No. 755,306. PATENTED MAR. 22, 1904.

D. McF. MOORE.

ELECTRIC TUBE LIGHTING.

APPLICATION FILED JAN. 19, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

FIG. 1.

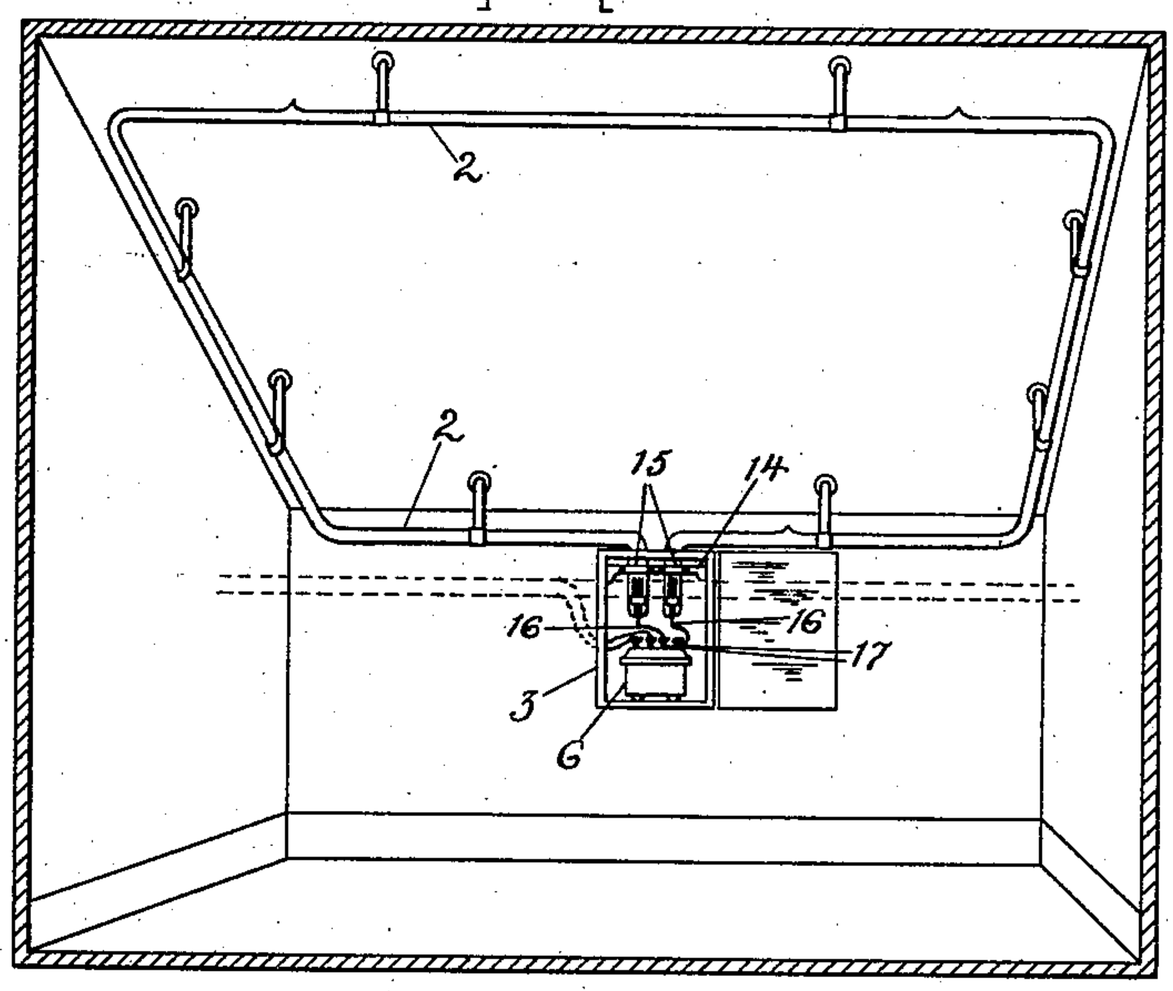



FIG. 2.

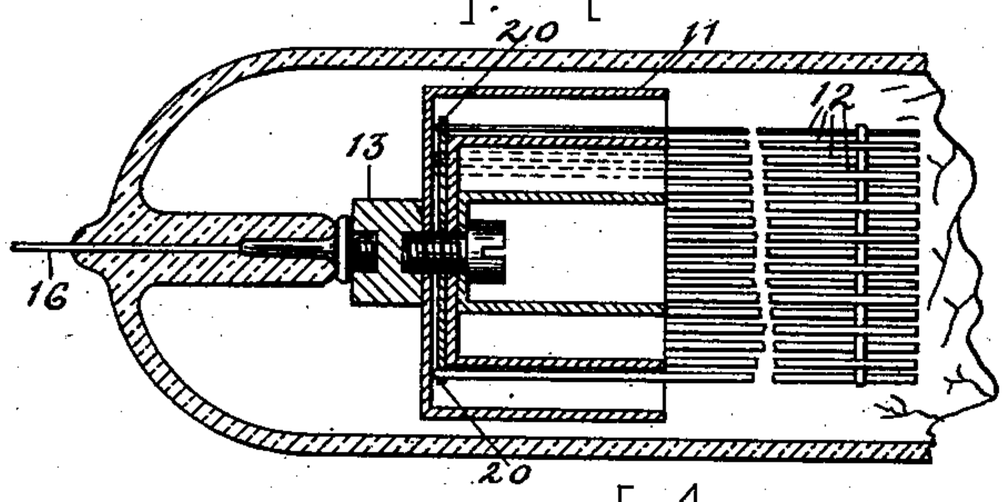



FIG. 3.

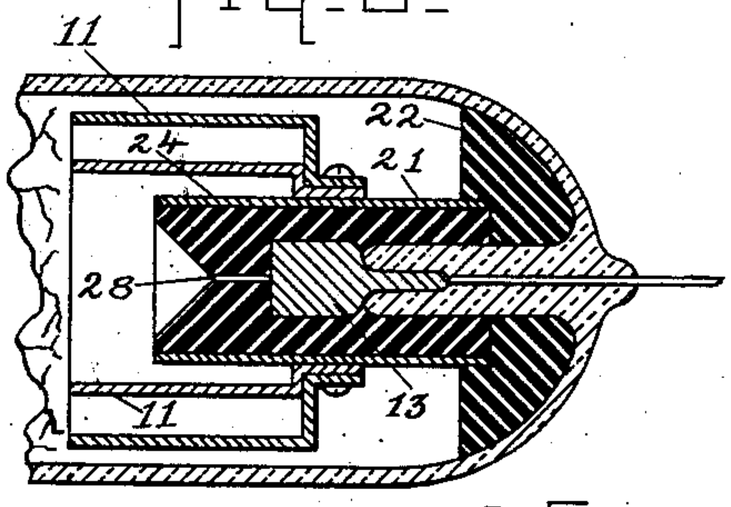



FIG. 4.

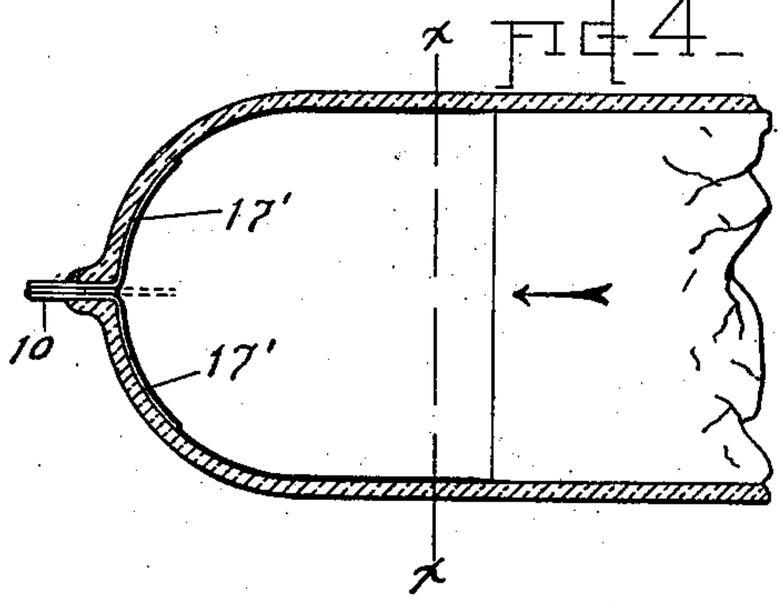



FIG. 5.

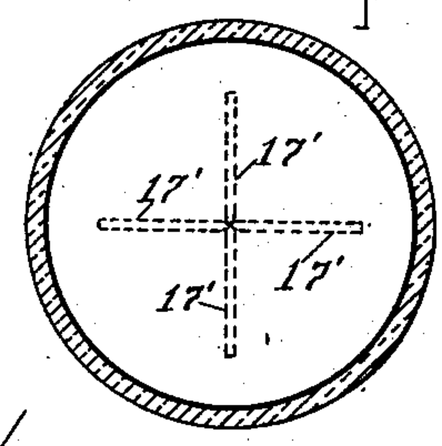
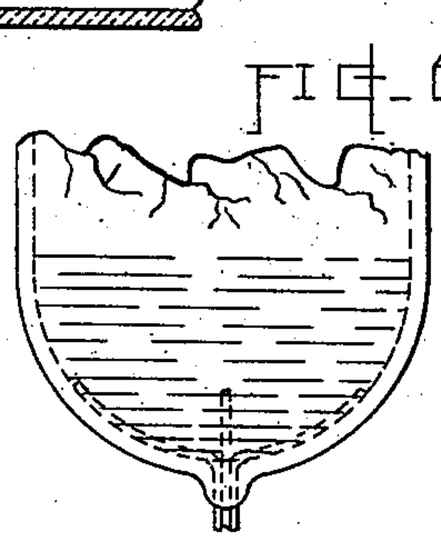



FIG. 6.



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ELECTRIC TUBE LIGHTING.

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NO MODEL. 2 SHEETS—SHEET 2.

FIG. 6.

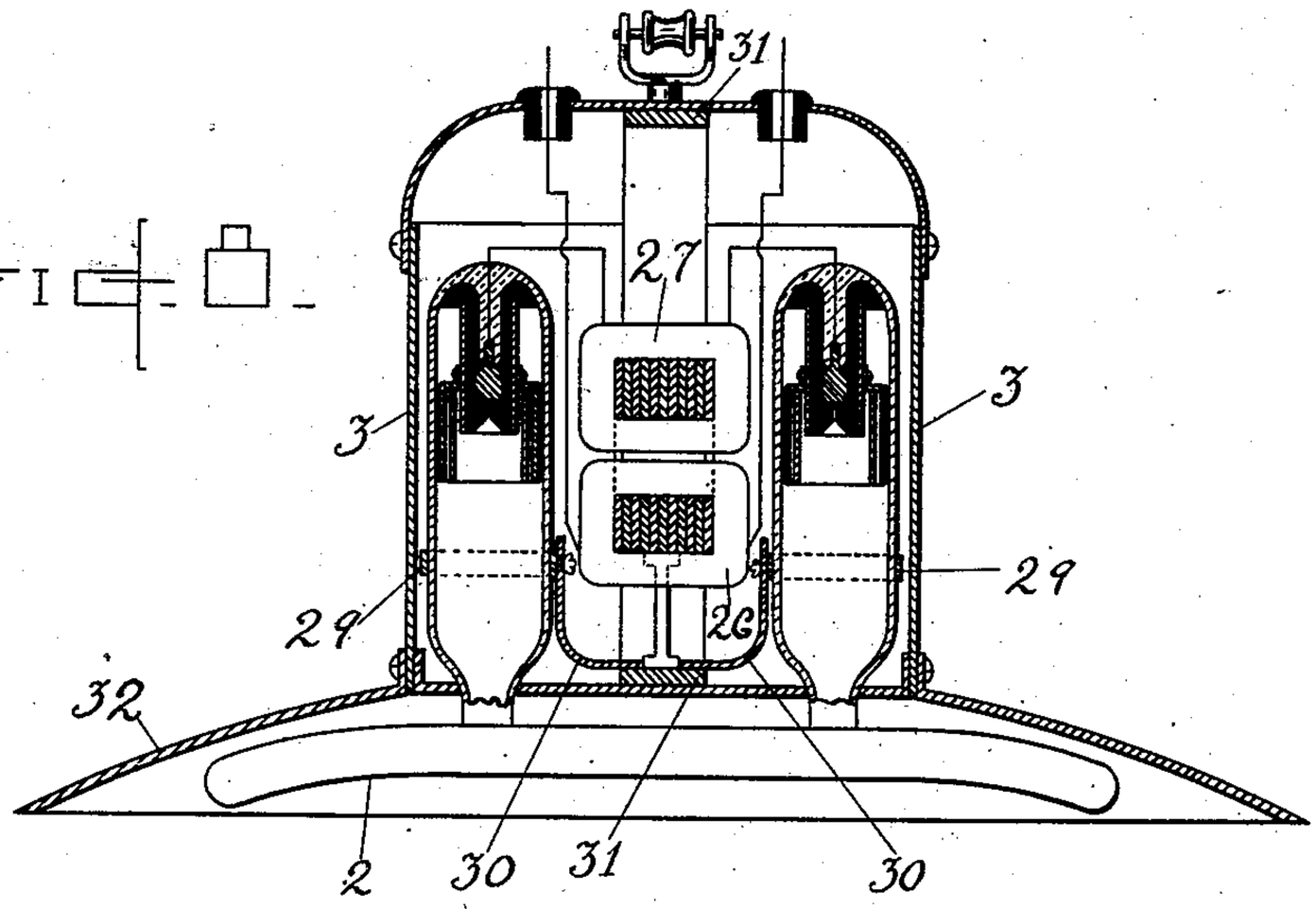
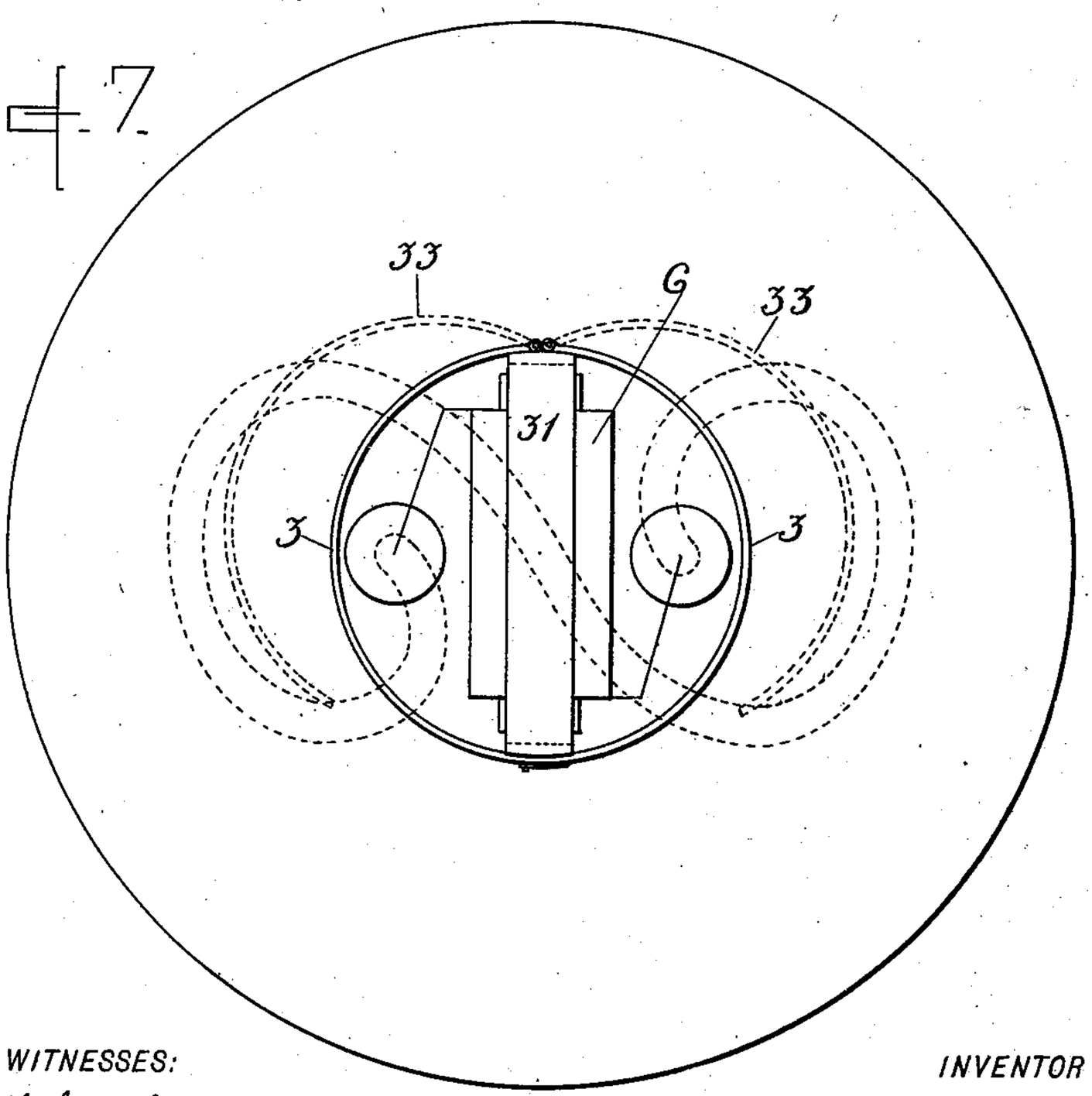



FIG. 7.

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# UNITED STATES PATENT OFFICE.

DANIEL McFARLAN MOORE, OF NEWARK, NEW JERSEY.

## ELECTRIC TUBE-LIGHTING.

SPECIFICATION forming part of Letters Patent No. 755,306, dated March 22, 1904.

Application filed January 19, 1903. Serial No. 139,559. (No model.)

*To all whom it may concern:*

Be it known that I, DANIEL MCFARLAN MOORE, a citizen of the United States, and a resident of Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Electric Tube-Lighting, of which the following is a specification.

My present invention relates to systems of lighting wherein the illuminating agent is a column or body of any suitable gas—as, for instance, air rarefied or having any desired degree of gaseous tension suitable for the gas employed and rendered luminous by means of electric energy applied to the terminals of said column and passed therethrough in any desired way.

The principal object of my invention is to permit the practical operation of lamps of the general character specified with greater economy and a higher density and steadiness of light in the luminous column than has heretofore been secured, to which end my invention consists in the combination, as hereinafter described, of a lamp composed of a sealed tube or receiver, of glass, having internal electrodes, a protective casing and transformer, whose secondary terminals are contained in said casing and are there in immediate union with the leading-in wires or conductors for the lamp.

The invention is designed also particularly as an improvement upon the system of lighting set forth in my prior patents, Nos. 702,314 and 702,315, and dated June 10, 1902, and wherein I have described the use of an elongated translucent tube or receptacle containing the gaseous body and provided with suitable conducting-caps, which are located in a suitable protective case or cabinet or otherwise protected from interference and are in direct connection with the source of energy, such as a transformer (in the case of the system set forth in Patent No. 702,315) dispensing with the use of high-potential distributing-wires to carry the high-potential currents which it is desirable to use for lights of this character and in contradistinction to distribution of the electric energy distributing the gaseous illuminating-column.

In the prior patents before referred to I have set out the use of conducting caps or terminals which are applied to the exterior surfaces of the tube containing the gaseous illuminating agent.

My present invention has for its object, among other things, to overcome certain objections which are incident to the use of the system when organized in the special manner illustrated and specifically described in said prior patents, and to increase the length of the illuminating-column, which it is practicable to employ according to the system of my Patent No. 702,315, and to diminish the length of the terminals used in accordance with my Patent No. 702,314, while at the same time securing increased economy and efficiency, as well as other advantages. In practice I find that with a system as described in said patents the provision of a conducting-cap of sufficient area makes it necessary to employ a very considerable length or amount of tubing, which is covered by the cap and is inclosed in the protecting cabinet or casing. Such cap is not only in a large measure objectionable because there is a great length of gaseous column which is not utilizable as a source of illumination, but, moreover, the size of the protective wall pocket or casing may in some cases be an undesirable feature of the system. Moreover, owing to the loss in the transfer of energy from the exterior cap through the walls of the inclosing tube a practical limit is soon reached to the length of illuminating-section of tube, which it is permissible to employ, because of the large size of inclosing casing or else because of the extremely high voltage which would be required.

My present invention is designed to overcome these objections, so as to make it permissible to use inclosing cabinets or pockets of very small dimensions, and, moreover, to operate the system with smaller potentials and to extend or increase the length of illuminating-column which may be operated from the source of electric energy of given potential.

My invention is also of great advantage in respect to the exhaustion of the tube prior to the introduction of the desired gaseous element, because I find in practice that it is not necessary to produce so complete an exhaus-

tion as is required when the electrodes for the tube consist of conducting-caps described in the prior patent before referred to, and also that the exhaustion may be more quickly effected, because the whole volume of the tube is less.

One part of my present invention consists, substantially, in the employment for the luminous tubes of my previously-patented system, of internal electrodes of such area and construction as to permit the use of electric currents of high potential and volume, as hereinafter described, said tube having its terminals in direct connection with a suitable source of energy and inclosed with the terminals of said source in a suitable protective cabinet or pocket, as set forth in said prior patent.

I am aware that it has been before proposed to use internal electrodes for a Geissler tube or similar tubes wherein the column of gas inclosed in glass is caused to glow by the action of the currents passed from one electrode to the other. Such prior lighting devices are entirely unsuited to the purposes of my present invention and differ radically from the light-giving source employed by me, because, in the first place, the construction of the electrodes and the manner of mounting the same in such prior devices was such as to prohibit the use of electric currents of large value, owing to the tendency of the current to seek the conductor carrying the electrode at the point of sealing in the glass envelop and to destroy the seal by melting down the glass at the point of sealing. The absence of protection at this point of itself renders such prior devices unsuited to my present invention, but, moreover, the area of the electrodes in such prior lamps was totally insufficient to carry the energy required to secure any considerable density of light without destroying the seal. When, therefore, in my present specification I speak of "internal" electrodes, it is to be assumed that I mean electrodes of such character as to permit the operation with a luminous density much greater than that possible with internal electrodes such as before employed with Geissler tubes.

In carrying out my present invention the tube may be provided with electrodes of various forms or character. Thus, for instance, the electrode may be one which although of restricted area has a leading-in wire and connections suitably protected against the attack of the electric discharge, or said electrode may be of large surface area and form an internal coating for glass surfaces within the lamp and be in proper electrical connection with or form, in effect, an extension of the leading-in wire. It is to be understood, however, that this particular form of electrode last specified is made the subject of claims in my application for patent filed of even date herewith and is one applicable not only to tubes of the character required in my system of illumination described in the patents before mentioned, but also to other kinds or forms of lamps wherein the illuminating agent is a body of gas excited to luminosity by the passage of electric currents.

In the accompanying drawings, Figure 1 illustrates in perspective my improved system of lighting as employed in illuminating a room or contained space of any desired size, the portions of the apparatus from which either fire or shock could possibly result by contact being shown as located in a cabinet or pocket, the walls of which appear in vertical section. Fig. 2 is an enlarged horizontal section through the end of a lamp containing one electrode of one of the forms that may be used. Fig. 3 is a similar horizontal section through a tube having a modified form of electrode. Fig. 4 is a section of still another form; and Fig. 5 is a section on the line $x\,x$, Fig. 4, looking in the direction of the arrow or into the open end made by such section. Fig. 6 illustrates another form of electrode. Fig. 7 shows in dotted lines the form which the tube may take when used in a light-giving unit adapted for attachment to a support, and also shows in plan the apparatus shown in Fig. 8. Fig. 8 shows said lamp in side elevation as supported in place in a suitable fixture and combined with a transformer in accordance with my invention, parts being shown in side elevation and parts in section.

Referring to Fig. 1, 2 indicates the translucent tube distributed as described in my prior patent, No. 702,315, and which may be of glass or other suitable translucent non-conducting material adapted to form an air-tight inclosure for its contents. The ends of said tube are brought to and within the pocket or casing 3, made as described in said patent or in any other suitable way and containing the terminals 17 of any suitable source of electric energy—as, for instance, the secondary coil of a static transformer 6, whose primary is supplied by current of any proper tension taken from any desired source.

16 indicates the exterior portion of the leading-in wires or conductors, which are sealed in the ends of said tubes in the well-known way and pass the energy to and from the internal electrodes of the gas-containing tube 2. These conducting leading-in wires, which for the best operation of my system should be of considerable electric potential, are located within the protecting wall or inclosure containing the terminals 17 of the same high potential and are joined to said terminals 17 in any desired manner. The inner ends of the tube may, if desired, be supported within the cabinet or pocket by clamps 15, securing them against a cross-bar 14, as described in my said prior patent.

In order that the internal electrodes may pass energy of the desired amount and potential properly to the gaseous contents of the

tube for carrying out my invention, they may be constructed as will be now described, although they might be otherwise formed. It is assumed in the present case that the electrodes at both ends of the lamp or tube are of the same kind, thus best adapting the lamp for use with alternating currents. It will be understood, however, that said electrodes might be of different kinds at said ends respectively, as would be preferably the case if a continuous current were used. In such case one electrode should be constructed especially with reference to the fact that it is at all times a positive electrode and the other with reference to the fact that it is at all times a negative electrode.

Referring to Fig. 2, the internal electrode is shown as of composite character, one portion 11 consisting of two or more concentric tubes or cups of suitable material set within one another and fastened together by a screw or other means to a suitable metal block 13 in which the leading-in wire sealed in the glass at the end of the lamp terminates. The other portion 12 of said electrode comprises a structure adapted to provide a large number of points for the reception of the electric discharge and securely attached in any desired way to the other portion of the electrode or to the block 13. This portion 12, as shown, consists of a number of wires looped through holes in a disk 20, inserted into the bottom of the outer cup and fastened between the cups. The cups or similar part afford a large superficial area for the passage of the current from the electrode to the gas when the tube is operated by alternating currents and said electrode is at any instant the positive electrode, while the wires afford a large number of discharge points or edges at the instant that said electrode is the negative electrode. By this means said electrode may maintain itself at a comparatively low temperature and will not readily disintegrate. This general form of the portion 11 of the electrode is the same as that described in my prior application, Serial No. 106,134, filed May 6, 1902, with the exception that I have combined therewith a structure designed to afford a larger number of discharge points or edges than are afforded by using simply a number of cups or cylinders as described in said prior application, thus permitting it to operate both as a positive and a negative electrode, which it must do when the gas is excited by alternating currents.

The material from which the electrode is constructed may be of any desired kind. Preferably I employ aluminium for the electrode; but I might use iron, which should be pure Norway iron treated previously to its insertion in the lamp by burning it at a white heat in a Bunsen flame, then boiling for several hours in hot water, previously to which it is scoured with a suitable alkali to clear it of oil, then baking in an asbestos oven to dry it, and finally dipping in alcohol and firing in a flame to burn off any remaining oil.

Fig. 3 illustrates another form of composite electrode adapted to perform the dual function of a positive and a negative electrode. In this form I show for the negative portion of said electrode a construction substantially the same as that described in my prior application, Serial No. 106,134, filed May 6, 1902. The portion 11, which gives the electrode illustrated in Fig. 3 the capacity for acting as a positive electrode, is substantially the same as that shown in Fig. 2 and comprises any number of cylindrical pieces of sheet metal fastened by screws or otherwise, as shown, to the other part of the composite electrode. Said other part comprises, as described in the prior application, Serial No. 106,134, a mass 21, preferably of lime or other oxid, such as oxid of magnesium or a mixture of any such oxid in immediate union or contact with a block of metal 13, which forms the terminus of the leading-in wire and is substantially fastened thereto. The mass of lime has a narrow or constricted opening, (indicated at 28), which receives the discharge, and the walls of which opening become highly heated.

22 is a jacket of soft lime which protects the stem for the leading-in wire from the electric discharge, and 24 is a tube or casing, preferably of metal, which reinforces block 21 and jacket 22, and also serving for attachment of the cups or tubes 11, constituting the positive portion of the electrode.

Other forms of electrode may be used. Thus, for instance, as shown in Figs. 4 and 5, the electrode may consist of a thin coating of graphite applied to the interior wall of the glass tube or envelop at the end of said tube and in electrical union with the inner end of the leading-in wire 10. Other conducting material might be used instead of graphite; but I prefer to employ graphite rather than metal, because it is freer from occluded gases and is less liable to interfere with the stability of the gaseous condition or with the chemical constitution of the gas employed.

Preferably the leading-in wire within the tube has a number of branches 17′, as shown, which may lie against the surfaces within the tube, and may, if desired, be the individual wires of a bundle of which the leading-in wire itself is made. The graphite coating may be applied by making a graphite paint from a suitable mixture of graphite with a liquid, such as alcohol or other liquid, which will permit said paint to dry quickly. A suitable length of tubing is closed at one end and sealed around the leading-in wire, which is spread out and lies against the inner walls of said tube, as shown. The said paint or adherent material is then poured into the tube and the tube moved about until the inner surfaces are fully covered with the adherent

graphite mixture, which, as will be obvious, will adhere to and be in union with both the glass and the wire ends of the leading-in wire. Any superfluous material may be wiped away from the surfaces of the section of tube being manipulated. After the coating has properly dried the end section of tubing, with its electrode thus made, may be united to other sections of tubing to make up the lamp. As will be seen, this form of electrode gives a large interior surface, and in practice I find that it may be used with heavy currents and with little tendency to rupture of the seal, since the discharge is spread out over a large or extended area of conducting material and does not tend to pass to the leading-in wire at any particular point.

While I have described the use of graphite, other materials might be employed and the electrode obviously need not be adherent to the interior surfaces of the tube, but may be otherwise formed or mounted without departing from my present invention.

Another form of electrode which might be employed is shown in Fig. 6 and consists of a conducting paste or liquid inclosed in the sealed end of the lamp and in immediate union with the leading-in wire, which should preferably be spread out, so as to afford a large surface of contact with said liquid or paste. As a liquid sulfuric acid might be employed.

While I have described the lamp as having electrodes of the same kind at its opposite ends and as therefore especially adapted for use with alternating currents, I do not wish to be understood as limiting myself thereto, since it would be possible to operate the same by continuous currents, in which case, however, the positive electrode would be preferably constructed differently from the other or negative electrode, since neither would in such case be required to operate both as a positive and a negative electrode.

Referring to Figs. 7 and 8, I show the tube as having its translucent or illuminating portion formed so as to give comparatively large length in one plane together with compactness.

The terminals of the lamp are located, as shown, in proximity to one another, and the tube starting from one of them curves outwardly and back through the space between said electrodes or the vertical lines in which they are located and then by a reverse curve extends around to the opposite electrode. The terminal portions of the tubes in which the electrodes are located project in a direction which may be described generally as transverse to the plane in which the major or illuminating portion of the tube is located and are contained and supported within a suitable protective inclosure 3, where they are protected against damage or accidental contact and have their leading-in wires or conductors in immediate union with the secondary terminals of a potential-raising static transformer 6, whose primary 26 is joined by suitably-insulated conductors with proper supply-wires, which may be of the ordinary voltage employed for electric distribution or such voltage as may be permitted by the underwriters' rules prevailing where the lamp is employed. The high-voltage terminals of the secondary 27 are protected by the inclosure 3, as are also the terminals or electrodes of the lamp which partake of the same high voltage.

The terminals of the tube may be supported or secured in collars or clamps 29, which project from brackets 30, carried by the frame or hanger 31, which supports or is supported from the casing.

The usual shade or reflector is shown at 32. The side or sides of the casing may be hinged to open out, as indicated in dotted lines at 33, Fig. 7, to permit access to the interior of the casing and for the purpose of fastening the lamp in place and making connection from its terminals to the terminals of the secondary 27.

While I have in the foregoing description spoken of gas and of air as the kind of gas suitable for use in carrying out my invention, it is to be understood that I use the term "gas" in its broadest sense and as including, therefore, any suitable vapor.

What I claim as my invention is—

1. In an electric-lighting system, the combination substantially as described of a lamp composed of a sealed tube or receiver of glass having internal electrodes, a protective casing and transformer whose secondary terminals are contained in said casing and are there in immmediate union with the leading-in wires or conductors for the lamp.

2. In an electric-lighting system, a danger-proof box containing a potential-raising transformer and the terminals of a tube containing a gas adapted to be rendered luminous by the current from said transformer and distributed as described over or through the spaces to be illuminated, and internal electrodes connected to said transformer.

Signed at New York, in the county of New York and State of New York, this 16th day of January, A. D. 1903.

DANIEL McFARLAN MOORE.

Witnesses:

J. GALLWITZ,

E. L. LAWLER.