(No Model.) 4 Sheets—Sheet 1.

E. R. ESMOND.

CLOSED CONDUIT ELECTRIC RAILWAY.

No. 556,311. Patented Mar. 10, 1896.

Fig. 1.

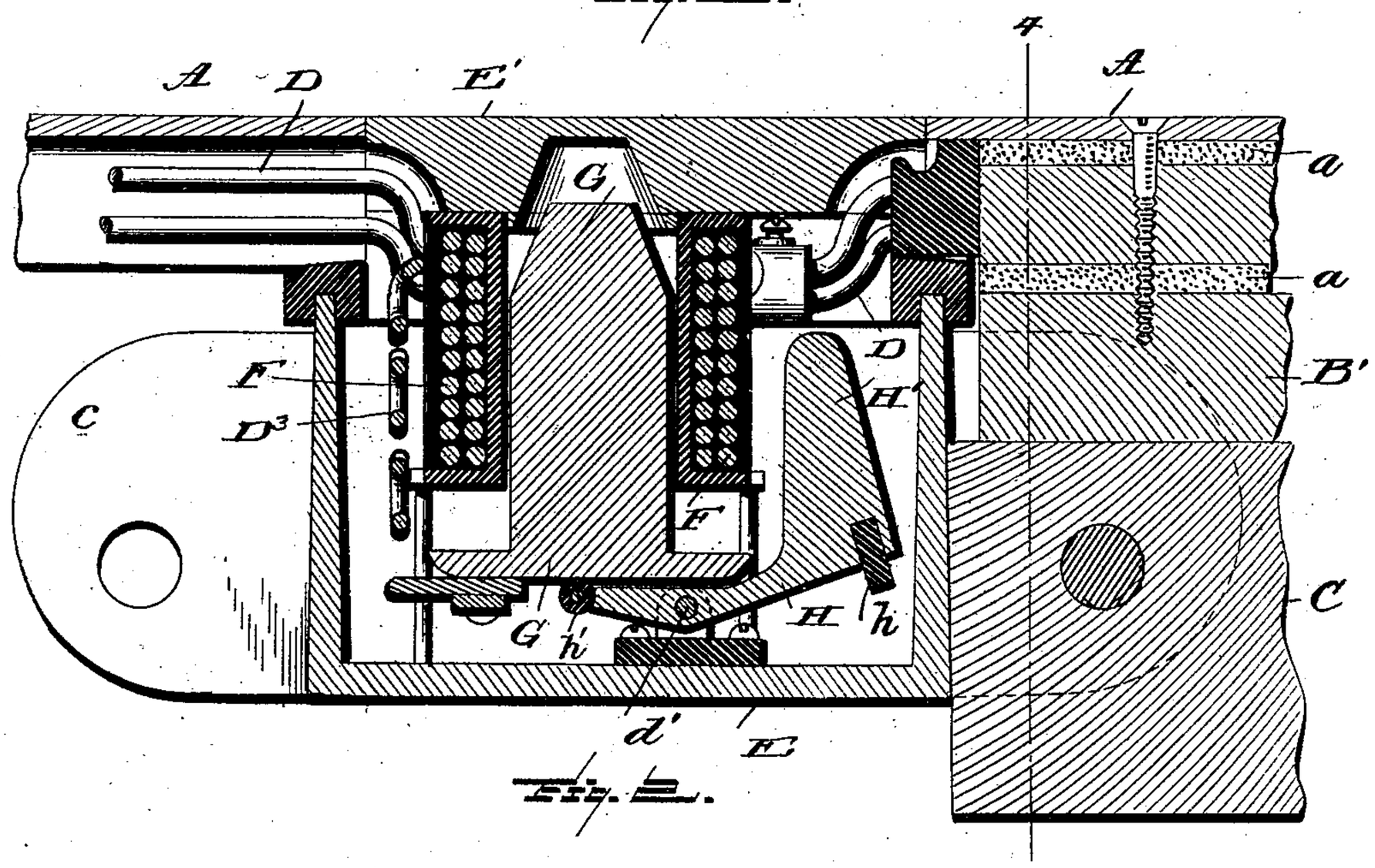


Fig. 2.

Fig. 3.

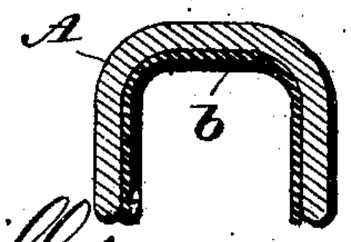
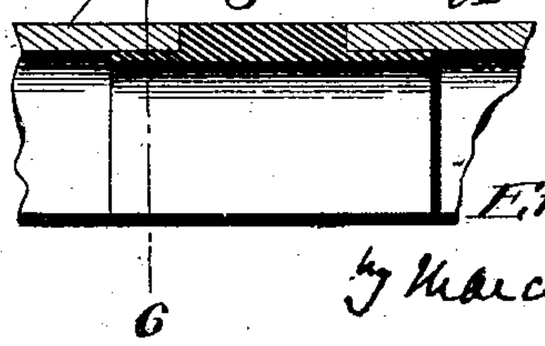


Fig. 4.



Witnesses:
L. C. Hills.
Edward Sick

Inventor:
Ernest R. Esmond,
by Macallen & Daily
his Attorneys

(No Model.) 4 Sheets—Sheet 2.

E. R. ESMOND.

CLOSED CONDUIT ELECTRIC RAILWAY.

No. 556,311. Patented Mar. 10, 1896.

Fig. 3.

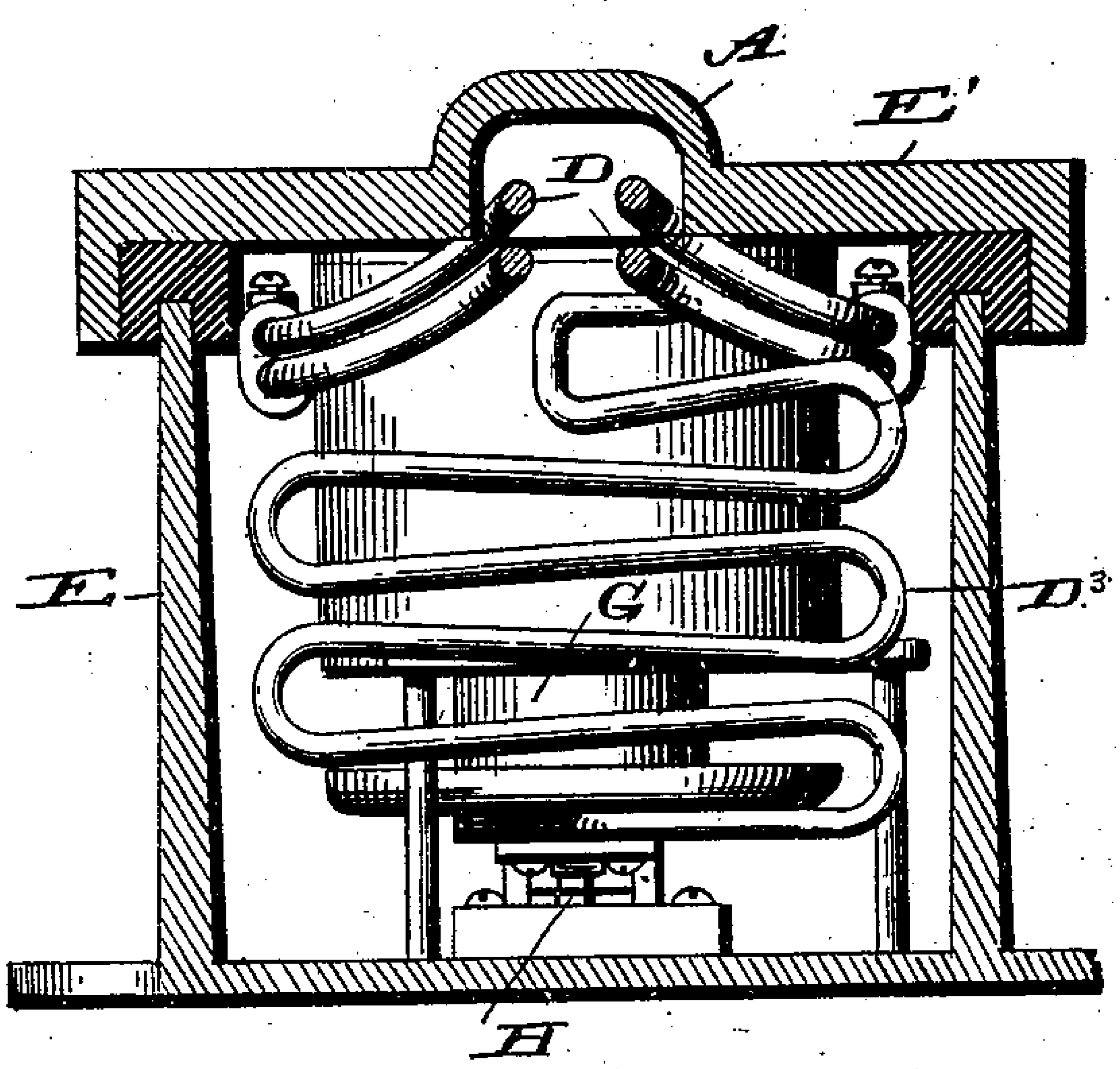


Fig. 4.

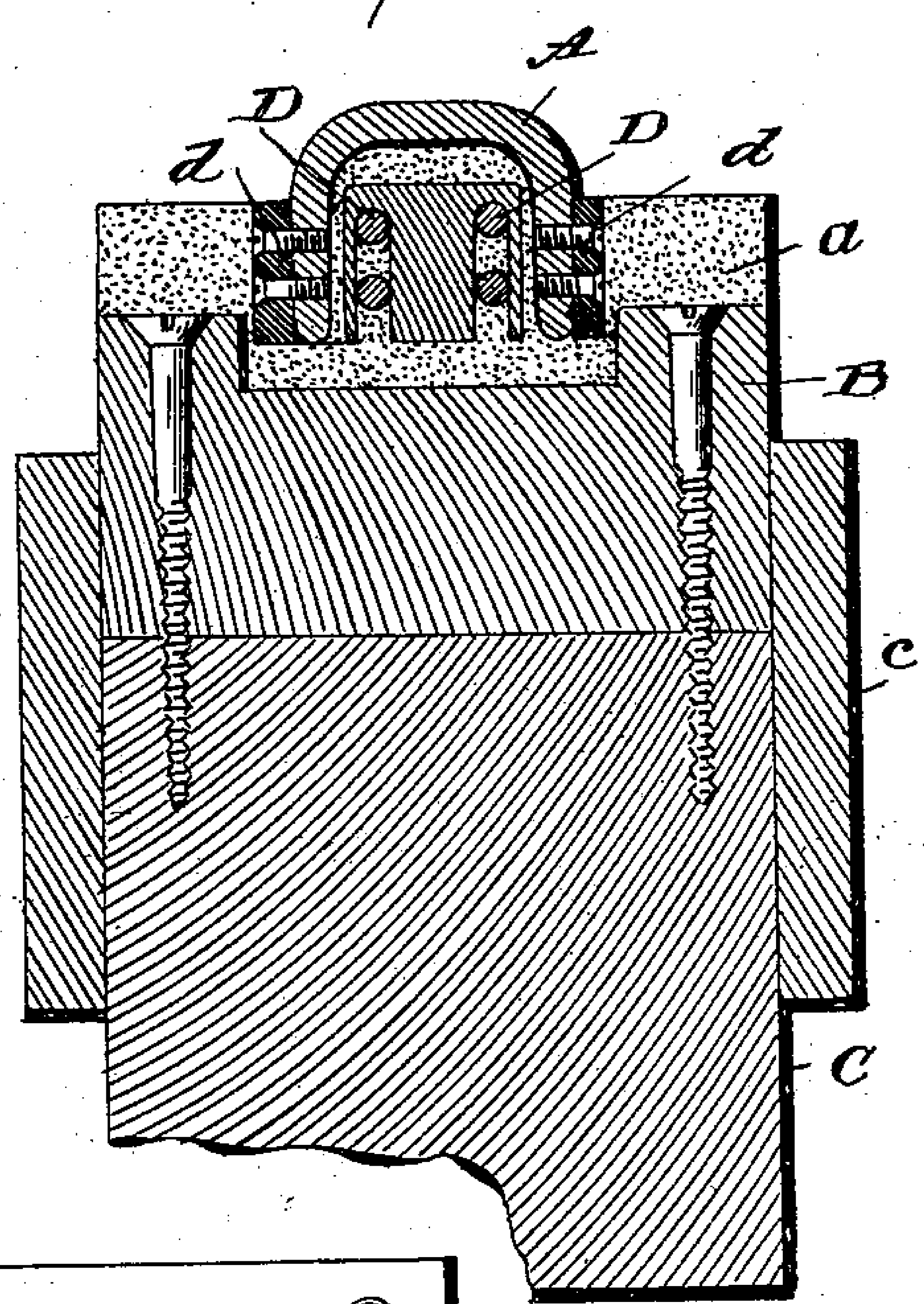
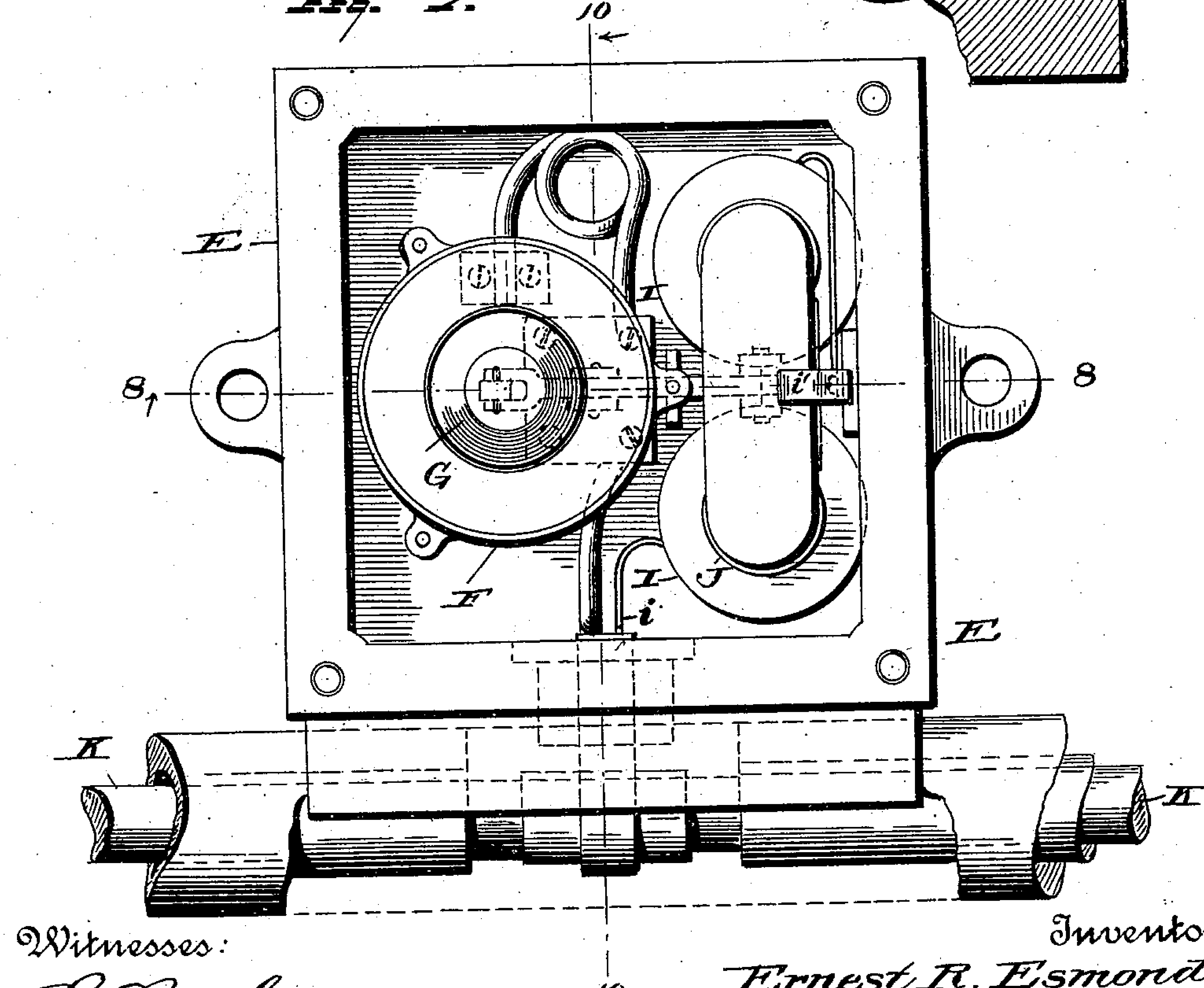


Fig. 7.



Witnesses:
L. C. Hills.
Edw. ...

Inventor:
Ernest R. Esmond,
by Marcellus Bailey
his Attorney

(No Model.) 4 Sheets—Sheet 3.

E. R. ESMOND.

CLOSED CONDUIT ELECTRIC RAILWAY.

No. 556,311. Patented Mar. 10, 1896.

Fig. 2.

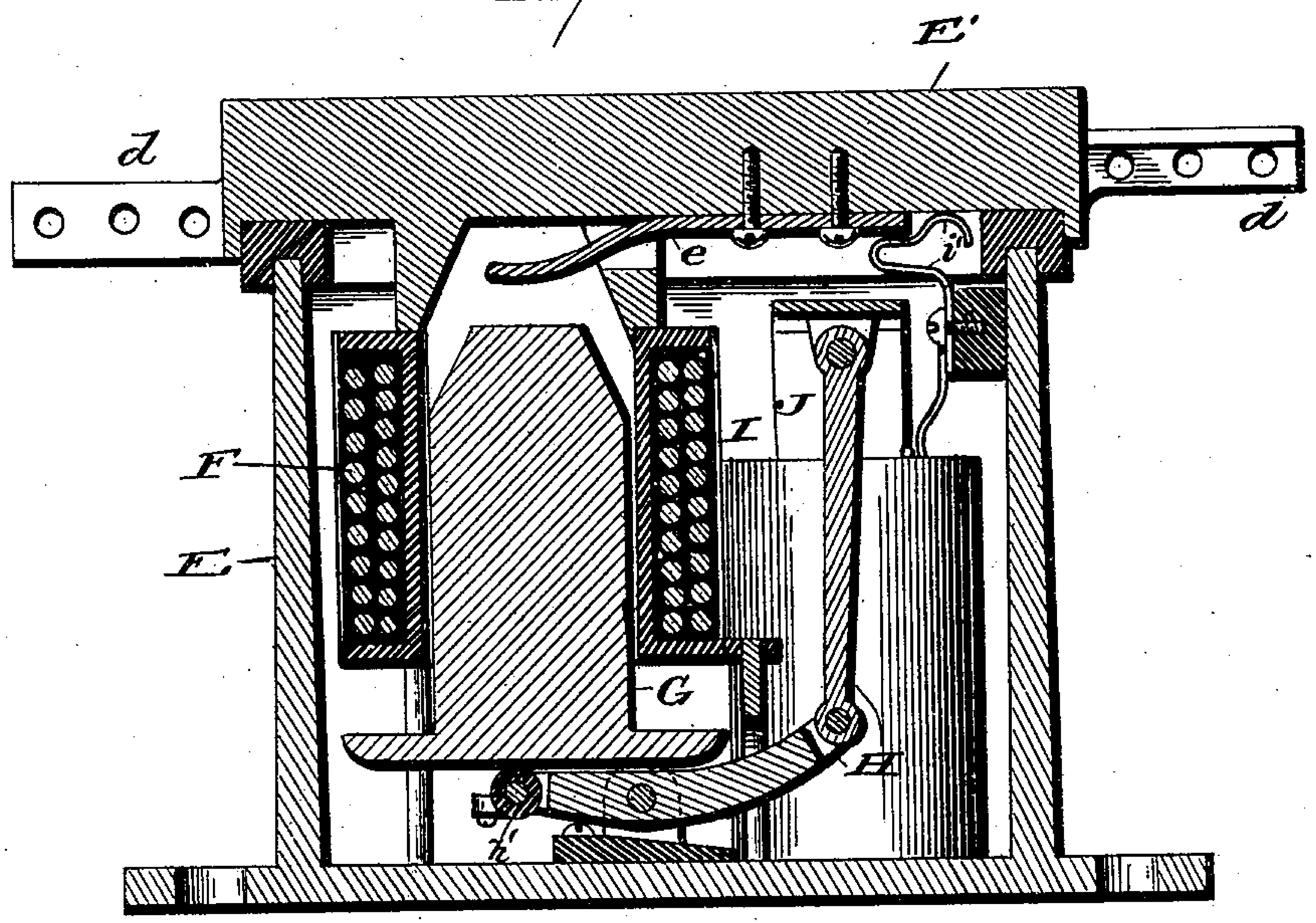
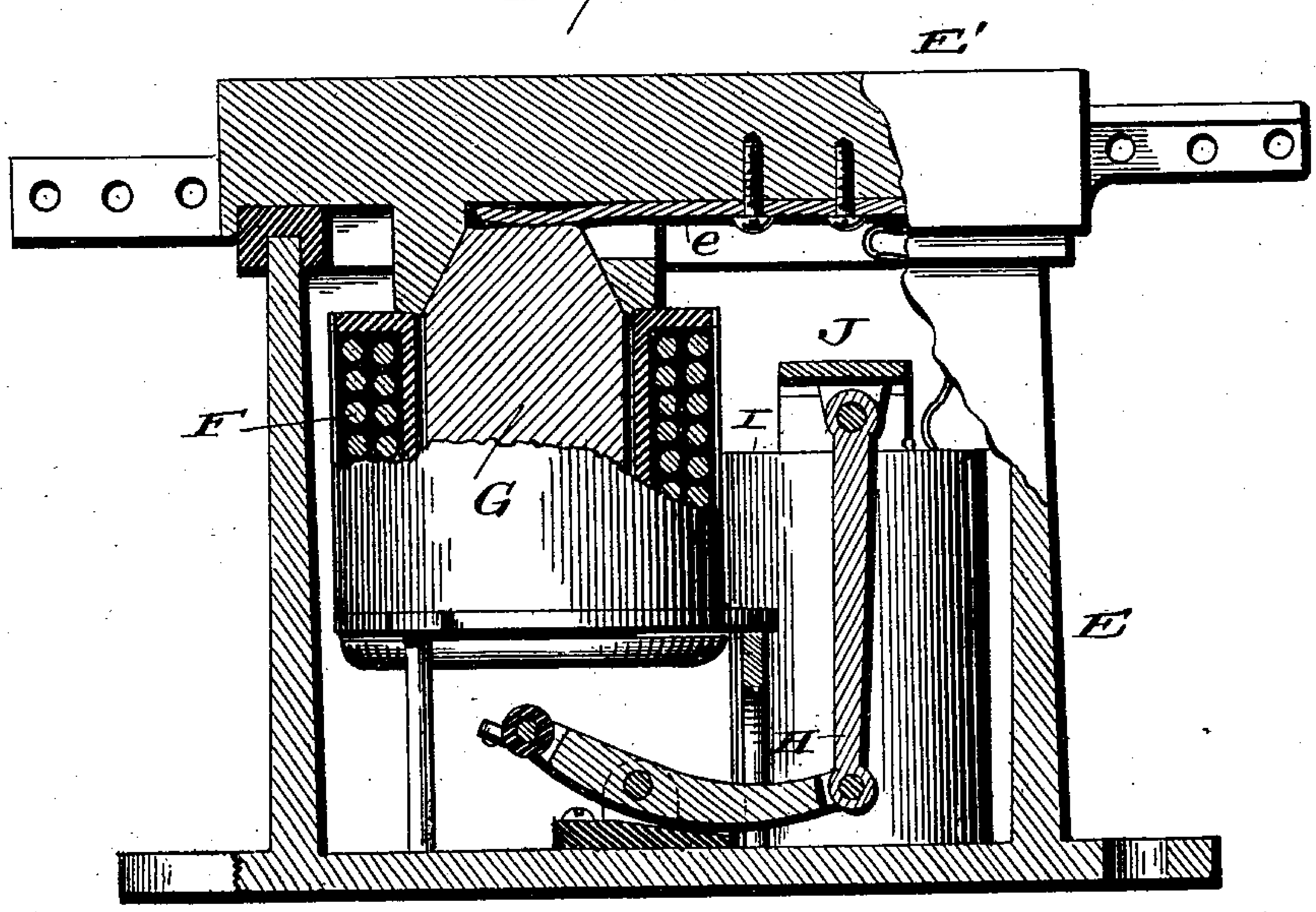


Fig. 3.



Witnesses:
L. C. Hills.
[illegible]

Inventor:
Ernest R. Esmond,
by Marcellus Bailey
his Attorney

ANDREW B. GRAHAM, PHOTO-LITHO. WASHINGTON, D.C.

(No Model.) 4 Sheets—Sheet 4.

E. R. ESMOND.

CLOSED CONDUIT ELECTRIC RAILWAY.

No. 556,311. Patented Mar. 10, 1896.

Fig. 10.

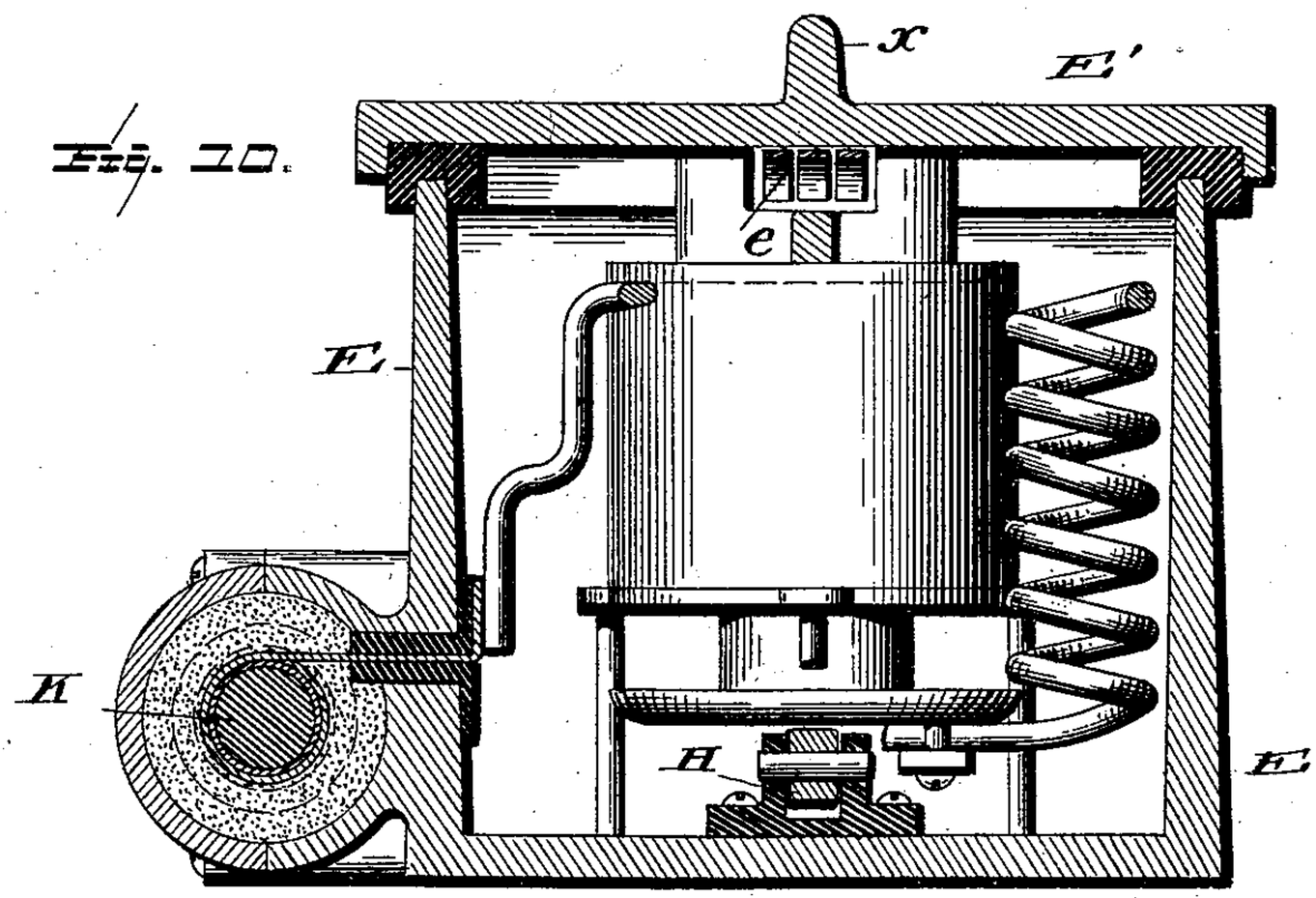


Fig. 11.

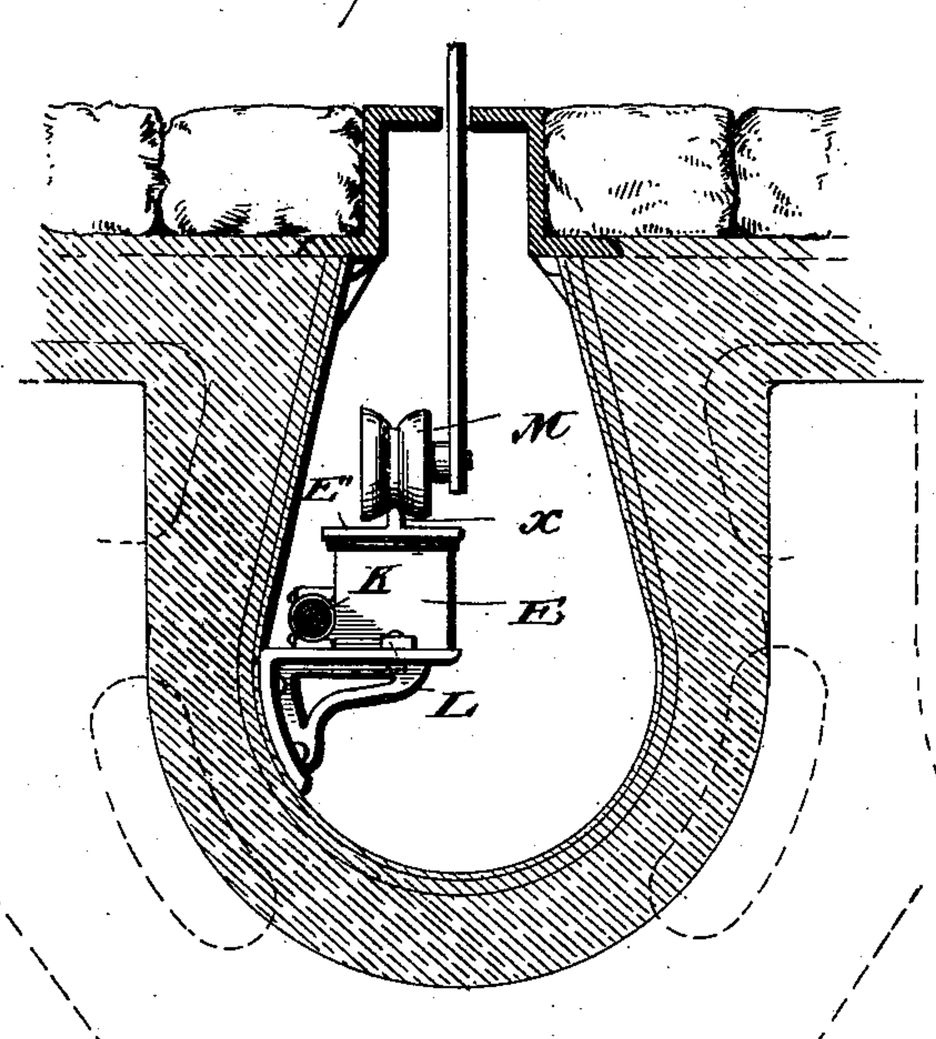
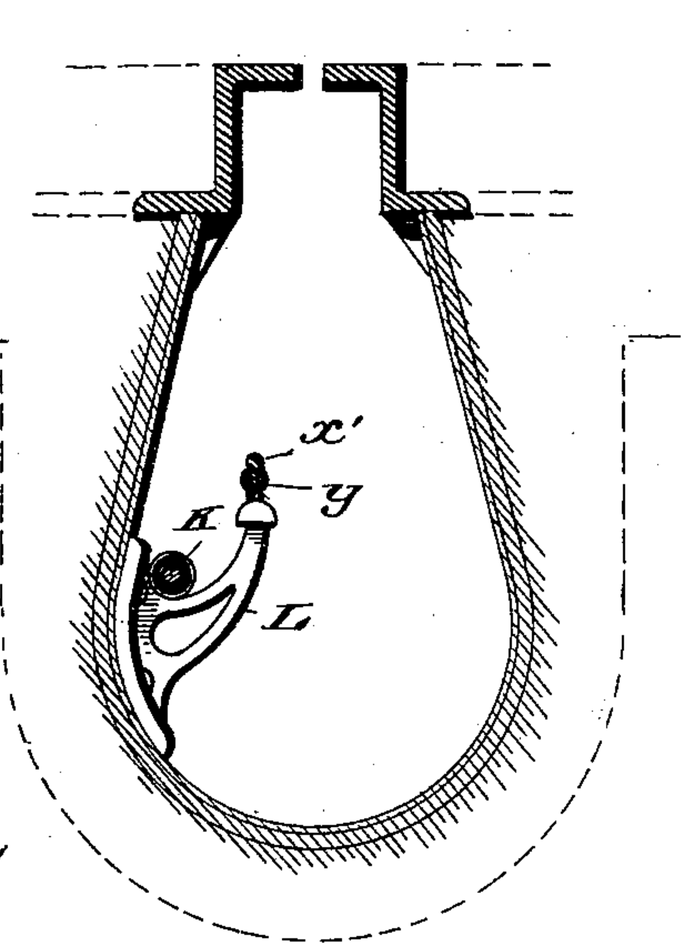


Fig. 12.



Witnesses:
L. C. Hills.
Edw. A. Dick

Inventor:
Ernest R. Esmond,
by Thaulow Davis
his Attorney.

UNITED STATES PATENT OFFICE.

ERNEST R. ESMOND, OF NEW YORK, N. Y., ASSIGNOR OF ONE-HALF TO WILLIAM C. CLARKE, OF WAKEFIELD, RHODE ISLAND.

CLOSED-CONDUIT ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 556,311, dated March 10, 1896.

Application filed October 18, 1893. Renewed January 8, 1896. Serial No. 574,756. (No model.)

To all whom it may concern:

Be it known that I, ERNEST R. ESMOND, of the city, county, and State of New York, have invented certain new and useful Improvements in Electric Railways, of which the following is a specification.

My invention has relation to electric-railway systems in which the conductor with which the trolley on the car makes contact is divided into sections that are electrically distinct from one another and are combined with a "pick-up," one for each section, whereby the sections are placed successively in circuit with the source of electrical supply, each section after having been thus connected remaining so until the trolley leaves it.

The system to which my invention more particularly refers is one in which the circuit through the trolley-conductor is maintained by the agency of an electromagnet energized by the passage of the car over the section to which the magnet pertains, this magnet (usually a solenoid) serving when energized to hold its armature (or core) in a position in which main supply-circuit or motor-circuit is closed through the trolley-rail or conductor-section.

The object of my invention is to render more sure and certain the action of the magnetically-controlled contact through which the motor-circuit is completed.

I will first describe, by reference to the accompanying drawings, the nature of my improvements and the best way now known to me of carrying the same into effect, and will then point out in the claims those features which I believe to be new and of my own invention, and which I desire to secure by Letters Patent.

In the drawings, Figure 1 is a longitudinal vertical central section of a portion of one section of a surface trolley rail or conductor embodying one form of my improved pick-up contact. Fig. 2 is a plan of the pick-up box with the cover removed. Fig. 3 is a section on line 3 3, Fig. 2. Fig. 4 is a section on line 4 4, Fig. 1. Fig. 5 is a longitudinal section of the joint between two sections of the trolley-rail. Fig. 6 is a section on line 6 6, Fig. 5. Fig. 7 is a plan, with the cover removed, of a pick-up box, in which the initial movement of the motor circuit-closing contact is obtained through the agency of a solenoid in a closed shunt. Fig. 8 is a section on line 8 8, Fig. 7, representing the main contact open. Fig. 9 is a like section of a portion of the box representing the main contact closed. Fig. 10 is a section on line 10 10, Fig. 7. Figs. 11 and 12 are sectional views illustrative of the manner in which the invention can be applied to conduits such as are used in ordinary cable systems.

The system in its general details is similar to those systems in which a sectional trolley-conductor is used in combination with a pick-up. I have therefore deemed it unnecessary to represent the car, the track-rails, and their connections.

The trolley-conductor is a surface conductor laid as a rail longitudinally of the roadway and between the track-rails. It is composed of metallic sections or rails A of inverted-U form embedded in asphalt or other suitable non-conducting material *a*, laid upon longitudinal stringers B, formed as shown in cross-section, Fig. 4, these stringers being laid upon and secured to main stringers C, which are to be secured to the cross-ties of the track-way, or to be otherwise suitably supported and held in place. The trolley-rail sections A are suitably insulated from each other, as indicated at *b*, Figs. 5 and 6, and they form a housing for the motor-circuit feeder-wires D, which are still further protected by being held in longitudinal grooves formed in a longitudinal wooden beam also embedded in the asphalt *a*, Figs. 1 and 4. Each section of the trolley-conductor has a "pick-up" box E containing a solenoid, the coil F of which is formed by one of the feeders D and the core G of which serves by its movement to make and break that circuit.

The box E is provided at each end with flanges *c*, which are secured to and received between the adjoining ends of the trolley-conductor rail-stringers, and its cover E′ (of conducting and preferably non-magnetic material) is formed as a continuation of the trolley-rails, and is connected electrically to the abutting ends of the same by straps *d*, Fig. 4.

From the feeder-wires, as at D′, Fig. 2, con-

nection is made with one end of the solenoid-coil F, while the other end of the coil is in communication at D^2 with the core G, slack-wire D^3 being left between the coil and the core to permit the free and unimpeded movement of the latter.

When the core has dropped to the position shown in Fig. 1, circuit of the trolley-rail section to which it pertains is interrupted. As soon however as the core is raised so as to contact with the cover E′, the motor-circuit is complete (assuming the trolley-wheel to be on that rail-section) and will so remain until the trolley passes off from the section. The coil F being energized will hold up its core so as to maintain the contact until the trolley quits the section. Then, the coil becoming inert, the core will drop of its own weight, thus breaking the contact which is made by its movement.

In the arrangement shown in Figs. 1 to 3 the upward movement of the core requisite to make the contact is effected by a magnet or electromagnet on the car, which as it passes over the cover acts to lift by its attraction the core G. It is my object to facilitate and insure this movement of the core. To this end I combine with it a counterbalance so arranged that the weight of the core when the latter is in its lowest position will be about counterbalanced, the device shown by me for this purpose consisting of a lever H pivoted at d' to an insulated bearing on the bottom of the pick-up box, having one of its free ends (which is armed with insulating material,) as for example with the roller h' of insulating material extending under the bottom of the core and contacting with the latter at about its center, and having on its other free end a weight H′ so proportioned with respect to the leverage that when the lever is about horizontal and the core is at its lowest position the weight will just about counterbalance the core. Thus when the pick-up magnet on the car influences the core there is but little, if any, weight to lift, and the weight by its action supplements the attraction of the magnet to instantly throw up the core. In this way the motor-circuit is completed through the contact controlled by the core with very great rapidity and certainty. Rapid initial movement of the core is thus obtained, the combined effect of the magnetic attraction and the counterbalance being to carry the core up against the top of the box and to a position where it will be above and out of contact with the short arm of the counterbalance-lever beneath, the lever having on it a stop-piece h, (of non-conducting material,) by which the drop of its weighted end is arrested before the core reaches its contact. The instant the contact is made (the trolley being now upon the rail-section) the motor-circuit is completed, and the solenoid-coil F, being in that circuit, holds up the core and thus maintains the contact until the trolley quits the section. Then, the coil becoming inactive, the core (being at this time entirely independent of and lifted above the counterbalance-lever) drops at once by its own weight, meeting and bringing up against the counterbalance-lever, which is thereby returned to its normal position.

In the arrangement shown in Figs. 7 to 11, inclusive, the initial upward movement of the core is due, not to a pick-up magnet on the car, but to a high-resistance solenoid I contained in the pick-up box E and included in a shunt from the motor-circuit feeder-wire around the main solenoid already described, one end of the coil of the high-resistance solenoid being connected to the motor-circuit at i and the other end of said coil connecting with a conducting-strip i', which has permanent contact with cover E′. Under this arrangement the shunt-circuit is completed through the trolley as soon as the latter enters upon the section to which the pick-up box pertains, and the high-resistance solenoid I consequently is energized. The core J of this solenoid occupies the position and has the function of the counterbalance-weight H′ in the arrangement previously described, and like that weight it is connected, as indicated in Figs. 7, 8 and 9, to one arm of a lifting-lever H, the other arm of which extends under and contacts with the bottom of the main solenoid-core G. The core J when all the parts are out of circuit about counterbalances the weight of the main solenoid-core G when the latter is in its lowest position, as seen in Fig. 8. As soon as the trolley on the car enters the section to which the box pertains, sufficient current passes over the shunt through the high-resistance solenoid to energize the latter, with the effect of drawing down its core J and (with the mechanical assistance afforded by the weight of that core) to instantly lift the core G of the motor-circuit solenoid F far enough for it to make contact with a flexible conducting-strip e, depending from and in electrical connection with the conducting trolley-rail on top of the box. The motor-circuit thus being established the main or motor-circuit solenoid-coil F is at once energized and by its action completes the lifting action, drawing the core F up against the top of the box and compressing the flexible contact-strip e, as seen in Fig. 9. With the motor-circuit thus established very little current will pass over the high-resistance shunt, barely enough at most to hold the shunt-counterbalance core in the position it occupied when the main comparatively low resistance main or motor-circuit solenoid-coil took up its work and completed the upward movement of its core G. Thus the core G, so long as the circuit is maintained, will stand with its bottom some distance above the end of the counterbalance-lever beneath it and will be absolutely unrestrained and free to drop as soon as the motor-circuit is broken, thus insuring the instantaneous opening of the contact controlled by it as soon as the motor-circuit is inter-

rupted from any cause. I remark here that I can employ this same auxiliary or initial flexible contact *e* in the arrangement shown in Fig. 1, using the combined force of the pick-up magnet on the car and the counterbalance-weight H′ to lift the core G up to the contact *e*, and then completing the lifting of that core by the action of the solenoid-coil F energized through the closing of the motor-circuit at *e*.

In the arrangement shown in Figs. 7 to 11 there is but one feed-wire K, which is carried in insulated housings on the side of the box, and from which connections are made in any suitable way to the main and shunt solenoids in the pick-up box. Under this arrangement the trolley-rail can be a mere solid rib or rail of conducting material, as indicated at *x*.

The ease with which my invention can be applied to existing cable-conduits is exemplified in Figs. 10 and 11. The feed wire or wires and pick-up boxes are carried by brackets L arranged in the conduit, as seen in Fig. 10, in which is represented a trolley M reaching down through the "grip-slot" in the top of the conduit to contact with its rail. These brackets also carry the solid trolley-rail sections *x*, which are carried by suitable insulating-supports *y*.

Having described my improvements and the best way known to me of carrying the same into effect, what I claim as new and of my own invention, and desire to secure by Letters Patent, is—

1. The combination of the trolley-rail or conductor section arranged to form part of the motor-circuit, the electromagnet or solenoid having its coils included in said circuit, contacts in the motor-circuit controlled by the armature or core of said magnet or solenoid, and a counterbalance-weight and system of leverage for said armature or core, under the arrangement and for joint operation substantially as set forth.

2. The combination of the trolley-rail or conductor section arranged to form part of the motor-circuit, the main electromagnet or solenoid having its coils included in said circuit, the armature or core of said magnet or solenoid controlling contacts in the motor-circuit, the auxiliary magnet or solenoid included in a comparatively high-resistance shunt, the counterbalance-weight connected to or forming the armature or core of the auxiliary magnet, and the system of leverage connecting said weight with the armature or core of the main magnet, substantially as and for the purposes hereinbefore set forth.

3. The combination with the trolley-rail or conductor section, the main solenoid, the shunt-solenoid and their circuit connections, the counterbalance-weight and system of leverage connecting the cores of the two solenoids, and a flexible or yielding initial contact included in the motor-circuit, and closed by the initial movement of the main solenoid-core due to the combined action of the shunt-solenoid and the counterbalance-weight, substantially as and for the purposes hereinbefore set forth.

4. In an electric-railway system of the kind herein described, the combination with the main solenoid and its core of a weighted counterbalance-lever, adapted to exercise lifting action on the core, but having no positive connection with said core, thus permitting the latter to be lifted above and out of contact with the lever, substantially as and for the purposes hereinbefore set forth.

In testimony whereof I have hereunto set my hand before two subscribing witnesses this 14th day of October, 1893.

ERNEST R. ESMOND.

Witnesses:
WM. C. CLARKE,
LEWIS A. CHAMPLIN.