D. McF. MOORE.

ELECTRIC TUBE LAMP AND SIMILAR DEVICE.

APPLICATION FILED MAY 6, 1902.

957,983. **Patented May 17, 1910.**

2 SHEETS—SHEET 1.

FIG. 1.

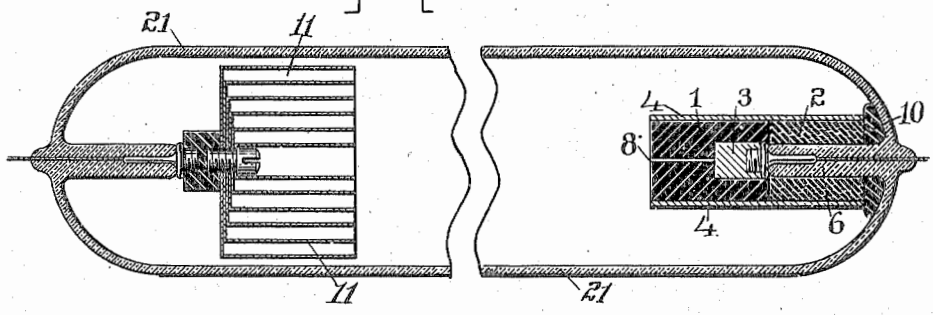


FIG. 2.

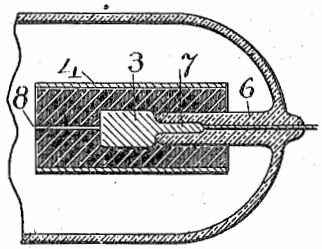


FIG. 3.

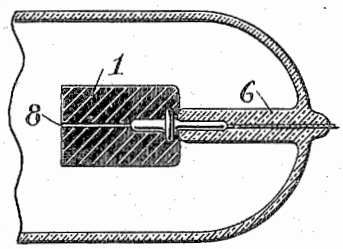
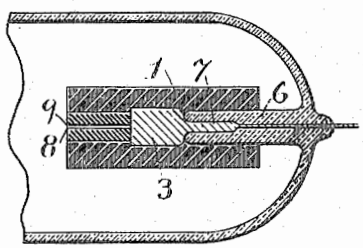


FIG. 4.



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2 SHEETS—SHEET 2.

FIG. 5.

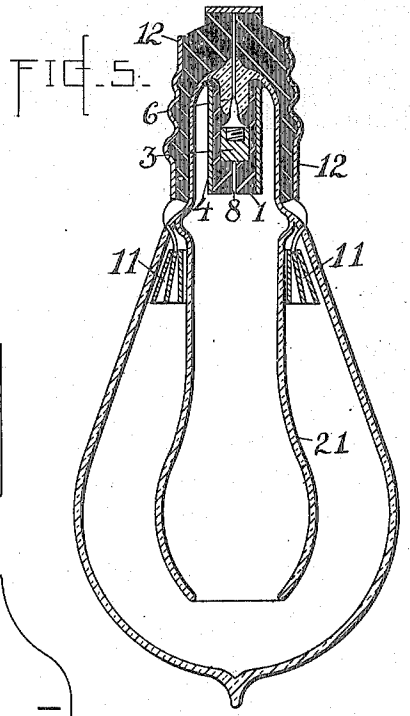
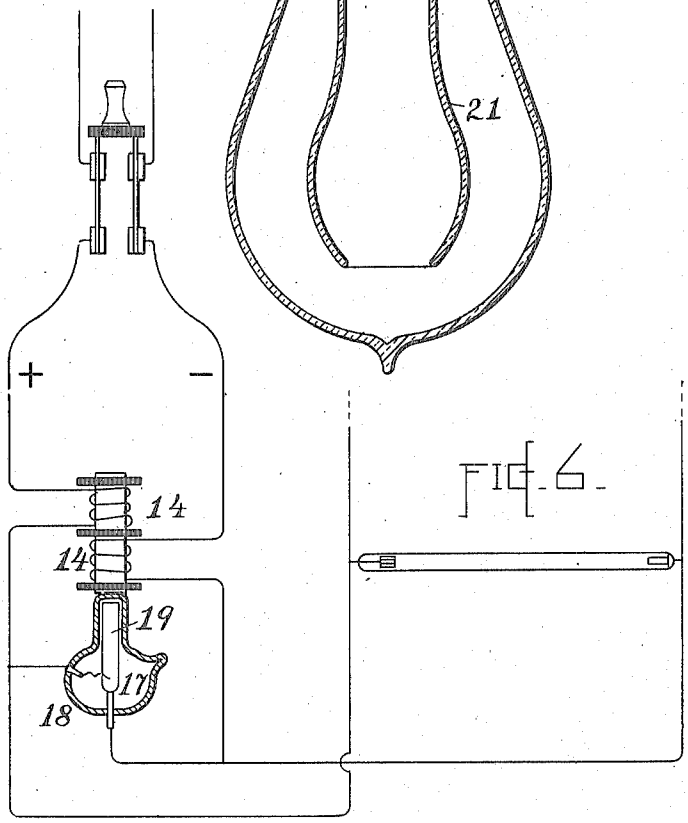


FIG. 6.



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UNITED STATES PATENT OFFICE.

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ELECTRIC TUBE-LAMP AND SIMILAR DEVICE.

957,983. Specification of Letters Patent. Patented May 17, 1910.

Application filed May 6, 1902. Serial No. 106,134.

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-Lamps and Similar Devices, of which the following is a specification.

My invention relates to apparatus in which an electric discharge is caused to pass from one to the other of two electrodes in a sealed receptacle or inclosure containing a rarefied gas or vapor.

The invention relates more particularly to apparatus of the character stated, provided with a rarefied gas or vapor of such character that it may be rendered luminous by the electric discharge and thus render the apparatus suitable for use as an electric lamp. This general type of lamp I herein term an electric gas lamp. In a general sense my lamp resembles the long known Geissler tube which produces a light of small life by the passage of the secondary currents produced from induction coils. This form of tube or lamp as heretofore constructed is of little utility, largely because of the great consumption of current per unit of light produced, and because, further, the oxidation or deterioration of the inclosed electrodes interferes with the stability of vapor tension contained within the gas tube. In proceeding along the lines first suggested by Geissler, other experimenters have employed lamps in which the gas or vapor is rendered luminous by the discharge of the continuous current passing from one to the other of two electrodes contained in the glass receptacle, but, so far as I am aware, all lamps of the general characters above mentioned have had but little life and small efficiency. It has been recognized by experimenters that when the negative electrode of this style of lamp is highly heated, the drop of potential between the gas and said electrode is largely reduced; but difficulty has been experienced in operating the lamp so as to maintain a high temperature of said electrode without disintegration, and to thereby eliminate to any great extent, the drop of potential at this point while at the same time securing a long life of the lamp.

One of the principal objects of my invention is to secure a high temperature in the negative electrode, thereby reducing to a great extent the drop of potential between the gas and said electrode so as to reduce the resistance of the lamp and secure increased economy for a given consumption of current.

A further object of my invention is to provide within the inclosure which contains the luminous vapor, electrodes of such character that they will not, through the action of the current, evolve gases or vapors that will disturb or vary the normal or proper vapor tension suitable for the operation of the lamp and the production of a maximum light.

To these ends my invention consists in the use for the negative electrode or cathode, of a material like lime, which may be rendered extremely hot without disintegrating or evolving a vapor or gas to any deleterious or harmful extent. While I specify lime, I do not, so far as the form of the electrode is concerned, limit myself to the use of such material, but may employ other refractory materials such as oxid of calcium or magnesium or an oxid of some of the rare earths.

My invention consists also of an improved form of cathode for an electric gas lamp. This part of my invention consists substantially in providing in said cathode, made of some refractory material, such, preferably, as that specified, a cavity of suitably contracted dimensions upon whose walls or surfaces the electric discharge is received and which thereby becomes highly heated.

My invention consists further in so constructing the negative electrode or cathode that the parts which receive the electric discharge immediately shall afford an inclosure for a body of gas or vapor which will be highly heated by contact with the walls of the inclosure, and will be thereby prevented from parting with its heat readily and hence will attain a high temperature and will therefore permit the discharge to pass more readily from it to the discharge-receiving surfaces.

My invention consists further in a cathode for an electric gas lamp consisting essentially of a metal terminal provided with a protective coating or envelop of lime, or equivalent material, in which said terminal is embedded, said coating or envelop being provided with one or more constricted passages or openings, in which the electric discharge is received and through which it passes to the said terminal, as hereinafter set forth.

Another part of my invention consists in the construction of the positive electrode, which I form in such manner that it shall have large surface or superficial areas together with a large number of points or great extent of edges for the passage of the current from the electrode to the gas, and which shall also, by reason of such construction, afford large heat radiating surfaces and thereby be less liable to acquire a high temperature and be thereby less liable to disintegration.

To carry out this part of my invention I propose to make the positive electrode in the general form of a brush, which may be done by constructing it either from a number of sheet-like pieces of metal that may take any form individually, each with relation to one another, as for instance, the form of concentric cylinders. As a material for the positive electrode, I prefer to employ metal, and as a metal I prefer to employ chemically pure iron, as this seems to be less harmful to the vacuum.

My invention consists also in the details of construction of the anode and cathode designed to facilitate the connection thereof with the leading-in wires.

In the accompanying drawings, Figure 1 is a longitudinal section through a lamp having electrodes of a form or construction embodying my invention; Fig. 2, is a longitudinal section through a modified form of negative terminal or electrode; Fig. 3 shows a modification in which the mass of refractory material is not extended back to cover the stem or column supporting the negative terminal; Fig. 4 shows another form or modification of the negative electrode; Fig. 5, shows my invention as embodied in a lamp in which the electrodes are located at one side or end of the inclosure or receptacle so as to produce a lamp having the general exterior appearance of the ordinary incandescent electric lamp; Fig. 6, is a diagram of the circuits showing the connections of the circuit interrupter and the lamp.

Referring to Fig. 1, the inclosure for the gas to be rendered luminous, is indicated by the numeral 21, and consists, preferably, of an all-glass inclosure with leading-in wires sealed in stems or pillars 6, projecting inwardly from the ends of said tube after the manner of the leading-in wires of an ordinary incandescent electric lamp. While this is the form or construction of inclosure and leading-in wires which I prefer to employ in order to furnish a sealed inclosure for the vapor and to pass the current to the electrodes within the same, I do not limit myself to such form of construction.

Referring first to the negative terminal or electrode, 3, indicates a piece of any suitable metal preferably chemically pure iron which is suitably attached to the leading-in wire by means of a screw connection, as clearly shown, although this method of connection may be varied at pleasure. In Fig. 2 the connection with the leading-in wires is made by means of a rearward extension of said piece of metal 3, which rearward extension, indicated at 7, extends down into the pillar or column, and is mechanically united with said wire. In immediate union or contact with the metal 3, is a mass 1 of lime, or other oxid, such as oxid of magnesium, or a mixture of any such oxids. Instead of the specified materials, I may employ oxids of any of the rare earths, such as oxid of thorium or cerium for this part of the electrode. The mass 1, may be made by compressing the powdered oxid into form and then boring the same out afterward to fit closely upon the piece 3 so as to be in close union therewith. Or, it might be formed by compressing it upon said electrode in the process of forming the piece 1.

The piece 1 is provided with one or more narrow passages indicated at 8, which constitute constricted passages or openings leading from the forward portion of the piece 1 toward the piece 3. This passage affords a path for the electric discharge and also serves to inclose a small body of gas which becomes highly heated by the discharge. The discharge in passing to the electrode heats the body of gas or vapor within said opening and also the walls of the passage, which are maintained at a high degree of temperature being inclosed in the body of lime so that they may not readily radiate heat.

The material 1, which surrounds the tubular or constricted passage, should be of material which is a poor conductor of heat and should be of sufficient thickness to effectually prevent radiation of heat from the heated surfaces within the passages. The piece 1, constitutes a protective coating or envelop for the metal terminal and protects the same against disintegration by the action of the discharge. The discharge is received upon the highly heated surfaces of the refractory envelop and passed to the metal terminal from such refractory mass. The metal terminal and the coating or body of lime or other material surrounding the same and

provided with one or more passages, openings or interstices through which the discharge may pass to the metal terminal forms a novel compound electrode for sealed inclosures or receptacles.

While I prefer to make the piece 1, all of the same material, it would be within my invention to make the center portion of the highly refractory material which I have mentioned, and the exterior portions of some good heat insulator and which, not being so highly heated, need not be of so high a refractory character. Thus, for instance, as indicated in Fig. 4, the center portion of the block 1 may consist of a tube or piece of highly refractory material 9, packed into an opening in the exterior heat-encircling insulating jacket 1, the piece 9 being bored or drilled to form a constricted passage and consisting, for instance, of any oxid or combination of oxids powdered and packed into a previously formed block 1 of any heat-insulating material sufficiently refractory.

In some cases it may be desirable to protect the stem or column 6, by a jacket 2, which will prevent the discharge from passing around behind the electrodes to the leading-in wire directly. Such a jacket is preferably made of some insulating and suitable refractory material, partially elastic, so as to closely hug the walls of the stem and avoid the existence of any air-space between the same and the stem through which the discharge might find its way.

As a packing I may employ asbestos fiber suitably disintegrated but not sufficiently to deprive it of its fibrous character, with which may be combined any insulating powder such as silex, lime, powdered fire brick, or any other similar material of a similar character. 10, indicates a fibrous asbestos washer adapted for surrounding the lower end of the stem or column 6. The packing 2 is constructed by the use of a mandrel of the same gage of the column 6, which is placed within the tube or jacket 4, in central position and the packing then consolidated around it by means of a suitable mandrel. The metal tube 4, which may be employed or not, as desired, not only reinforces the block 1 to prevent it from breaking, but also preserves the form of the jacket 2. The screw union between the leading-in wire and the block 3, serves as a means for forcing the completed electrode down upon the washer 10, thus making a good electrically tight joint which will prevent the discharge from passing around behind the electrode proper.

In Fig. 2, the metal 3, is united with the leading-in wire by means of a rearward extension 7, which passes into the stem or column and to which the leading-in wire is mechanically attached. In this form the washer 10 is dispensed with, and the jacket or sleeve 2 does not extend so far back upon the stem as in Fig. 1. In some cases this rearward extension of the parts so as to incase the stem may be dispensed with, as indicated in Fig. 3. Fig. 3, also shows that in some cases the exterior jacket 4 may be dispensed with.

11 indicates a positive electrode which, in the form shown, is composed of a series of concentric cups of iron, or other metal, set within one another and fastened at the bottom by a screw or other device, to a metal block in which the leading-in wire terminates. This form of positive electrode affords large superficial area for the passage of the current from the electrode into the gas and a large number of discharge points or edges, and further it maintains itself at a comparatively low temperature so that it will not disintegrate or become so highly heated as to interfere with the proper action of the lamp.

The diameter of the positive electrode should be of substantially the same diameter as that of the discharge column, and it should also preferably furnish a large number of points or edges from which the discharge may emanate. As will be seen, this form of electrode practically furnishes a large number of separate forward extensions which project from the button or base and give a large number or extent of points, areas or projections for the discharge. This construction of electrode I find to have a decided advantage in this respect, namely, that the discharge is maintained with greater stability and the lamp is less liable to go out.

In Fig. 5, the bulb or receptacle is shown as of the ordinary form employed in incandescent electric lamps. The negative electrode is of the form already described and is placed centrally of the bulb in the manner clearly shown in the drawing. Within the bulb is a directing tube or barrier 21, extending from the base toward the opposite end thereof and adapted to direct the discharge from the positive electrode 11, toward the opposite end of the lamp and back through the tube 21, to the negative electrode. The positive electrode 11 is placed concentrically with the tube 21, and may be formed, preferably, of one or more rings concentric with one another and secured to a common base to which are attached wires leading through the glass bulb and connected to a conducting ring, collar or shell 12, which may be of the construction ordinarily employed in incandescent lamps and form one of the terminals thereof, while the leading-in wire which connects with the negative electrode terminates in the corresponding opposite electrode or terminal of the lamp which is located centrally of the base.

The barrier, while shown as of tubular form, might be made in other shapes and constitute a wall or diaphragm extending directly across the lamp from one wall to the other thereof, but terminating short of the end of the bulb opposite that in which the electrodes are located. In this case a corresponding modification in the form and disposition of the electrodes with relation to one another would obviously be necessary.

To start the lamp, especially when using long tubes, I employ the induced current from a coil of wire wound upon a suitable core, the extra current being produced by the action of an automatic interrupter the actuating coils of which constitute the extra current coils of the device. In the diagram, Fig. 6, the actuating coils of the interrupter are indicated by the numeral 14. I prefer to employ two coils or spools 14, one included in one side and the other in the other side of the supply circuit to which the lamp is connected. The interrupter contacts are connected in multiple with the lamp so that at the moment of starting the lamp they will short-circuit the current of the supply wires from said lamp. The interrupter contacts indicated at 17 are inclosed in a suitable receptacle 18, as set forth in my Patent No. 702318, dated June 10th, 1902, although they might be otherwise constructed and located, and the interruption of the circuit is produced by the magnetic action of the core for coils 14, upon a suitable armature 19 located within said receptacle and actuating one of the interrupter contacts.

When the apparatus is at rest the circuit is from one of the supply wires through one of the coils 14, to and through the contacts of the interrupter and back through the other coil to the other pole of the circuit. If current is permitted to flow, the contacts will be separated, the coils will lose their power and the armature 19 being then no longer attracted, will drop, and the circuit through the contacts will be again established, and this operation will continue provided that there is no closed path for the current around the contact.

In the drawings the lamp is shown as in a shunt to the contacts, but said lamp when cooled or out of action, does not permit sufficient current to flow to keep the coils 14 charged to the degree necessary for keeping the armature 19 lifted at the time the contacts are separated.

In the normal operation of this apparatus, the current when turned on to the circuit of the lamp by means of the switch shown will flow through the coils 14, causing the contacts 17 to separate, which interruption of circuit produces a high potential discharge current from the coils 14, which passes into and through the lamp, and is immediately followed by the current of the low potential circuit through the coils 14, which will flow steadily through the lamp, and the coils 14 will permanently hold up the armature 19, thus causing the action of the interrupter to cease. Should the lamp go out, coils 14 will lose their power and the armature 19 will drop back and reëstablish the circuit at the interrupter contacts, which will be instantly disrupted and furnish the high potential current necessary to restart the lamp.

It is obvious that one of the coils 14 might be dispensed with, but I prefer to employ one in each side of the circuit. It is also obvious that if the first high potential current from the self-inductive coils 14 resulting from the interruption of the circuit of contact 17 does not start the lamp, the action will be repeated until finally the lamp is lighted, after which the interrupter will remain out of action with the circuit opened at the interrupter contacts until the switch is opened, when the lamp will go out and the parts will resume their normal position. Using tubes about 1 foot long, I have been able to start them directly on a circuit of 400 v. or more, that is, without any interrupter or potential raising device whatever.

As a luminous vapor or gas I may employ any gas or vapor known in the art, but I find in practice that excellent results may be obtained by simply using rarefied air. The degree of rarefaction adapted to produce the best results cannot be stated in exact terms. In practice good results may be obtained by exhausting to such a point that when the current is afterward turned on to the lamp the vapor will give a pink or reddish light for a short time, after which, by the ionizing action of the current the luminosity changes from a pink to a white color. While it is possible to carry the degree of exhaustion to such a point that when the current is turned on the lamp will begin to operate with a white light, this is not to be preferred, as I find, especially when air is employed, that the lamp does not have as long a life.

The cup or cavity in the negative electrode during operation becomes heated to an extremely high temperature, and the device furnishes a practical means for securing a temperature by which any material placed in said cup or cavity may be fused or vaporized, thus affording a novel electrical crucible.

In my improved lamp I do not depend upon the luminosity of any electrodes, but primarily upon the luminosity of any vapor or gas through which the discharge passes. The point or portion of the negative electrode which is luminous, is very small, but its degree of temperature is very high. The luminous portion is localized in the cup

cavity or passage, the surrounding parts of the electrode being non-luminous and serving mainly as a means for preventing the radiation of heat from the heated portion where the discharge is localized or concentrated.

My improved form of electrode is especially adapted for use in hermetically sealed gas lamps wherein the negative electrode or cathode is of such a material that when highly heated it will produce a gas or vapor of suitable character for being rendered luminous by the electric discharge passing from one to the other of the electrodes sealed within the glass or other inclosure, and this method of generating light from electric energy is one of the features of the invention for which I seek a patent.

The refractory oxid embodied in this electrode when heated to the high degree of temperature produced in the lamp constructed according to my invention, may become a source of gas or vapor for renewing the supply of gas or vapor which is the source of the illumination.

While I have described my invention as used in a device organized for giving light, and operated by a continuous current, it is to be understood that an alternating current might be passed through the device from one electrode to the other, in which case it would operate to eliminate or stop the alternations of one polarity and allow the others to pass, thus practically converting the alternating current into a continuous current. In this instance the device herein termed "cathode" would be the cathode only so far as concerns the alternations at one polarity. While, therefore, my invention is of great utility when operated to cause luminosity in the gas contained within the inclosure, it may also be used with devices in which the production of light is not required.

What I claim as my invention is:

1. The combination with a closed receptacle containing a rarefied gas or vapor, of a cathode composed of lime and having surfaces which receive the electric discharge and are highly heated thereby.

2. The combination with a closed receptacle containing a rarefied gas or vapor, of a cathode composed of a refractory oxid such as described and provided with one or more discharge-receiving cavities whose walls receive and become highly heated by the electric discharge.

3. The combination with a closed receptacle containing rarefied gas or vapor, of a negative electrode having one or more discharge-receiving cavities of contracted dimensions and whose surfaces receive and become highly heated by the electric discharge.

4. In an electric gas lamp, a negative electrode mounted upon a supporting stem or column combined with a jacket or covering of a semi-elastic non-conductive material surrounding said stem.

5. In an electric gas lamp, a negative electrode having a discharge receiving body or block composed of a highly refractory material provided with a metal jacket.

6. In an electric gas lamp, a positive electrode formed with a multiplicity of discharge points or edges.

7. In an electric gas lamp, a cathode whose discharge-receiving surfaces are composed of a highly refractory oxid constituting the walls of a constricted passage leading to a metal terminal, as and for the purpose described.

8. In an electric gas lamp, a cathode whose discharge-receiving surfaces are composed of a highly refractory oxid as described and constitute the walls of one or more constricted passages or cavities in the body of the cathode.

9. In an electric gas lamp, a compound negative electrode consisting of a metal terminal and a protective coating or envelop of a refractory oxid, in which the metal terminal is embedded and which is furnished with one or more constricted passages or cavities whose walls are highly heated by the electric discharge and inclose a body of highly heated vapor.

10. In an electric gas lamp, a terminal of metal to which is secured a block or mass of highly refractory material having one or more constricted passages whose walls are highly heated by the electric discharge.

11. In an electric gas lamp, the combination in a closed receptacle, of a positive electrode of metal and a negative electrode whose discharge-receiving surfaces consist of lime, as and for the purpose described.

12. In an electric gas lamp, the combination in a closed receptacle, of a positive electrode or anode of metal and a negative electrode or cathode comprising a block of lime whose surfaces are highly heated by and receive the electric discharge.

13. In an electric gas lamp, the combination in a closed receptacle, of a positive electrode of metal having a large surface area as described, and a negative electrode or cathode having a mass of highly refractory material provided with one or more contracted discharge-receiving cavities the walls of which become highly heated and aid in passing the discharge from the gas to the cathode.

14. In an electric gas lamp having a hermetically sealed inclosure, a cathode consisting of a block or piece of lime or other highly refractory oxid having a cavity the walls of which receive the electric discharge and become the inclosure for a body of highly heated gas or vapor.

15. In an electric gas lamp, a hermetically sealed inclosure having a compound negative electrode composed of metal and a piece of highly refractory material inclosing the metal and provided with one or more constricted passages whose walls receive the electric discharge and form a highly heated inclosure for a body of highly heated vapor.

16. The combination in an electric gas lamp and the positive and negative electrodes therefor and located at one side or end of the lamp, of a barrier projecting from between said electrodes into the gas-containing space and serving to cause the discharge to follow an extended path through the gas-containing space.

17. In a luminous vapor electric lamp, a receptacle having electrodes located at or near one end thereof, and a tubular barrier extending within said receptacle toward the opposite end thereof and joined to the base portion of the lamp between said electrodes.

18. The combination in an electric gas lamp, of a cathode of lime having a constricted passage in which the electric discharge is received, as and for the purpose described.

19. An electrode for sealed inclosures containing a gas or vapor, consisting substantially of a metal terminal inclosed in a body of refractory material having one or more passages, openings or interstices for the passage of the electric discharge to said terminal.

20. The combination with a sealed inclosure containing a vapor or rarefied gas, of a metal terminal surrounded by lime.

Signed at New York in the county of New York and State of New York this 2nd day of May A. D. 1902.

DANIEL McFARLAN MOORE.

Witnesses:

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E. L. LAWLER.