(No Model.) 2 Sheets—Sheet 1.

# S. Z. DE FERRANTI.

## ELECTRIC RAILWAY.

No. 409,775. Patented Aug. 27, 1889.

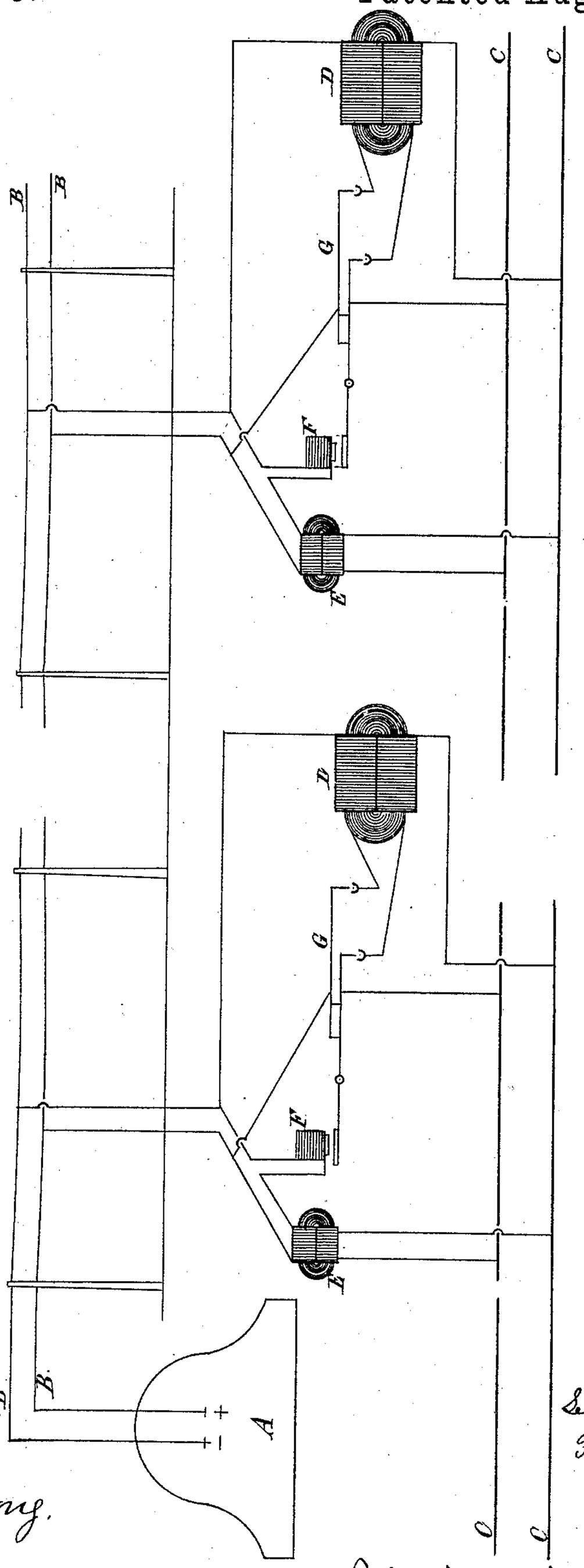


Fig. 1.

Witnesses
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Inventor:
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(No Model.) 2 Sheets—Sheet 2.

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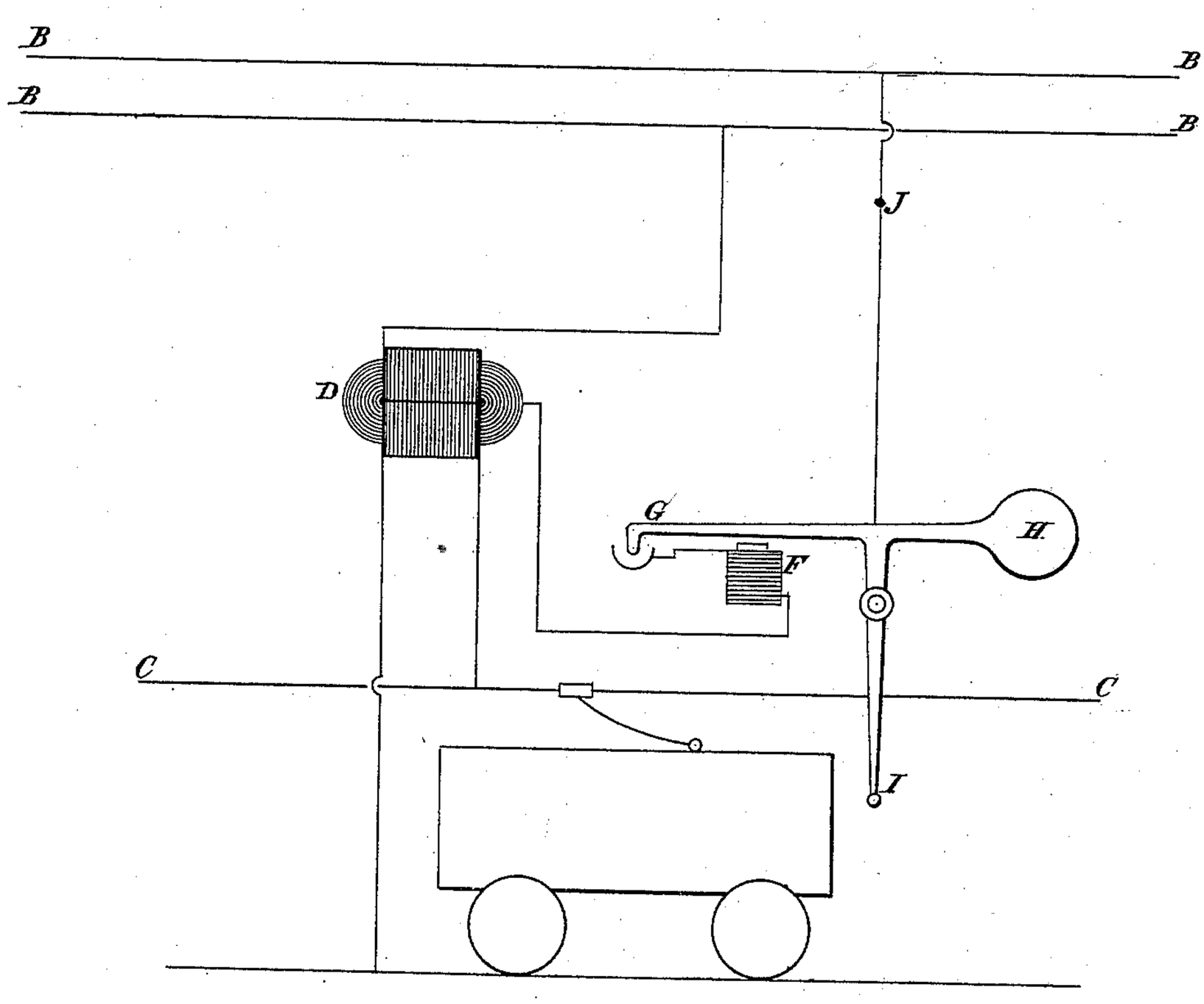
*Fig. 2.*

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# UNITED STATES PATENT OFFICE.

SEBASTIAN ZIANI DE FERRANTI, OF HAMPSTEAD, COUNTY OF MIDDLESEX, ENGLAND.

## ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 409,775, dated August 27, 1889.

Application filed September 24, 1888. Serial No. 286,203. (No model.) Patented in England September 13, 1887, No. 12,419.

*To all whom it may concern:*

Be it known that I, SEBASTIAN ZIANI DE FERRANTI, electrician, a subject of the Queen of Great Britain, residing at 120 Fellowes Road, Hampstead, in the county of Middlesex, England, have invented certain new and useful Improvements in Electric Railways, of which the following is a specification.

Letters Patent upon this invention have been granted to me in Great Britain September 13, 1877, No. 12,419.

The object of my invention is to provide means whereby electromotors used on electric railways may be worked advantageously by electric currents of low tension supplied to them from an insulated conductor, which is itself fed with current through converters from an insulated conductor, which conveys alternately currents of very high tension along the line. Hitherto this means of supplying currents of low tension, although available for working motor-engines for a variety of purposes, has not been rendered available for working motor-engines used on electric railways, and would be impracticable if the converters were at all times kept supplied with high-tension current, owing to the loss which must necessarily be then taking place at every converter along the line. I remedy this by arranging that the converter used for supplying each section or length of line with low-tension current shall only be in operation at the time when a train is passing along that section or length of line.

Figure 1 of the drawings hereunto annexed shows one method of doing this, and Fig. 2 represents a modification.

In Fig. 1, A is a dynamo-electric machine situated at a main station upon the line and generating alternating currents of very high tension. B are conductors for conveying the currents along the line for a considerable distance. C are low-tension conductors, which may be the rails of the railway insulated, or insulated conductors parallel with the rails. These are divided into sections of comparatively short length, say each a mile long. Two sections are shown in the diagram. D are converters or induction-coils, which serve to maintain the required tension in the conductors C.

When high-tension current is allowed to pass in the primary fine winding of the converter, it develops tension in the secondary or thick winding which is connected with the sectional conductor C, supplying the train-motors. For each sectional conductor C, I provide two converters. One, a small one E, is intended to maintain the tension while no train is upon the line. The other, the large converter D is intended to supply the current for propelling the train. Through the small converter E the high-tension circuit is constantly closed; but the high-tension circuit is only closed through the larger converter D when a train is upon the line. Thus a waste of energy, which would occur if the main converter were constantly excited, is avoided. The closing of the main circuit is effected automatically by means of an electro-magnet F or its equivalent in the high-tension circuit of the smaller converter. When, in consequence of a train passing onto the line, the low-tension circuit is completed through the train-motor, a powerful current immediately passes through the high-tension circuit, and this current excites the electro-magnet, which operates a switch G, which closes both the circuits of the main converter. This larger converter D is of sufficient capacity to maintain the requisite tension on the sectional conductor C, notwithstanding the amount of energy which is at this time being applied to the propulsion of the train. When the train passes off the section of the line, the secondary circuit is thereby opened, and, as little or no current then passes from the converters to the sectional conductor and but little current also in the high-tension circuit of the converters and through the magnet F, the switch is no longer retained by the electro-magnet F. Consequently the primary and secondary connections of the main converter D are broken.

In some cases I so arrange that the train in passing onto any section of the line mechanically closes the primary circuit of the converter. The switch is afterward held on by an electro-magnet in the low-tension circuit, and when this circuit is opened by the train passing off the line the switch, being no longer retained by the magnet, is opened by a spring or equivalent means. A diagram

illustrating this arrangement is shown at Fig. 2. In this diagram, B are the high-tension conductors, C the low-tension conductors, D the converter, G the switch, and F the electro-magnet for keeping the switch closed so long as a current is passing in the low-tension circuit. H is a weight for opening the switch as soon as this circuit is broken, and I a lever-arm on the switch to be moved by a passing train to close the switch. With this arrangement secondary batteries could be carried upon the locomotives or trains to drive the motor of the locomotive whenever the current through the motor has been arrested, either by the stoppage of the locomotive or train or from any other cause, so as to propel the locomotive or train until it has passed on to the next section, when the motor will again receive current from the low-tension conductors.

In order to avoid injury to the converters in case a short circuit should be accidentally established through one of the sectional conductors, I provide a fuse J in the connection between the high-tension conductor and the converter. If the flow of current to the converter becomes excessive, this fuse is burned and the circuit opened.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

1. In an electric railway or transportation system, the combination of relatively short sections of conductors, from which the motors are fed with currents of comparatively low tension, a circuit supplied with high-tension alternating current, converters interposed between the sections of conductors and the high-tension circuit, and circuit making and breaking devices controlled by the train when upon a section of conductor, by which the converters are thrown into and out of action.

2. In an electric railway or transportation system, the combination of relatively short sections of conductors, from which the motors are fed with currents of comparatively low tension, a circuit supplied with high-tension alternating current, two converters interposed between each short section of conductors and the high-tension circuit, one of said converters being a constantly-acting small converter and the other of larger dimensions, and circuit-controlling devices interposed between the two converters, whereby the larger one is brought into action by the increase of current passing through the small one during the passage of a train over the section, substantially as set forth.

SEBASTIAN ZIANI DE FERRANTI.

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