(No Model.) 2 Sheets—Sheet 1.

J. H. VAIL.

ELECTRIC RAILWAY.

No. 509,002. Patented Nov. 21, 1893.

Fig. 1.

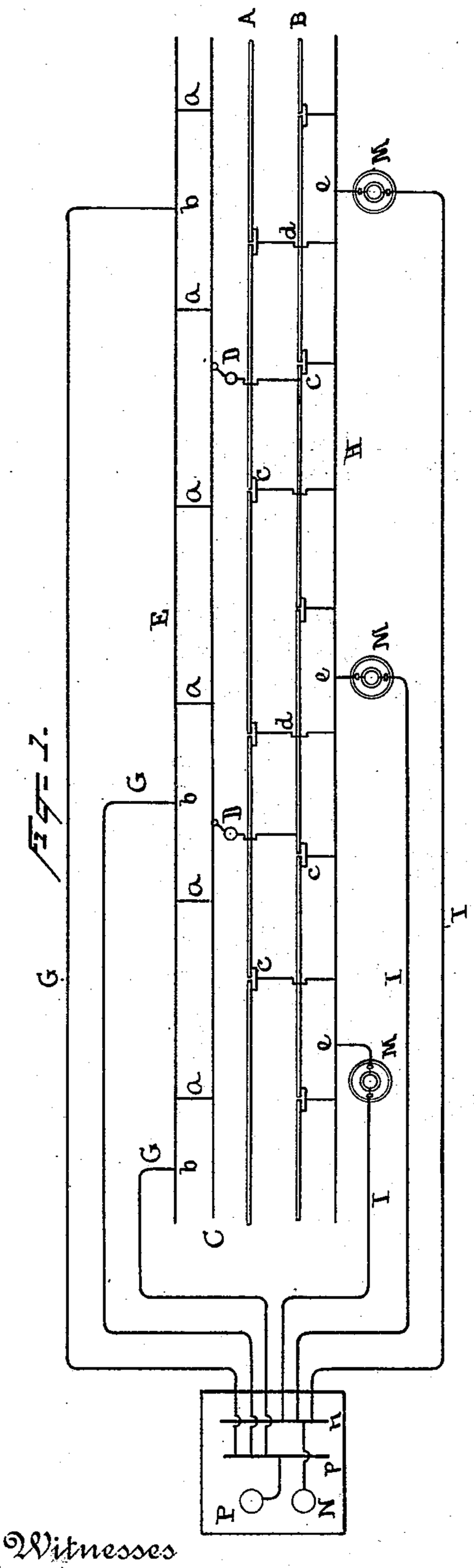
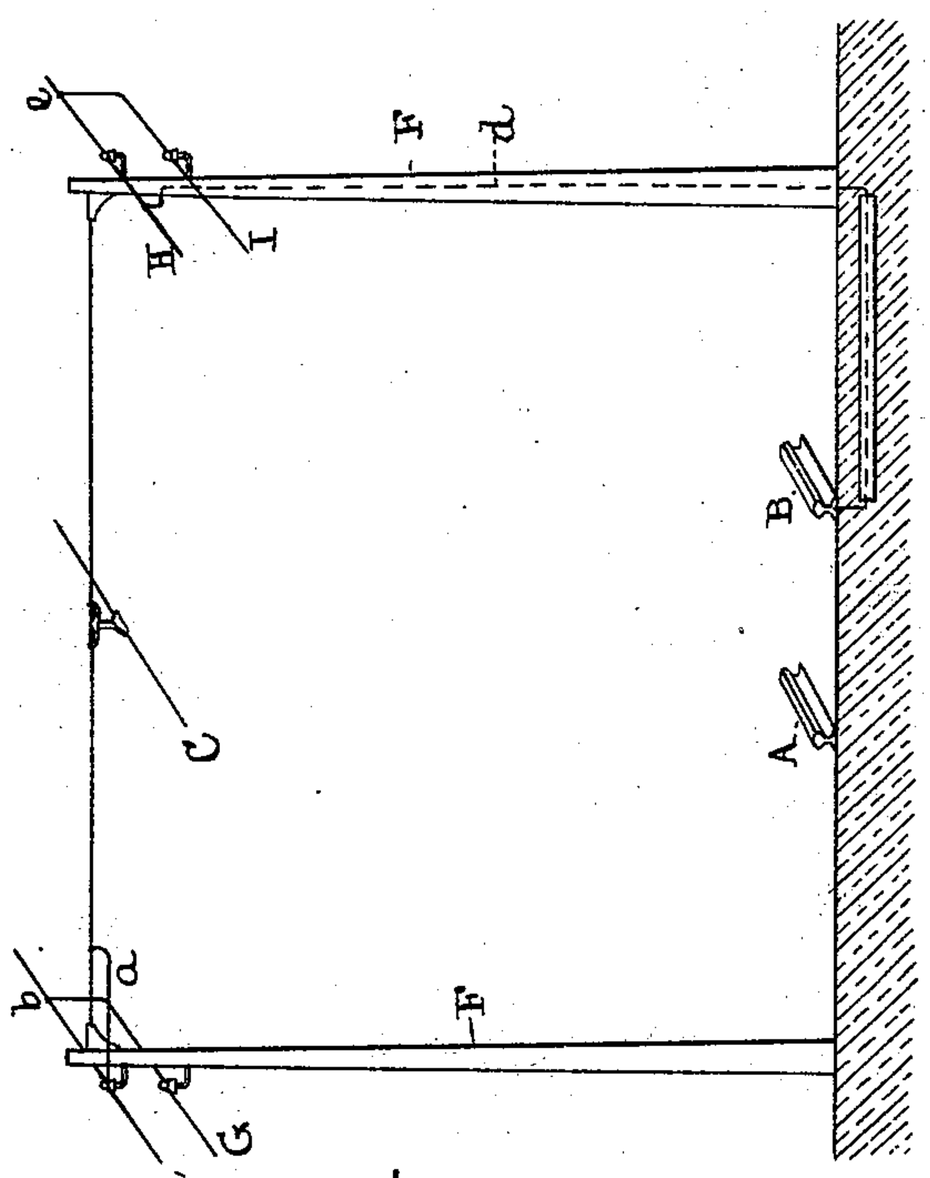


Fig. 2.



Witnesses
Norris A. Clark.
Eugene Conran

Inventor
Jonathan H. Vail
By his Attorneys
Geo. H. Story & Co.

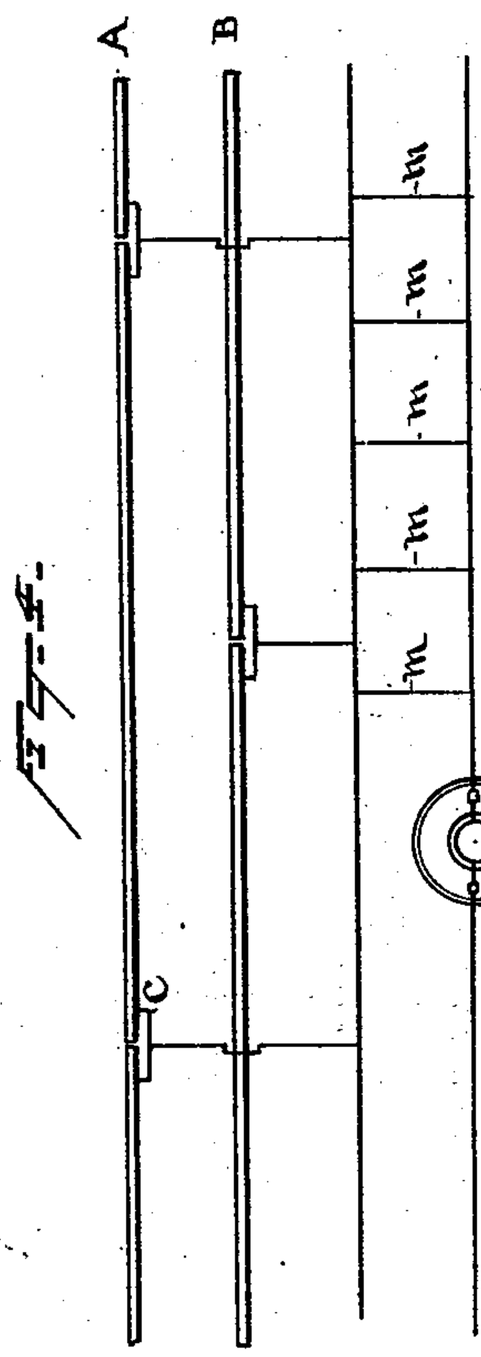
THE NATIONAL LITHOGRAPHING COMPANY,
WASHINGTON, D. C.

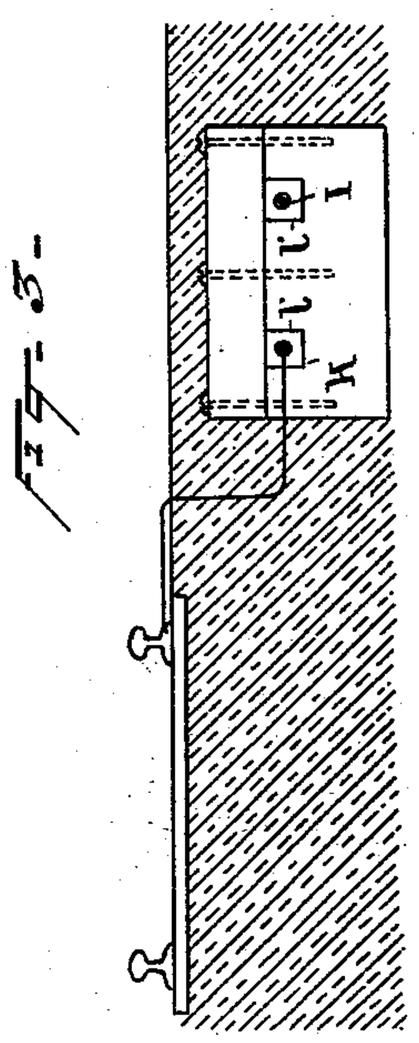
(No Model.) 2 Sheets—Sheet 2.

J. H. VAIL.

ELECTRIC RAILWAY.

No. 509,002. Patented Nov. 21, 1893.





Witnesses
Norris A. Clark.
Eugene Conran

Inventor
Jonathan H. Vail
By his Attorneys
Geo. H. Strong & Co.

THE NATIONAL LITHOGRAPHING COMPANY,
WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

JONATHAN H. VAIL, OF NEW YORK, N. Y.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 509,002, dated November 21, 1893.

Application filed March 17, 1893. Serial No. 466,426. (No model.)

To all whom it may concern:

Be it known that I, JONATHAN H. VAIL, a citizen of the United States, residing at New York city, in the county and State of New York, have invented a certain new and useful Improvement in Electric Railways, of which the following is a specification.

The object of my invention is to increase the efficiency of the system of conductors in an electric railway of that character in which the rails of the railway track connected electrically with the earth are employed to form the whole or a part of the return circuit. Prior to my invention, various difficulties have arisen in the operation of electric railways of this class. These are due mainly to the fact that current is conveyed through the earth with which the rails are in electrical connection. The use of the earth as a part of the circuit causes by induction serious difficulty in the use of grounded telephone lines; it also causes by electrolytic action injury to gas pipes and water pipes which are buried in the ground in the neighborhood of the railway; furthermore, such a circuit is often of too high resistance and may result in an undesirable fall of potential at a distance from the source of electrical supply.

My invention consists in the arrangement of circuits and devices employed by me to avoid these difficulties as hereinafter described and claimed.

In the accompanying drawings, Figure 1 is a diagram of the circuits of an electric railway system embodying my invention; Fig. 2, a perspective view intended to illustrate a suitable mechanical arrangement of the conductors; Fig. 3 a sectional view, showing another arrangement for the track conductors; and Fig. 4, a diagram illustrating the preferred way of connecting a feeder with the track conductor.

A B are the rails of a railway track.

P and N are respectively the positive and negative terminals of the generator or generators at the power station which supply current to the electric railway, such terminals being connected to the bus-bars *p n* at the station.

C is the overhead working conductor or trolley line preferably suspended above the center of the track as shown in Fig. 2, and D, D represent electrically propelled cars receiving their current from the trolley line C in the usual manner and returning it to the rails A B on which their wheels travel.

E is a continuous conductor extending along the line, preferably carried upon the poles F F, although it may be placed under ground and insulated from the ground. The conductor E is connected at intervals by branch conductors *a* with the trolley line C.

Extending from the positive bus-bar *p* at the station are a suitable number of conductors G which extend to different distances from the station where they are connected with the main conductor E at points *b*. The conductors G are each of such size and capacity as to have a certain predetermined drop in potential, and the points at which they are connected with the main conductor are mathematically determined in advance with the object of securing a constant potential on all parts of the conductor E, and so supplying all the cars and all parts of the working conductor at the same or substantially the same potential. The lines of rails A B preferably have the ends of adjacent rails united by short wires *c* or other suitable metallic connections so as to make the rail circuit as complete and uninterrupted as possible. In addition, I extend a continuous conductor H along the line of the road. This conductor is insulated from the earth either by supporting it upon the poles as shown in Fig. 2, or by placing it under ground inclosed in a suitable insulating covering. The conductor H is connected at intervals with the rails A B by wires *d* and it is found convenient to make this connection through the rail bonds *c*. As shown in Fig. 2 the wire *d* is carried down the pole and under the surface of the ground, but insulated from the ground, to the rails. The wire H may, however, if desired, be laid between the rails, it being as before stated insulated from the earth, whereby short lengths of wire only are required to connect it with the rails.

In order to complete an efficient metallic return connection from the motors to the power station, I provide a suitable number of conductors I I, which, like the conductor H, are insulated from the earth either by carrying them upon the poles or by burying them

inclosed in insulating coverings. The drop in potential on each of the conductors I is previously calculated, and the points *e* at which they are respectively connected with the conductor H at different distances along the line are also mathematically determined so that each will have the same potential at its point of connection with the line, whereby the potential delivered to any motor remains practically constant as it travels along the line, and does not vary substantially as the distance of the motor from the power house varies.

In Fig. 2, the conductors H and I are shown as carried upon one of the poles which support a trolley wire. In Fig. 3, I have shown a different arrangement, in which a wooden body L, containing two grooves or troughs *l*, *l'*, is laid along the line of the railway in proximity to the track. In the groove *l* is laid the continuous track conductor H, which is connected at intervals with the rails of the track, and in the groove *l'* is laid one of the conductors I. I prefer to join the conductors I with the conductor H through junction-boxes M, shown in Figs. 1 and 4, these being ordinary junction-boxes, in each of which is a metal ring with which the incoming and outgoing wires which form the conductor are connected. By this means any one of the conductors I can be electrically detached from the circuit for the purposes of testing or repairs.

Instead of connecting a conductor I with the conductor H at a single point only, as illustrated diagrammatically in Fig. 1, I prefer to make a number of connections by different wires *m*, as indicated by the diagram Fig. 4. That is, I may make several connections within the space of say one hundred feet, so that while electrically the connections are practically all at one point, there are a number of independent connections, whereby if at any one wire *m* oxidation of the wire occurs, so as to break the circuit, the circuit will be completed by other wires.

It will be seen that by the arrangement described, I am enabled to take make use of the rails in the return circuit without any alteration in their usual construction and arrangement, while at the same time I furnish such a conducting path for the return current as prevents any appreciable portion thereof from passing by way of the earth, whereby the difficulties hereinbefore referred to in the use of telephones, and gas and water systems are obviated. I further provide for the delivery of the current at the same potential on all parts of the system.

What I claim is—

1. In an electric railway, the combination of a source of electricity, two working conductors, one of which is insulated from the earth and the other of which is in connection with the earth, and a suitable number of separate conductors extending from one terminal of the source, insulated from the earth, and each having upon it a predetermined fall of potential and each being connected with the working conductor which is in connection with the earth at a predetermined point, substantially as set forth.

2. In an electric railway, the combination of a source of electricity, a working conductor insulated from the earth, a second working conductor consisting of the track rails, a suitable number of separate conductors extending from one terminal of the source, each having a predetermined fall of potential, and each connected with the said insulated working conductor at a predetermined point, and a suitable number of other separate conductors extending from the opposite terminal of the source, insulated from the earth, and each having upon it a predetermined fall of potential and each being connected with the said track rails at a predetermined point, substantially as set forth.

3. In an electric railway, the combination of a source of electricity, a working conductor insulated from the earth, another working conductor consisting of the track rails, a suitable number of separate conductors extending from one terminal of the source, each having upon it a predetermined fall of potential and each being connected with said insulated working conductor at a predetermined point, a continuous conductor extending along the line, insulated from the earth and connected at intervals with the said track rails, and a suitable number of separate conductors extending from the opposite terminal of the source, insulated from the earth, and each having upon it a predetermined fall of potential, and each being connected at a predetermined point with said continuous conductor, substantially as set forth.

4. In an electric railway, the combination with the track rails used as a working conductor, of the continuous wire insulated from the earth and connected at intervals with said rails, and a conductor having upon it a predetermined fall of potential and connected with said continuous wire at a predetermined point, the said connection being made by means of several independent wires, substantially as set forth.

This specification signed and witnessed this 15th day of March, 1893.

JONATHAN H. VAIL.

Witnesses:
WILLIAM A. GRAHAM,
EUGENE CONRAN.