(No Model.)

A. L. RIKER.

ELECTRIC RAILWAY SYSTEM.

No. 483,366. Patented Sept. 27, 1892.

FIG. I.

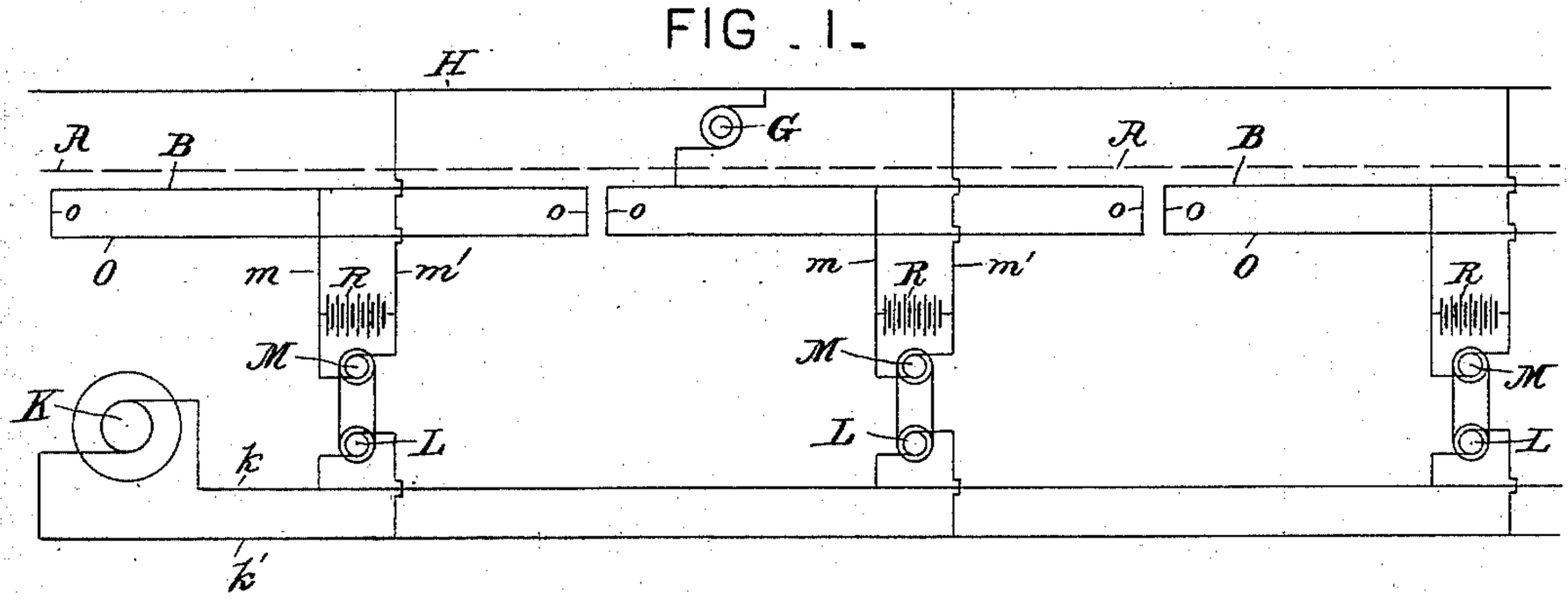


FIG. II.

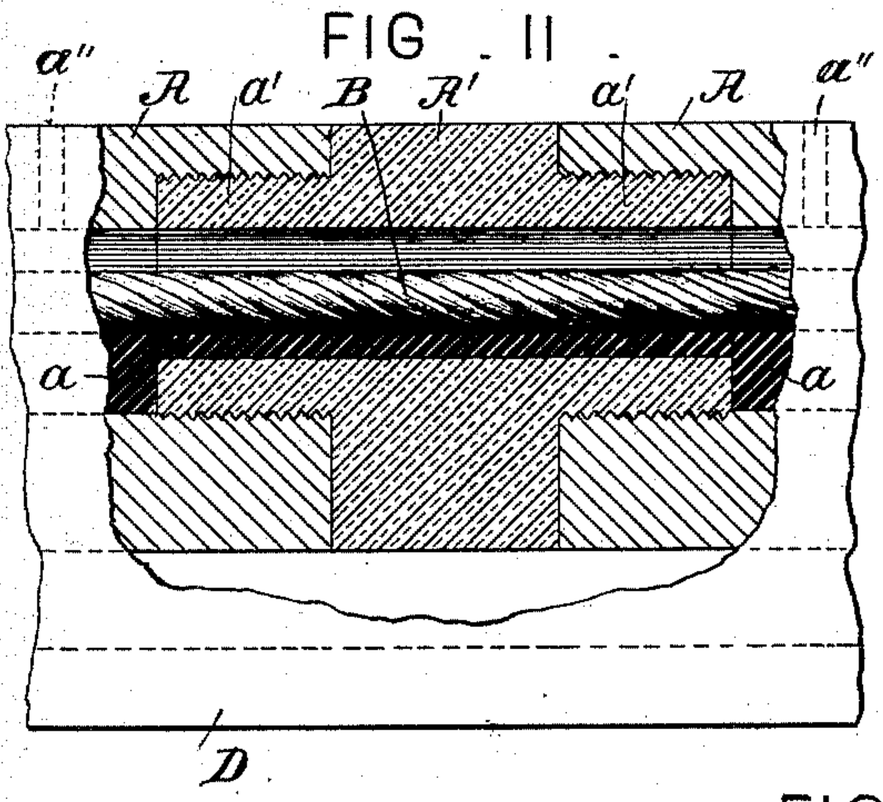


FIG. III.

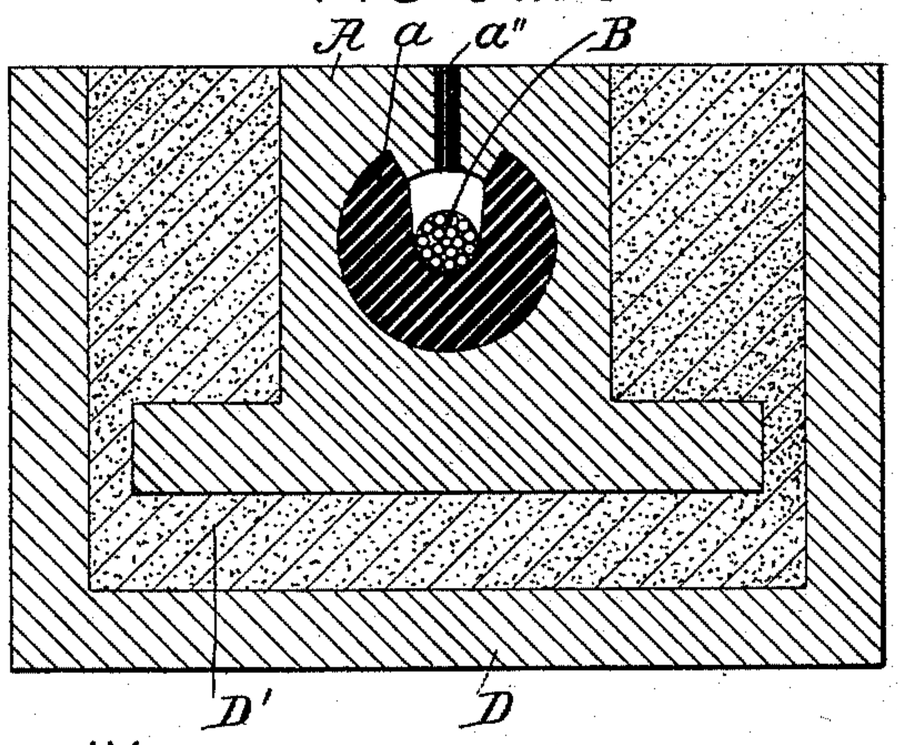
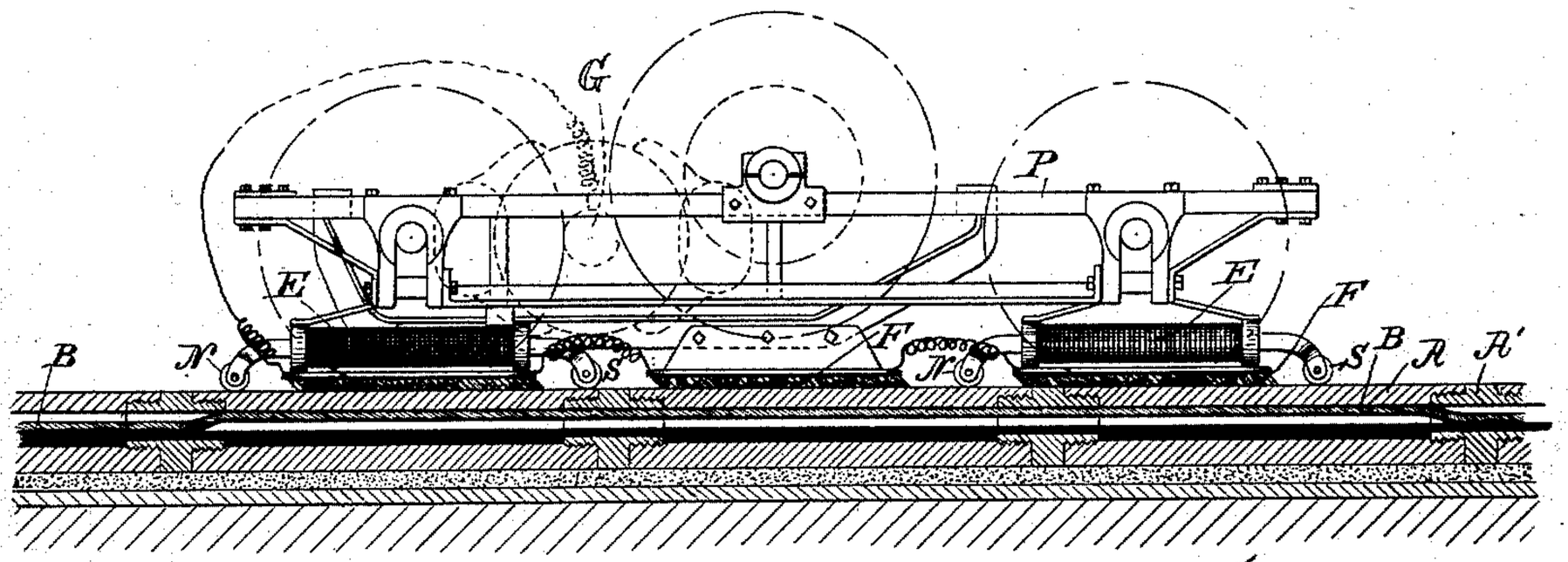


FIG. IV.



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UNITED STATES PATENT OFFICE.

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ELECTRIC-RAILWAY SYSTEM.

SPECIFICATION forming part of Letters Patent No. 483,366, dated September 27, 1892.

Application filed December 22, 1891. Serial No. 415,918. (No model.)

To all whom it may concern:

Be it known that I, ANDREW L. RIKER, a resident of New York city, in the State of New York, have invented a new and useful Improvement in Electric-Railway Systems, which improvement is fully set forth in the following specification.

This invention relates to electric-railway systems, and has for its object to obviate or lessen the difficulties that have heretofore prevented the general use of underground conductors for supplying current to the driving-motors of the cars.

The main difficulty encountered in the attempt to use underground systems is attendant on the use of an open conduit, in which the working or service conductor is laid, and though many efforts have been made to overcome this difficulty none of the plans proposed has, so far as I am aware, proved of practical value or utility.

The present invention provides for the protection of the working or service conductor by inclosing it from end to end in a sheath, tube, or casing. In other words, it relates to what are known as "closed-conduit systems." It further provides for the complete and perfect insulation of the service-conductor from external contacts, except at the points where the cars are passing.

It has been proposed heretofore to carry the service-conductor in a conduit closed from end to end and to make electrical connection between the same and an external conductor by lifting *seriatim* a series of pivoted contact-pieces, the lifting of these contacts being effected by means of magnets carried by the car. My invention also involves the use of magnets for the purpose of making temporary connection between the driving-motor of the car and the inclosed conductor; but my system differs in important respects, as will be hereinafter pointed out, from any heretofore devised.

It has been proposed to inclose the conductor in a conduit above which is a magnetic rail or rails, which when magnetized inductively lift the conductor into contact therewith and allow it to drop by gravity after the car (carrying the lifting magnet or magnets) has passed. In its broad features this system resembles that herein described; but my invention differs therefrom in certain respects tending to simplification, economy of construction, and efficiency, as hereinafter indicated.

According to my invention the working conductor is loosely laid in a magnetic tube—that is to say, a tube made wholly or in part of magnetic material. It is, however, in its position of rest or non-action electrically insulated from the tube, this being most conveniently effected by lining the bottom of the tube with insulating material. The upper surface of the magnetic tube or conduit is exposed above or about flush with the ground and is most conveniently arranged between the two rails upon which the car travels. The poles of the lifting-magnet are arranged to make contact with the surface of the tube or conduit, and thus to magnetize the latter. The poles of the magnets may be in the form of brushes, making a sliding contact with the magnetic tube or in the form of wheels to roll thereon. The latter form is preferred. Under the influence of the magnets that part of the inclosed conductor which lies beneath them is attracted to the top of the conduit, and thus makes electrical contact therewith, falling back again when the car has passed. It is of course necessary that the conductor or cable be composed of iron wires or have an iron core, so that it may respond to the attraction of the magnets. The surface of the magnetic tube is preferably galvanized for the purpose of preventing rust and also to prevent the conductor from sticking to the top of the conduit.

The principle of the invention may be carried out in various ways, and I do not limit myself to matters of detail. The invention, however, includes certain special features of construction and arrangement which are of practical value. For example, in practically carrying out the invention the inclosing tube is divided into sections of short length—say about five feet—which, though mechanically connected into a continuous conduit, are magnetically insulated from each other. Thus the effective magnetism for lifting the service-conductor is concentrated at the points of use, rendering the action more certain and efficient. It is preferred to employ magnets of the horseshoe type of such size that their poles

will bridge over the space between two adjacent sections of the tube and bring a considerable length of cable into contact therewith, thus reducing the resistance of the circuit.

It will be understood from the explanation thus far given that the tube or conduit in which the service-conductor is laid and whose upper surface is exposed above the ground does not form part of the electric circuit except at the sections where cars are passing, so that the possibility of accident and of loss by leakage is minimized.

Another object contemplated by this invention is to provide a low pressure at the points of use. The accomplishment of this object necessitates the employment of a separate main or supply circuit conveying a high-pressure current from the central station and of converting or transforming devices at sub-stations along the lines between the supply-circuit and the service-conductor. The necessity for such provision arises not only from the fact that safety requires the use of low-pressure currents, but also from the further fact that the service-conductor must be so light as to respond readily to the attraction of the lifting-magnets. The devices for converting and distributing the high-pressure current may be arranged in various ways. According to the plan herein described the conversion is effected by a high-pressure motor driving a low-pressure dynamo. The method of conversion by means of motor-dynamos is commonly practiced. The converting devices will be placed at suitable intervals apart—say half a mile, more or less, according to the grades and other conditions of the road—and they may, if desired, be placed underground. As the service-conductor is of small cross-section, and consequently of high resistance, the current from the secondary or local generator is carried by a feed-wire of large capacity arranged parallel with the service-conductor and connected therewith by a suitable number of branch wires.

To render the system more efficient, it is preferred to employ at each sub-station a group of storage-batteries bridged across the two wires of the circuit supplied by the secondary generator. As this generator is in constant operation and is continuously charging the storage-batteries, the latter act as a reservoir to catch the overflow of current, and thus tend to equalize the load at the central stations. In a system so organized the generator at the central station may be run constantly at nearly its maximum of efficiency. As the time when passing cars cause a draft upon the current, the supply is taken largely from the batteries, on account of the relatively-low resistance of their circuit as compared with that of the secondary generator. The use of the batteries is therefore attended with the further advantage that it permits the employment of smaller motors and generators at the sub-stations than would otherwise be required.

Having now outlined the general nature of the system, I will proceed to describe the same in detail, reference being had to the accompanying drawings, in which—

Figure I is a diagrammatic view illustrating the general arrangement of the apparatus and the electrical circuits and connections. Fig. II is a view, partly in longitudinal vertical section, of a portion of the conduit which contains the service conductor or cable. Fig. III is a cross-section of the same. Fig. IV is a side view illustrating, partly by diagram, the working of the system when current is being taken by a passing car.

In the diagram Fig. I the broken line A represents the tube, conduit, or hollow rail for the inclosing conductor. Its form is shown in detail in Figs. II and III. It is composed of separate sections, of convenient length, of cast-iron cored out to form a space or chamber for the service-conductor B. This space is lined on the sides and bottom with insulating material *a*, against which the conductor normally rests. The upper part of the space is uninsulated, so that when the conductor is lifted it makes electrical contact therewith. The conduit A may be of small dimensions—say not more than three or four inches in cross-section. It is laid in a box D, filled with cement D′, the upper surface of the tube being exposed and constituting a rail having a smooth face for contact with the sliding brushes. This tube or hollow rail is most conveniently located between the two rails forming the car-track. It is to be observed that putting it in place causes but little disturbance of the road-bed. The sections of the "hollow rail" (as the tube or conduit A may be most aptly termed) are connected together by means of coupling-pieces A′, of brass or other non-magnetic or it may be of insulating material, provided with threaded bosses *a*′, which screw into the interiorly-threaded ends of rail-sections.

Referring now to Fig. IV, the cars P working in this system are provided with a contact-making magnet or magnets E, (preferably two,) the poles of which may be, as shown, in the form of wheels or rollers N S, adapted to run on the hollow rail A. These poles are of such distance apart that they bridge over the space between two adjacent sections of rail A, making them for the time being respectively a north and south magnetic pole or polar prolongation of the lifting-magnets. The service conductor or cable B is made wholly or in part of iron wires, so that it will respond to the attraction of the magnets, and be raised, as shown in Fig. IV, into contact with the top of its inclosing space, thus making electrical contact with the sections of the rail A lying under the passing car. Cable B thus acts as an armature or keeper for the traveling magnets, and a considerable length thereof is in contact with the rail A. The current for the driving-motors is collected by a series of brushes F, arranged to move over the

upper surface of the rail A and connected with the driving-motor G in the usual way. The position and electrical connection of one driving-motor are indicated diagrammatically in Fig. I, the circuit being completed to the side rails on which the car runs, one of which is represented by the line H. To further insure a good electrical connection between the service-conductor B and the brushes F, it may be found desirable to insert through the top wall of the hollow rail A a series of copper pins *a''*, as indicated in Figs. II and III. When the car has passed, the conductor B falls back into its original position by gravity, thus breaking contact with rail A. The rail-sections are not likely to store sufficient residual magnetism to hold the conductor against the top of its chamber or cavity, for the reason that they are exposed alternately to the influence of north and south magnetic poles, so that the resultant effect is practically neutral.

Referring now to Fig. I, I will describe the arrangement of the circuits and apparatus for supplying, distributing, and converting the current generated at the central station. K indicates the prime generator at the central station, supplying a high-pressure current to the main supply-circuit *k k'*. At each sub-station along the line (three of which are indicated on the drawings) is placed a high-pressure motor L, driving a low-pressure generator M. Motors L are placed in multiple-arc branches between the main conductors *k k'*. The secondary generators M are connected by wires *m* with a feed-wire O and by wires *m'* with the ground-rail H. This arrangement of motor and generator constitutes a well-known means of converting a high-pressure into a low-pressure current. Feed-wire O is connected by wires *o* at suitable intervals with the service-conductor B, so as to supply current thereto at a number of points. The feed-wires O run parallel with the conductor B, and may be in disconnected lengths extending from one sub-station to the next. The feed-wires O may be laid in any suitable trough or conduit adjacent to or parallel with the hollow rail, and the connecting-wires *o* between the feed-wire and conductor may be placed at any convenient intervals.

It will be understood from the diagram that when there is no car on a section of line supplied by a given secondary generator the circuit of the latter will be open. To complete the circuit through the motors requires, first, the contact of conductor B with the hollow rail A, and, second, the contact of the brushes F with said rail.

For reasons already explained I prefer to place between the conductors *m m'* of the local generators M a group of storage-batteries R, which are being constantly charged from the local generators, and from which the main portion of the current consumed by the car-motors is drawn.

It will be seen that my invention resides mainly in the improved construction of the tube or hollow rail having an insulating portion upon which the conductor loosely rests and which may be very quickly laid and at relatively low cost in magnetically-insulated sections having their ends in close proximity and mechanically connected. Other features of the system described are believed to be new, as pointed out in the following claims.

Having now fully described the said invention, what I claim, and desire to secure by Letters Patent, is—

1. In an electric-railway system, a hollow rail of magnetic material inclosing a conductor, also made, wholly or in part, of magnetic material and resting normally on an insulated portion of the interior of said rail, in combination with a vehicle having magnets adapted to attract said conductor into electrical contact with said rail and with brushes for collecting the current therefrom, substantially as described.

2. The combination of a continuous hollow rail laid in sections magnetically insulated from each other and lined, except at the upper portion, with insulating material, a service-conductor inclosed by said rail and resting normally on said insulating-lining out of contact with the rail proper, and a vehicle provided with magnets adapted to lift the conductor into contact with the rail, substantially as and for the purpose described.

3. In an electric-railway system of the character described, the combination of the hollow magnetic rail laid in sections magnetically insulated, the inclosed service-conductor made wholly or in part of magnetic material and normally resting on the insulating-lining covering the bottom of the interior of said rail, and a vehicle provided with horseshoe magnets whose poles are adapted to move in contact with said rail and to bridge the space between two adjacent sections thereof, substantially as described.

4. In an electric-railway system, the combination of a prime generator of high-potential currents, a main supply-circuit leading to local stations along the line, current-converting devices at said sub-stations, a service-conductor connected at intervals with said main circuit through said converting devices, a hollow rail of magnetic material inclosing said conductor, but normally separated therefrom by a layer of insulating material extending partly around the interior of said rail, and a vehicle having magnets for drawing said conductor against the unlined portion of said rail, substantially as and for the purpose set forth.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

ANDREW L. RIKER.

Witnesses:
DANIEL T. O'BRIEN,
E. RITZEMA DE GROVE.