adapted to constant speed. The generating-armature E revolves in the field produced by the field-magnets T and is in series relation with the two parts or sections C^1 C^2 of the positive conductor. It is evident that the motor and generator of the motor-generator may be coupled or connected in any suitable manner so long as the motor drives the generator. Such a machine, for example, may be comprised in a shunt-motor belted or geared or connected to the same shaft with a series generator. Assuming, for example, that the distant end of that portion of the line conductors indicated by the letter C starts out with a potential of five hundred volts at the generating-station and has a drop of five volts at its distant end, so that the voltage is four hundred and ninety-five. Also assume that it is desired to prevent further drop in the parts C^1 of the conductors and, further, to increase the voltage again to five hundred volts. To do this, it is necessary that the armature E of the motor-generator shall run at such a velocity that it will introduce into the line-circuit at a point between circuits C C^1 five volts in pressure, so that the conductor C^1 starts out with five hundred volts, as indicated in Fig. 4. At the distant end of the circuit C^1 the voltage may again drop to four hundred and ninety-five volts, and this is again raised to five hundred volts by a similar motor-generator, and such increased voltage supplied to the section C^2 . In this manner the current in the line may at various points distant from the generating-station be utilized to increase its own potential with the consumption of a very small amount of current. It is also evident that in place of the generating-armature E being connected by a circuit R to the section C^1 , immediately adjacent to the section C and upon the opposite side of the insulation-joint e, as shown in Fig. 4 and in solid lines in Fig. 2, it may be connected at a distant part of the conductor C^1 or C^2 , as indicated in dotted lines at e, Fig. 3, so that the current may flow in either direction through the said parts C^1 C^2 of the conductors. In the latter case the short feeding-conductors e will enable the circuits C C^2 to supply to the current-translating devices H the necessary amount of current with only one-half the drop of potential that would occur if the potential-increaser were connected, as indicated in solid lines.

In the construction shown in Fig. 1 the conductors B and C are combined with a series of feeding-conductors I I' I². The feeding-

conductors I' I², leading from the central station A and connecting with distant parts of the positive conductor C, may be provided with potential-increasers D, as clearly shown; but in this case the armature E of the generator portion of the motor-generator is in series with the feeding-conductor, while the motor portion F is in parallel with the conductors B and C. In this manner the current which is delivered to the conductors B and C by the feeding-conductors is made to have any desired potential to compensate for their greater or less length. By properly proportioning the motor-generators it is not so necessary to accurately proportion the feeding-conductors as has heretofore been the case. It is evident that the feeding-conductors may be supplied from separate generators at the central station or from a bus-wire common to all of said feeding-conductors.

In the construction shown in Fig. 2 we have the same structure as illustrated in Fig. 1, except that in this case we have a continuous return-conductor B and a sectional outgoing or positive conductor C, the said conductor being subdivided to form the sections C' C². In the case of Fig. 2 the current passing to any section is supplied by independent supply-conductors, the said supply-conductors in whole or part being provided with potential-increasers D.

In the construction shown in Fig. 3 we have the main line-circuits B and C, as before, receiving current from the central station A. At a distance from the central station are shown branch circuits of a branching railway, the negative conductor B' thereof being electrically connected with the return-conductor B, and the positive conductor C³ being preferably electrically independent of the conductor C except through the potential-increaser D. The main line is also shown as provided with one section of positive conductor C' beyond the branching railway. The motor portion F of the motor-generator D for increasing the potential is coupled in parallel by circuit G with the conductors B C, and the generating-armature portion E has one terminal connected with the positive conductor C and the other terminal connected by feeding-conductors e with preferably distant parts of the conductors C' C³. It is of course evident that the part E of the motor-generator might receive its current direct from the central station by a feeding-wire, such as I', (shown in Figs. 1 and 2,) or, in other words, the branching conductors B' and B³ may be applied to Figs. 1 or 2, having its potential maintained at the required potential by either one of the motor-generators D.

It is evident that the principle of my invention may be applied in a variety of ways, both for railway and general distribution service. I do not confine myself to any special arrangement of the apparatus or to the details of construction, as it is clear that spe-

cial applications of the invention may be had to suit particular requirements, the invention being adapted to any case where it is desired to keep up the potential in distant portions of the line and particularly those portions which at times are subject to heavy demands for current. It is also evident that while I have applied my potential-increasers or motor-generators to the positive conductor they may be equally well applied to the negative conductor. The translating devices H may be of any kind—such as electrically-propelled cars, electric lamps, and electric motors for stationary work and, in fact, any devices for consuming or transforming current into mechanical energy—though I have kept more in mind the adaptability of the invention to extended lines of electric railways and long distance transmission.

While I prefer the construction shown, I do not confine myself to the details thereof, as they may be modified in various ways without departing from the principles of my invention.

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

1. In a system of electrical distribution, the combination of a stationary source of electric energy, positive and negative main conductors extending from said source of electric energy to a distance, an electrically-actuated potential-increaser arranged at a great distance from the source of energy, two more feeding-conductors leading from one pole of the potential-increaser and connected with the conductor of one polarity at different places, a long feeding-conductor leading from the source of energy to the other pole of the potential-increaser, current consuming or translating devices arranged in parallel between the conductors on each side of the potential-increaser, and an electric motor to operate the potential-increaser operated by current taken directly from the main conductors at a great distance from the source of energy.

2. In a system of electrical distribution, the combination of a stationary source of electric energy, positive and negative main conductors extending from said source of electric energy to a distance, a long feeding-conductor leading from the source of energy and connecting with one of the main conductors at two distantly-located places, and a potential-increasing device arranged at a great distance from the source of energy and in the feeding-circuit between the two connections with the main conductors.

3. In a system of electrical distribution, the combination of a stationary source of electric energy, positive and negative conductors extending from said source of electric energy to a distance, an electrically-actuated potential-increasing device arranged at a great distance from the generating-station, two or more feeding-conductors leading from one

pole of the potential-increaser and connected with one of the conductors and at different distant points, a long feeding-conductor between the source of electric energy and the distant potential-increaser whereby current may be delivered from the source of energy and have its potential increased at a distance from the central station, and an electric motor to operate the potential-increaser connected directly with the main conductors at a great distance from the source of energy.

4. The combination of a source of electric energy, a conductor of one polarity extending therefrom, a main conductor of the opposite polarity arranged parallel to the first-mentioned conductor and divided into sections, feeding-conductors between the source of energy and the sections of main conductor, a potential-increaser for one or more of said sections receiving current from the source of electric energy through the feeding-conductors and adapted to increase the potential of the current in the particular section or sections to the extent desired, and current con-

suming or translating devices in parallel with said main circuits.

5. The combination of a source of electric energy, a conductor of one polarity extending therefrom, a conductor of the opposite polarity arranged parallel to the first-mentioned conductor and divided into sections, a potential-increaser for one or more of said sections receiving current from the source of electric energy through separate feeding-conductors and adapted to increase the potential of the current in the particular section or sections to the extent desired, current consuming or translating devices in parallel with said main circuits, and electric power devices arranged in the main circuits for automatically operating the potential-increasers.

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

R. M. HUNTER.

Witnesses:

ERNEST HOWARD HUNTER,
C. H. NEWCOMB.