(No Model)

J. HOFFMAN.

UNDERGROUND ELECTROMAGNETIC RAILWAY SYSTEM.

No. 583,178. Patented May 25, 1897.

Fig. 1.

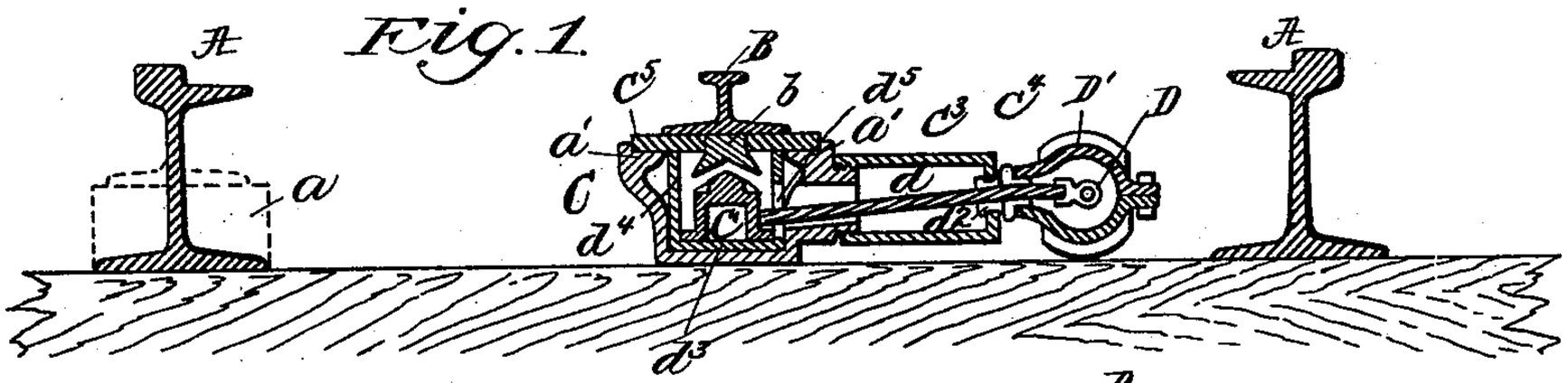


Fig. 2.

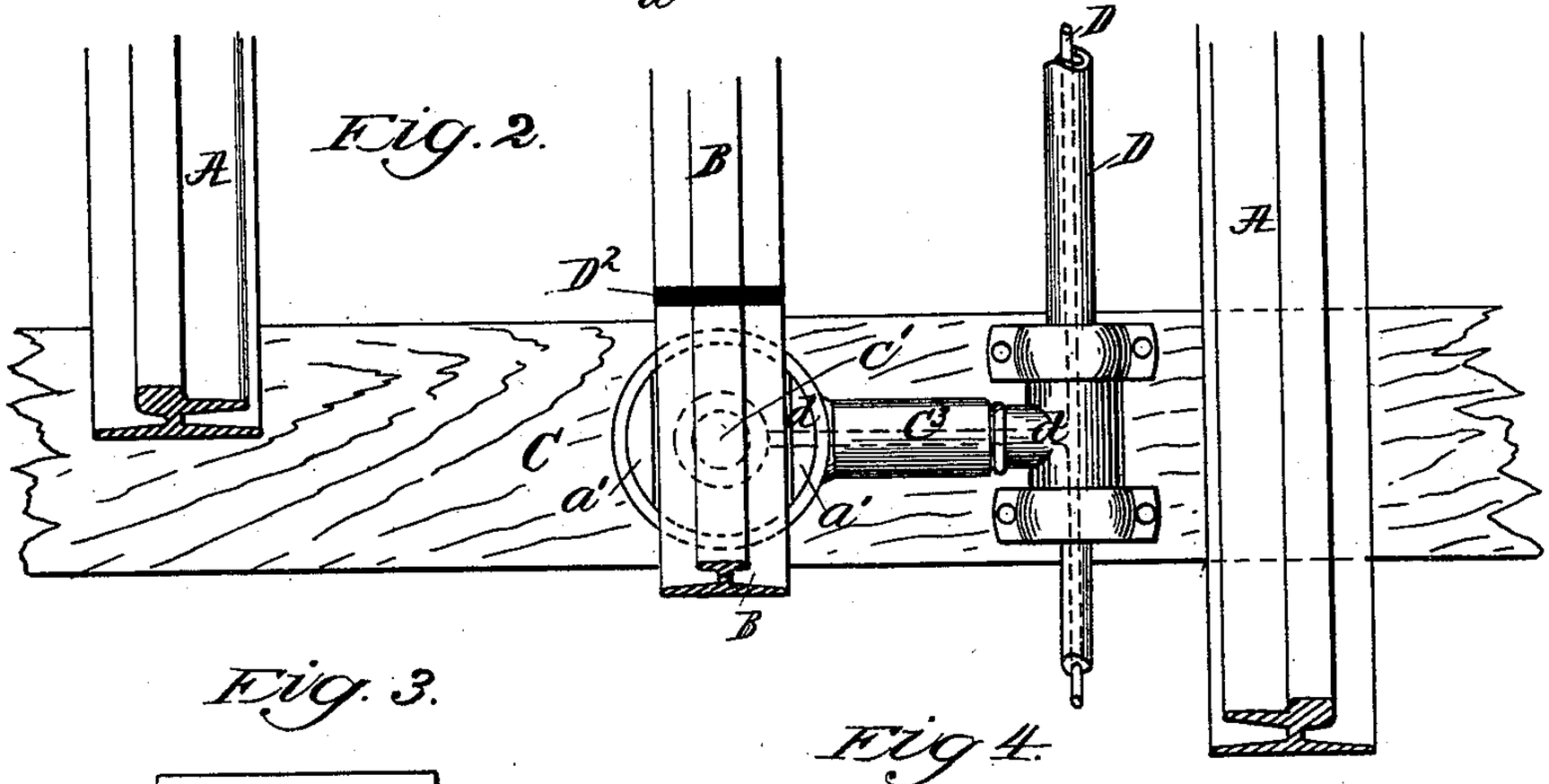


Fig. 3.

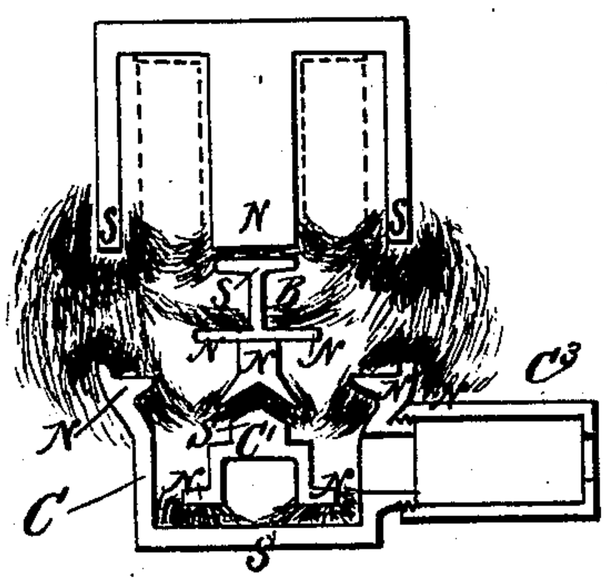


Fig 4.

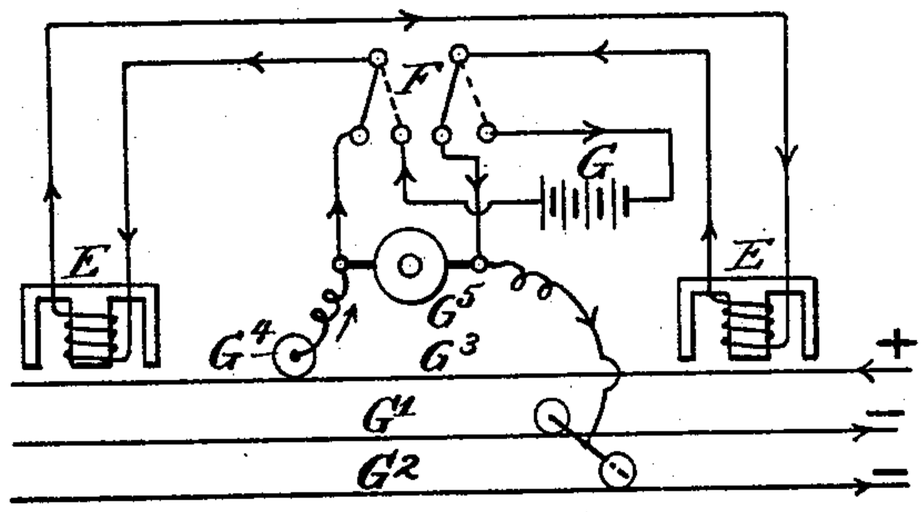


Fig. 6.

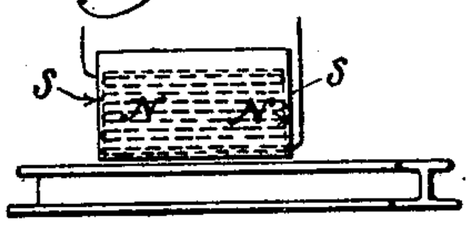
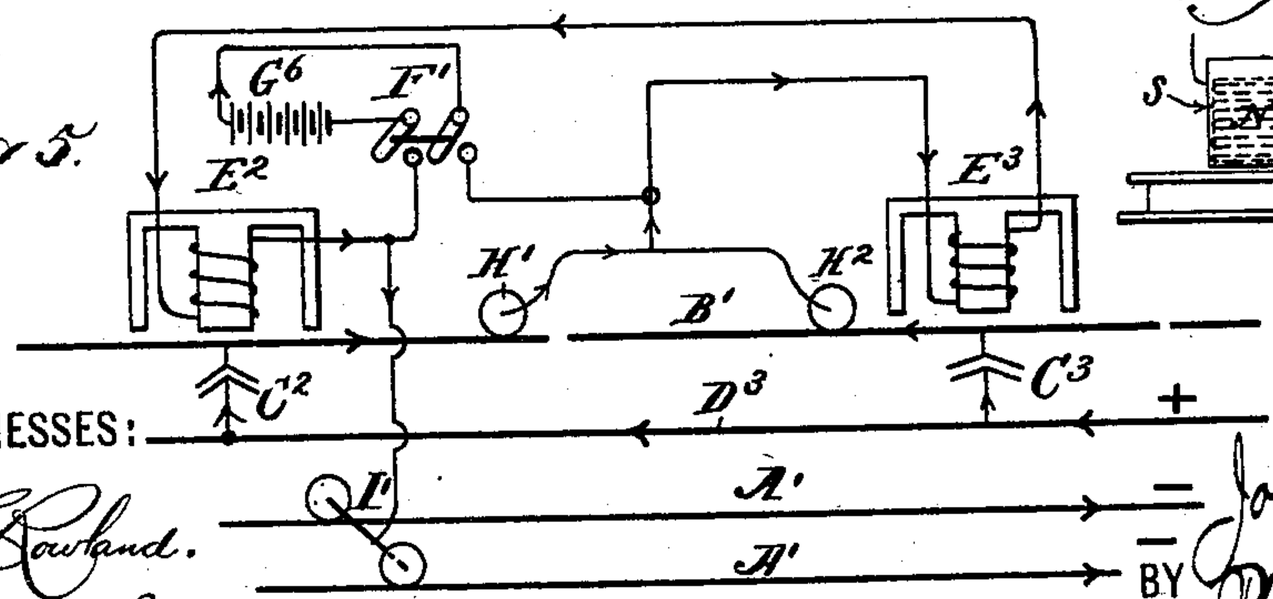


Fig 5.



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UNDERGROUND ELECTROMAGNETIC RAILWAY SYSTEM.

SPECIFICATION forming part of Letters Patent No. 583,178, dated May 25, 1897.

Application filed May 13, 1896. Serial No. 591,358. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH HOFFMAN, a citizen of the United States, and a resident of Schenectady, in the county of Schenectady and State of New York, have invented certain new and useful Improvements in Underground Electromagnetic Railway Systems, of which the following is a specification.

My invention relates to improvements in underground electrical railway systems of the electromagnetic-contact type, in which the current carried by an insulated feed-wire is automatically switched onto a section of a contact-rail by means of electromagnetic circuit-closing devices which respond to the attracting force of electromagnets carried by the car.

The invention consists in the employment of an electric conductor, which I prefer should be a continuous flexible metallic substance rigidly attached to the feeding-wire at one end, whereby a permanent electrical connection is established between that wire and the movable part of the circuit-closing devices; and my invention also embodies the arrangement of the parts in such a manner that the entire operating mechanism can be placed at the surface upon the track-ties and does not require any underground or conduit work, yet is perfectly inaccessible to the public, the live parts being inclosed within sealed and fully-insulated boxes, cases, or tubes.

Figure 1 illustrates a vertical cross-section through one of the contact devices. Fig. 2 illustrates a plan view of that which is shown in Fig. 1. Fig. 3 illustrates the magnetic circuit, indicating the polarity of the various iron parts of the contact device. Fig. 4 illustrates, diagrammatically, the electrical connections and circuits. Fig. 5 illustrates, diagrammatically, a modified arrangement of the circuits. Fig. 6 illustrates a side view of one of the magnets and contact-rail.

A A are the track-rails.

B is the contact-rail.

C is the box or casing, which contains the major portion of the contact devices.

D is the feeding-wire, which is suitably incased within a properly-insulated iron pipe D'.

The contact-rail B consists of several sections insulated from each other by insulation D^2, and likewise insulated from all parts in contact with the return circuit, and it is provided with polar extensions or contact-surfaces *b* of magnetic material at such distances apart that at least two of them are at all times under a passing car.

The casing C for the contact devices incloses a movable contact C′ of magnetic material, which is free to describe a vertical reciprocating motion within the exterior casing C. This casing has a lateral extension C^3, communicating at one end with its interior, and at the other end there is an opening C^4. An insulating-plate C^5 forms the cover to the casing C and serves as a support for the contact-rails B.

The feed-wire D is tapped at intervals corresponding to the location of the polar lugs *b* by branch conductors, which I prefer to make of flexible copper, as shown at *d*. The free end of these copper conductors passes through the openings C^4 in the cast-iron extension C^3 of the casing C and extends through the extension and through the walls of the casing C and connects with the movable contact C′. A water-tight bushing d^2 of insulating material is provided in the opening C^4, which prevents entrance of dampness to the contact devices and also avoids the establishment of electrical connection between the conductor and the surrounding parts. An insulating layer d^3 is placed in the bottom of the casing C, thus preventing objectionable electrical connections, and an interior casing d^4 of insulating material, which may be tubular in form, surrounds the movable contact and prevents any objectionable electrical connections laterally. The tube d^4 is of course provided with a slot d^5, through which the conductor *d* works.

The construction and arrangement of my system is such that it may be laid rapidly and inexpensively, because the contact-boxes are adapted to be placed on top of the rail-ties, as shown in Fig. 1. Therefore no conduit or underground construction is required, and this feature makes the system peculiarly simple and especially well suited for suburban roads, where existing tracks may be utilized, all that is necessary being to introduce between them my contact-boxes and to lay the contact-rail and feeding-wire suitably insulated in a metallic tube, the whole being put

in a trench a suitable distance under ground and covered over. I do not, however, limit myself to the construction described. My invention is applicable also to an ordinary underground conduit arrangement as well as to the more simple and inexpensive form described.

Referring now to Fig. 4, each car is equipped with two electromagnets E E, which have the terminals of their windings brought to a double-throw switch F, to one side of which is connected a battery of accumulators G and to the other side a shunt from the motor-circuit. The object of this arrangement is to use the accumulators for energizing the electromagnets when the car starts from a condition of rest and to switch over to the motor-circuit as soon as the car moves along, picking up its own current. By this means the storage capacity required for the battery is reduced to that only which is needful to energize the magnets and thus elevating the movable contact for the purpose of starting the car. In this diagram, G' G^2 illustrate the tracks-rails; G^3, the contact-rail; G^4, the trolley wheel or brush, and G^5 the motor.

The operation of the system is as follows: The electromagnets E E are in the first instance excited by the current from the accumulator battery and are thus made to magnetize the section of the contact-rail B immediately beneath it, and the magnetic lines of force pass into the tubular extensions *b*, which are so shaped as to concentrate the major part of their magnetism upon the contact-piece C′, whereby the latter is attracted upwardly, the flexible conductor *d* bending to the necessary extent, and thus electrical connection is made between the movable contact C′ and the stationary contact or tubular extension *b*, thus automatically switching the current from the feeding-wire D into the appropriate section of the contact-rail B, from which it is taken into the motors by the contact wheels or brushes which slide upon or otherwise engage with the contact-rail. The motors now being supplied with current, the car will start and in so doing will automatically pick up its current while moving from section to section of the contact-rail. The contact-boxes C are so located that two of them will be beneath each car at all times. The double-throw switch F is then thrown over from the position shown in dotted lines into that shown in full lines. The current from the battery is thus broken and the shunt from the motor-circuit is closed, whereby the exciting current is thereafter furnished from the main feeding-wire. When the car is stopped, the switch F is thrown back again, so that the current from the accumulator battery may be used, as already stated, for the starting of the car. The contact-boxes are spaced along the track at such frequent intervals as that at least one of them will be within the magnetic influence, and it will be obvious to those who are familiar with this art that the distance separating these contacts will depend on the number of magnets carried by the car, their length, and location on the car. This is so well understood as not to require further description or special illustration.

The functions of the various iron parts used in this construction in actuating the electromagnetic contact devices is clearly seen from the accompanying Fig. 3, in which N indicates a magnetic north pole and S a magnetic south pole. The movement of the magnetic force is indicated by pen-marks on Fig. 3. In order to more effectually secure this action or flow of the magnetic current, the magnets are made square or oblong, as shown in Fig. 6, so that the south poles run parallel with the north pole. This arrangement brings the north pole over the contact-rail and the south poles over the edge of the box containing the movable contact, and the iron box is so constructed that its edges serve as a return path for the magnetic lines of force, as indicated.

In order to avoid all danger of the contacts remaining together after the car has passed them, by reason of the action of residual magnetism, I prefer that the surfaces of one at least of them shall be made of non-magnetic material—as, for instance, the movable contact-piece C′ may have a ring made of non-magnetic metal, slightly raised above the iron of which it is composed, the object being to have a non-magnetic contact and at the same time a magnetic surface exposed to the action of the magnets. I do not especially illustrate this, because it is a feature now well known and understood.

The rails A need not set directly on the cross-ties, as shown in Fig. 1. Wooden stringers may be run lengthwise of the track on top of the cross-ties, as shown in dotted lines at *a* in Fig. 1 at the left. If this construction is employed, then rails which are not so high and consequently less expensive than those illustrated may be used, and I call attention to the fact that the insulating-plates C^5, located between the contact-rail and the casings or boxes for the contact-surfaces, in turn rest on lugs or projections *a′* made on the casings in such manner that the air-spaces between the contacts *b* and C′ will be permanently maintained irrespective of any sinking of the road-bed or any part of it, which sometimes arises, because of heavy trucking over it. Such a safeguard is necessary, for should the contact-rail B be depressed so far as to form contact with C′, then that section of the contact-rail would be dangerous.

Referring now to Fig. 5: In it I show an arrangement of the connections within the car, so made that the current when once picked up will continually energize the electromagnets, thus requiring a storage battery for the very beginning of the run only, they being also valuable in the event of momentary disablement of the line. Under this construction I derive the electromagnetic circuit

from the main feeding-wire in such a manner that current always circulates through the magnets irrespective of whether the car-motors are fed or not. One arrangement of the connections which I employ under this construction is shown in Fig. 5, in which A′ A′ are the track-rails. B′ is the contact-rail. C^2 C^3 are the contact devices. D^3 is a feed-wire. E^2 E^3 are the electromagnets. F′ is the switch. G^6 is the accumulator battery. H′ H^2 are the contact wheels or brushes, one of which engages with each of the two sections of the contact-rail under the car at any time. I′ is a pair of car-wheels. In closing the switch F′ the accumulator current is made to energize the electromagnets E^2 E^3, which in consequence close the contacts C^2 C^3. The main feed-current now communicating with the two sections of the contact-rail B′ beneath the car at that moment, the current is picked up by the contact-wheels H′ H^2 and carried through the electromagnets, returning through the car-wheels I′ to the track-rail A′. The main current is thus made to maintain attracting power of the electromagnets instead of the accumulators, which therefore can be switched off at F to be thereafter used in case of accidental interruption of the current. The current will be supplied to the motor or motors by suitable connections, which need not be explained in detail.

It will be obvious to those who are familiar with this art that modifications may be made in the details of construction of the parts without materially departing from the essential features of the invention. I therefore do not limit myself to such details.

I claim—

1. The combination with a feeding-wire, and a contact-rail, of separated contact-boxes, each provided with a horizontal extension projecting toward the feeding-wire, a movable electromagnetic contact device within each contact-box, and a flexible conductor for conveying the current from the feed-wire to the said movable contact device, inclosed partly within the extension, for the purposes set forth.

2. The combination with a feeding-wire, and a contact-rail, of separated contact-boxes which act as supports for, but are insulated from the contact-rail, a movable electromagnetic contact device within said box or casing, adapted to make contact with the rail, and a flexible conductor rigidly attached at one end to the feeding-wire, and at the other to the movable contact device, for the purposes set forth.

3. The combination with a feeding-wire, and a contact-rail, of separated contact-boxes having horizontal lateral extensions toward the feeding-wire, insulating material between the said boxes and the contact-rail, a movable electromagnetic contact device within the boxes, having a horizontally-disposed, flexible conductor rigidly attached at one end to the feeding-wire and at the other to the movable contact device, and means for sealing the said box or casing water-tight, for the purposes set forth.

4. In an underground electric-railway system, separated contact-boxes, which act as supports for, but are insulated from a superposed contact-rail, said rail itself, a feeding-wire, located laterally from the contact-boxes, a movable electromagnetic contact device within each of said boxes, a horizontally-disposed, flexible conductor connecting at one end with the feeding-wire, and at the other with the movable contact device, and means to insulate and seal the contact-boxes water-tight, for the purposes set forth.

5. In an underground electric-railway system, separated contact-boxes which act as supports for but are insulated from a superposed contact-rail, said rail itself, a feeding-wire, extensions projecting horizontally from the boxes toward the feeding-wire, a movable electromagnetic contact device within each of said boxes, a flexible conductor inclosed partly within the extension, and which is rigidly connected at one end with the feeding-wire, and at the other with the movable contact device, and means to insulate the box and its extension electrically and to seal the same water-tight, for the purposes set forth.

6. The combination of a sectional contact-rail, one or more separated contact-boxes, placed under each section of the rail, which act as a partial support therefor, insulating material between the box and the rail, an insulated feeding-wire, located outside of said box, a movable contact device within the box adapted to make contact with the rail, and a flexible conductor partly within said box and connected at one end with the feeding-wire, and at the other with the movable contact device, for the purposes set forth.

7. In an underground railway system, the combination of a sectional contact-rail, one or more contact-boxes located under each section of the rail upon which the rail rests, insulating material between the rail and the box, a feed-wire outside of said box, a horizontal extension from the boxes toward the feed-wire, a movable contact device within each of the boxes, a conductor for each box, partly within and protected by it, and its extension, and which connects with the feed-wire at one end and with the movable contact device at the other, and means to insulate the box and its extension electrically and to seal them water-tight, for the purposes set forth.

Signed at Schenectady, in the county of Schenectady and State of New York, this 4th day of May, A. D. 1896.

JOSEPH HOFFMAN.

Witnesses:

MARCUS WING,

WM. P. NOLAN.