(No Model.) 3 Sheets—Sheet 1.

G. H. BENJAMIN.

UNDERGROUND CONDUIT FOR ELECTRICAL CONDUCTORS.

No. 315,225. Patented Apr. 7, 1885.

Fig. I.

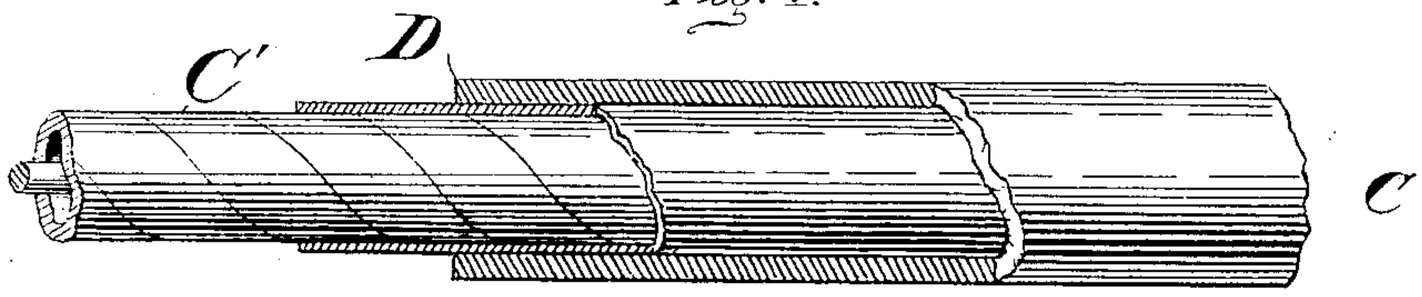


Fig. II.

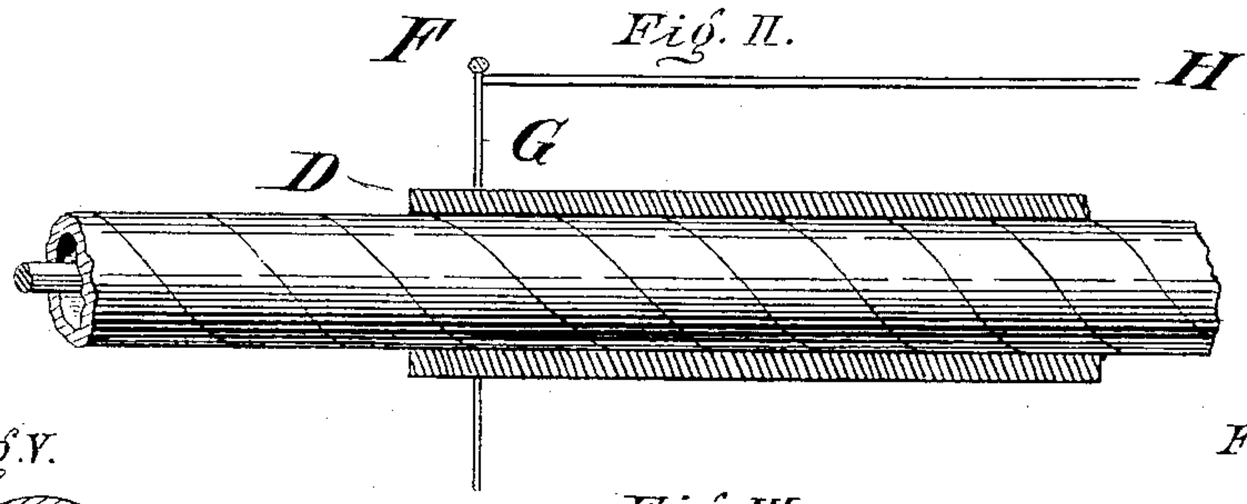


Fig. V.

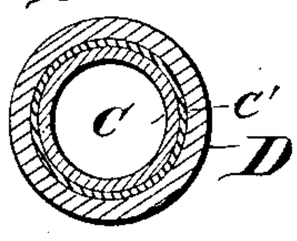


Fig. III.

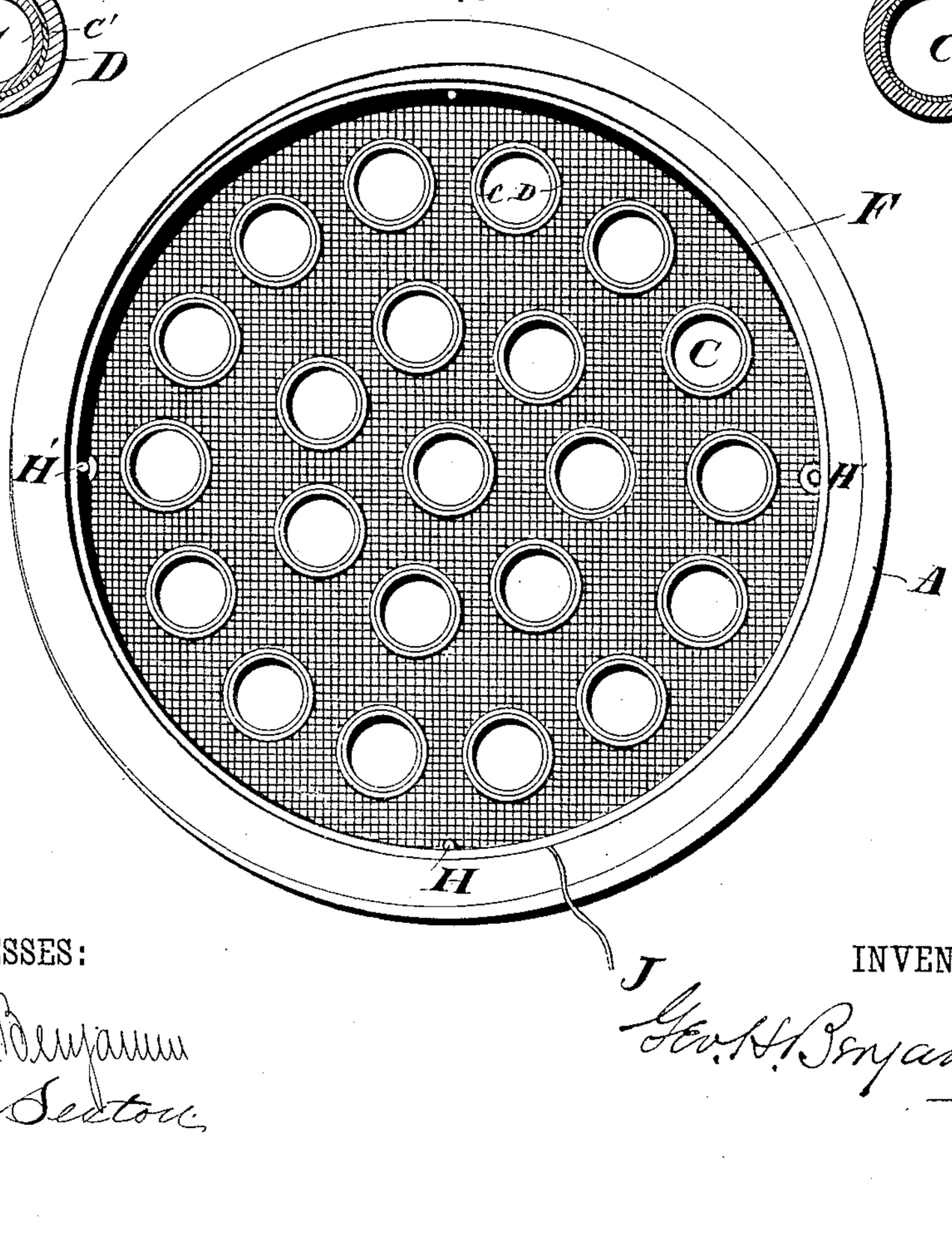
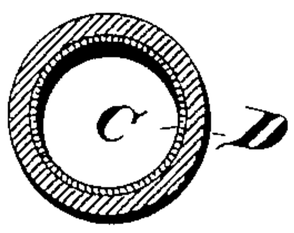


Fig. IV.



WITNESSES:

C. W. Benjamin

A. E. Sexton

INVENTOR

Geo. H. Benjamin

N. PETERS. Photo-Lithographer. Washington, D. C.

(No Model.)

3 Sheets—Sheet 2.

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Fig. VI.

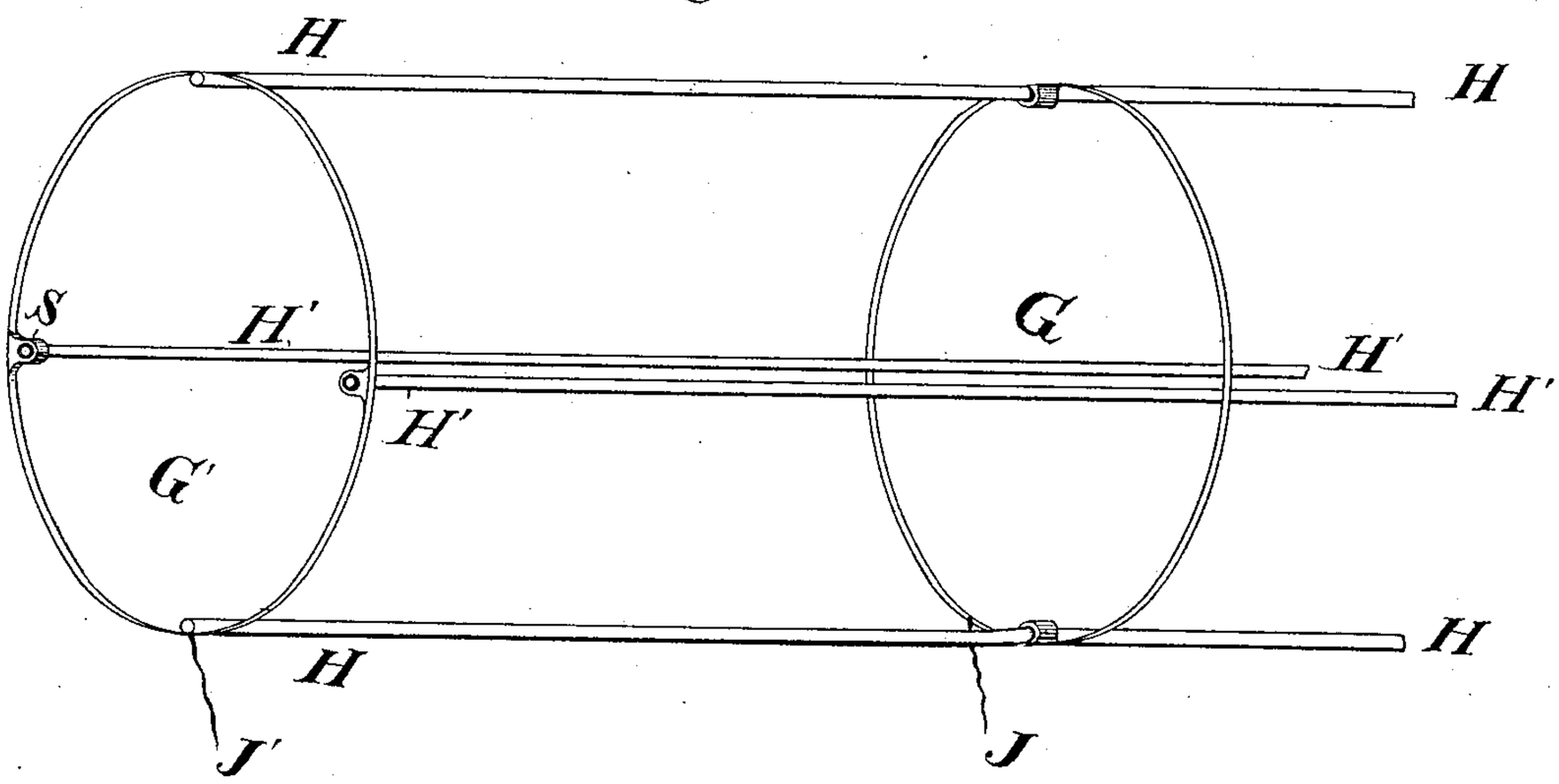
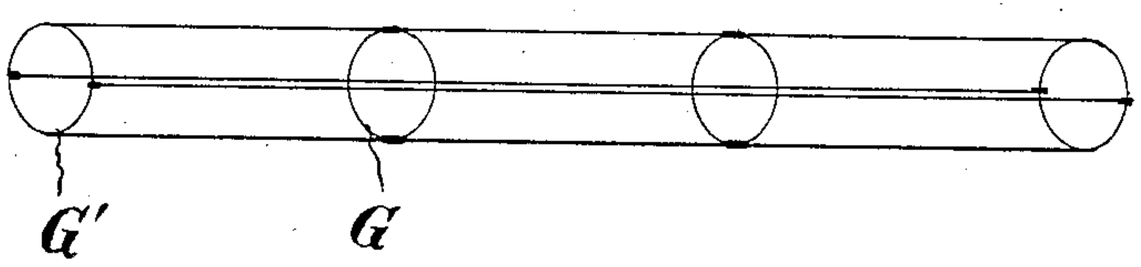


Fig. VII.



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C. W. Benjamin

A. E. Sexton

INVENTOR

Geo. H. Benjamin

N. PETERS. Photo-Lithographer. Washington, D. C.

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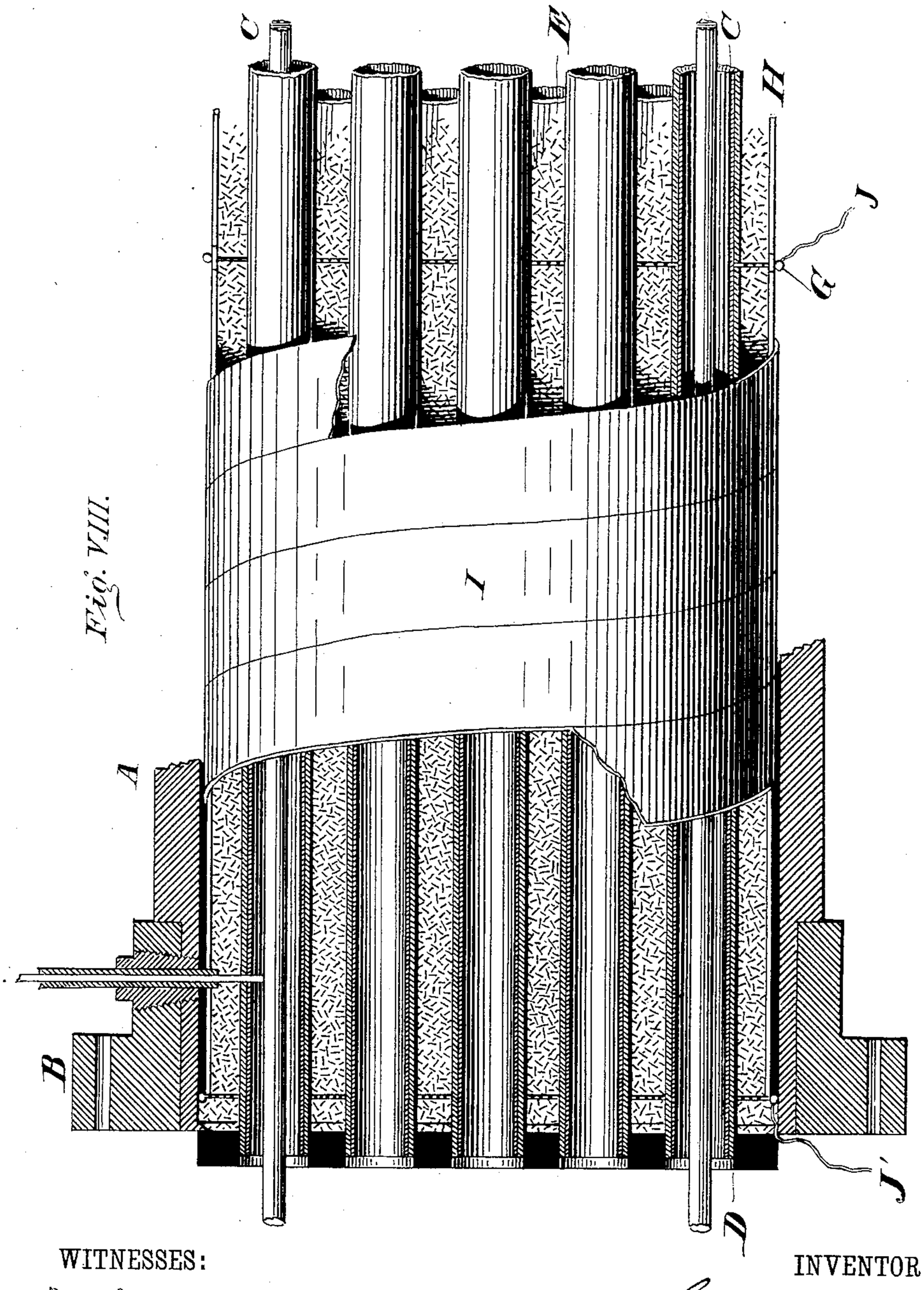
Fig. VIII.



WITNESSES:

C. W. Benjamin

A. E. Sexton.

INVENTOR

Geo. H. Benjamin

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

GEORGE H. BENJAMIN, OF SHORT HILLS, NEW JERSEY.

UNDERGROUND CONDUIT FOR ELECTRICAL CONDUCTORS.

SPECIFICATION forming part of Letters Patent No. 315,225, dated April 7, 1885.

Application filed July 11, 1884. (No model.)

To all whom it may concern:

Be it known that I, GEORGE H. BENJAMIN, of Short Hills, Essex county, State of New Jersey, have invented certain new and useful Improvements in Underground Pipes or Conduits for Conveying Electrical Conductors, of which the following is a specification.

My invention relates to the means and apparatus employed for conveying electrical conductors under ground, and in such a manner that the separate wires or conductors through which the electric currents are transmitted shall be properly insulated from each other, the metallic tubes, conduit, and the earth, and at the same time, by reason of the particular arrangement and material of the different parts, the inductive effects of the electric currents transmitted by such electric conductors each upon the other shall, in a measure, be avoided.

My invention consists of inclosing within an outer pipe or conduit a number of smaller tubes, each arranged to contain a single wire or conductor. The outer pipe or conduit can be of sheet-iron rolled in liquid asphalt, or of any material such as can be used for the purpose. The inner inclosing-tubes, which in their material and method of construction constitute one essential feature of my device, I make of paper or cloth that has been treated with any resinous compound and which is a non-conductor of electricity. These tubes are enveloped in an envelope or covering of tin-foil and sheet-lead, or sheet-lead alone, or an alloy of lead and tin. I have found, however, by experience, that the greater proportion of lead in the covering the more useful it becomes in preventing, absorbing, or cutting off induced currents transmitted between currents conveyed by separate conductors in separate tubes.

In order to sustain the small tubes, made as described, within the inclosing pipe or conduit and to connect their resinous or metallic surfaces together, I provide a number of disks, made of metal or metallic netting, through which holes are perforated of a size sufficient to receive the small tubes. These disks, which are arranged equally distant from each other in the inclosing-conduit, I connect together by means of copper wires attached to their circumference.

The method of attaching the copper wires is such that alternate disks are connected electrically with the same longitudinal wire, the object of which construction will hereinafter be more fully described. The spaces surrounding the separate small tubes I pack with a fine quality of mineral wool, which I find to be an excellent non-conducting material, owing to the amount of dry air contained in the interstices of the fibrous mass. Around the whole, before insertion in the conduit or inclosing-pipe, I wind a layer of ordinary tarred building-paper. The conduit as thus formed has attached to its ends coupling-boxes similar to those described in United States Letters Patent No. 302,883, granted to me August 5, 1884.

By the construction as above described I form, so to speak, a large condenser, wherein the conducting-wire forms one armature and the lead inclosing-tube the second armature, and the resin-treated tube the non-conducting body interposed between the armatures. To discharge the charges of electricity which have been induced in the resinous tube and the metallic envelope, I provide two wires, one of which is connected to the resinous or non-conducting tube and the other to the metallic envelope or external armature of the condenser, each being connected to earth. The effect of this arrangement is in a great measure to cut off the induced currents. I have found that the lead covering absorbs such currents, thereby becoming charged, or having induced therein currents which flow in a direction opposite to that of the inducing-current. I have also found that such currents induce static charges of negative electricity in the resin-treated tube. Both the lead tube and the resinous tube being in metallic contact with the earth, the static charges or currents induced therein are readily discharged. As a consequence, the currents transmitted through the separate conductors are not at all, or but little, influenced by their proximity to each other.

In the accompanying drawings, which illustrate my invention, similar letters of reference indicate like parts, in which—

Figure I is a view, partially in section, illustrating one form of the wire or conductor inclosing tube, showing the inner resin-treated

tube, tin-foil envelope, and lead covering. Fig. II is a similar view showing the tube with the lead covering alone. Fig. III is a transverse section of the conduit and inner inclosing-tubes, and showing the metallic disk in elevation, and the wire-inclosing tubes in their position in the conduit. Fig. IV is a transverse section of Fig. II. Fig. V is a transverse section of Fig. I. Fig. VI is a view in outline showing the position of the metallic disks relatively to each other and the method of making the connections with the longitudinal wires which support the disks and convey the currents therefrom. Fig. VII is a view showing the position of the wire disk in the conduit. Fig. VIII is a view of my conduit as a whole, shown partially in section and partially in elevation, and showing the relative position of the parts to each other in the conduit with attachment to the coupling-boxes, ground-connections, &c.

In the drawings, A represents the inclosing pipe or conduit, formed, preferably, of sheet-iron rolled once or twice upon itself and covered both on the outside and inside, as well as between the convolutions of the sheet-iron, with asphaltum. A pipe formed in this manner I find to be a non-conductor of electricity, light, strong, and well adapted to stand the moisture of the earth.

I do not limit myself to any particular form, design, or material of inclosing-pipe or conduit, as it will be understood that the device, as hereinafter described, can be inserted into any pipe, conduit, or subway made of any material.

B represents a coupling-box attached to the end of the inclosing-pipe. That shown in the drawings, Fig. VIII, represents such a one as I prefer to use, and which is described in United States Letters Patent No. 302,883, granted to me August 5, 1884.

C represents such a tube as I use for inclosing the current-conducting wire or conductor, and consists, primarily, of a tube formed of paper, cloth, or paper-pulp, thus including wood pulp, which has been treated at any stage of its manufacture—that is, during the manufacture of the pulp, cloth, paper, or of the tube itself—with any resinous substance or material, such, for instance, as ordinary varnish, or a composition, as of beeswax and resin, or of resin in any menstrum which will dissolve it, or a mixture or compound composed of resin, a dissolving medium, and tungstate of sodium. By resinous material I include gutta-percha, which can also be combined with the tungstate of sodium.

I do not wish to limit myself to any specific compound or treatment of the tube, as I claim the use of any material in combination with the other parts, as hereinafter described, which will act in conjunction with them and at the same time be negatively electrified by induction.

C′ represents a thin layer of tin-foil wound around the inclosing-tube, and preferably attached thereto by means of a resinous varnish.

D represents the lead envelope inclosing the whole. In Fig. II the envelope D, of lead, is shown covering the paper, the tin-foil being dispensed with. In this case the lead is fastened to the paper by means of the varnish, as described.

Instead of using pure lead for the envelope I may make it of any metal covered with a lead outer surface, or I may use an alloy of lead and any other metal, or I may use a tube of vucanized fiber with a lead-coating as the enveloping tube.

I may use any substance for an envelope, provided that the outer surface of the tube shall be of lead. I have found, however, by experience, that a tube constructed with tin-foil and lead, or lead alone, as coverings, is the most efficacious in absorbing or intercepting the induced currents.

Surrounding the separate tubes and filling the spaces between them I place the mineral wool E, which acts as a non-conductor of electricity, and also is a poor conductor of heat, and thus prevents the tubes in the interior of the conduit from being affected by changes in the temperature on the outside of the conduit. Mineral wool can be conveniently placed in position by means of the hand. It should be packed firmly but not compactly. It should be sufficiently firm to retain its position and not settle away from the tubes in the ordinary handling to which they are subjected.

G represents a metallic disk such as I use for supporting the wire-conveying tubes. It can be formed in any shape to fit the outer inclosing conduit, and it can be made of metal, such as iron, tin, or copper, or, preferably, of wire cloth or netting, as shown in the drawings.

In order to preserve the form of and to keep the disk straight, I fasten a wire, F, around the circumference by soldering or other means. The disks, as described, are located equally distant from each other in the inclosing-conduit, and vary in number depending upon the size and number of the wire-conveying tubes which they are to support. In an ordinary conduit, say of from six to twelve inches in circumference, the disks or supporting-pieces would be from two and one-half to three feet apart. Attached to the circumference of the disks are a number of copper wires, H H′, of the same length as the inclosing-conduit.

Referring to Figs. VI and VII, details are shown of the method of attaching the wire H H′. In Fig. VI the wires H′ are shown attached by soldering or other means to the disk G. The wires H are shown attached to the disk G′ by means of non-conducting connections, as at S. These connections may be of any form that will answer the purpose.

It will be observed that the disk G is electrically attached to the wires H′ and insulated from the wires H. Fig. VII shows the method of connecting all the disks in the conduit.

I do not limit myself to any particular ar-

rangement for connecting the disks together, as they may be connected by pairs or in any other way that may be found desirable. The metallic disks G′, by contact with the metallic envelopes D of tubes C, connect them all together, thus forming what is equivalent to a single lead plate and one of the armatures. The disk G is shown connected with the outside surface of the resinous inclosing-tubes C, and insulated from the metallic surfaces, and, as in the case of the metal coverings, connecting all of said resinous tubes together. By this arrangement, as described, I form what may be considered a condenser in which all the current-conducting wires form one armature, all the metallic surfaces of the wire-conveying tubes connected together by the metallic disks in contact therewith the second armature, and all the resin-treated tubes connected together through the metallic disks the interposed dielectric or non-conducting body.

In order to discharge the induced charges of electricity, I provide the wires J and J′, one of which is connected to the disks G′, and the other to the disks G, and both to the earth.

In order to retain the mineral wool in its place, surrounding the wire-conveying tubes, I cover the entire cylinder with ordinary tarred building-paper, as shown at I. The cylinder as completed is then inserted into the pipe or conduit forming the outer containing-body, and the coupling-pieces, of whatever form, are suitably attached thereto.

Where the sheet-iron conduit is used, as described, it is preferable to ground the metallic portions, and this may be done by connecting the sheet-iron to the wire J′ and the outside directly to the earth.

R represents a wire or electric conductor in its inclosing-tube.

I have stated that I could use tungstate of sodium incorporated with any resinous compound with which the wire or conductor inclosing tubes are treated. The object of using this material is to render the said tubes non-inflammable, so that, should the wire or conductor contained therein become very hot by means of a short circuit or other cause, the destruction of the inclosing-tube will not affect any other tube near by, or within the same conduit. The tungstate of sodium, as also various other chemical substances—such as the oxide of aluminium, sulphate and silicate of sodium, or the sulphate of potassium, or almost any of what may be called "neutral salts," and also various heavy earths and minerals—such as talc, gypsum, serpentine, mica, and asbestus—can be mixed with a paper or wood pulp during the process of manufacture, and by their presence tend to prevent combustion. Tungstate of sodium, however, by being freely soluble in water, seems best adapted for use, as it is a poor conductor of elecricity, does not deliquesce and absorb moisture, even when located under ground, and, further, adds very little increased weight to the tubes themselves.

I claim as my invention—

1. In a pipe or conduit for conveying electrical conductors under ground, separate wire or conductor conveying tubes consisting of an inner tube formed from fibrous material treated with a resinous material, and provided with an envelope formed from layers of tinfoil and lead.

2. In a pipe or conduit for conveying electrical conductors under ground, a separate wire or conductor conveying tube consisting of an inner tube treated with a non-inflammable material and a resinous material, and an outer envelope formed from layers of tinfoil and lead.

3. In a pipe or conduit for conveying electrical conductors under ground, separate wire or conductor conveying tubes made from any fibrous material treated with any non-inflammable substance and resinous substance, and provided with an envelope composed of lead or an alloy of lead, substantially as described.

4. In a pipe or conduit for conveying electrical conductors underground, a separate wire or conductor conveying tube made of any fibrous material treated with a resinous material, and provided with an envelope composed of lead or an alloy of lead.

5. In a pipe or conduit for conveying electrical conductors under ground, separate wire or conductor conveying tubes made from an inner resin-treated tube provided with a metallic envelope, in combination with plates or disks of metal or wire-cloth, supporting and in electrical contact with the resinous or the metallic portion of said tubes, substantially as described.

6. In an underground conduit, the combination, substantially as set forth, of the separate conductor-conveying tubes, the metallic supporting plates or disks, and the means for connecting them together, consisting of the connecting-wires, all the disks in contact with the metallic envelope, and all the disks in contact with the resinous envelope, the arrangement being such that the wires which connect one set of disks are insulated from the opposite set of disks, and the means for connecting said tubes and disks to earth.

7. In a pipe or conduit for conveying electrical conductors under ground, a plate or disk of wire-cloth for supporting and connecting the wire-conveying tubes together, and provided with openings through which the said tubes are inserted, substantially as dedescribed.

8. In a pipe or conduit for conveying electrical conductors under ground, a plate or disk of wire-cloth for supporting and connecting the inner or outer envelope of said tubes together, in combination with the means for connecting said plates or disks together, consisting of wires attached to their outer edge or circumference, and electrically connected thereto or insulated therefrom, substantially as described.

9. In a pipe or conduit for conveying elec-

trical conductors under ground, the combination, with an outer inclosing-pipe, of two or more tubes contained therein, made of an inner tube treated with a resinous material and a non-inflammable substance, and provided with a metallic envelope, plates or disks of metal or wire-cloth for connecting and supporting said tubes, the non-inflammable fibrous insulating material, the building-paper envelope, and the electrical conductors for connecting the tubes and conduit to earth, substantially as described.

10. In a pipe or conduit for conveying electrical conductors under ground, the combination of an inclosing-pipe made of rolled sheet-iron in asphalt, with two or more tubes contained therein, made of the materials and treated as described, plates or disks of metal or wire-cloth, a non-inflammable fibrous insulating material of mineral wool around and between said tubes, an envelope of building-paper, and electrical conductors for connecting tubes and conduit to earth, substantially as described.

11. In a pipe or conduit for conveying electrical conductors under ground, the combination, substantially as set forth, of the conducting-wires within said conduit, and the means whereby the induced currents induced by the currents conveyed on said conducting-wires can be absorbed and carried out of the inclosing pipe or conduit, consisting of the resinous tube, its metallic envelope, the metal or wire-cloth supporting plates or disks, and the ground-connecting wires.

GEORGE H. BENJAMIN.

Witnesses:
A. E. SEXTON,
C. W. BENJAMIN.