July 10, 1934. T. E. FOULKE 1,965,583

ELECTRIC DISCHARGE DEVICE

Filed July 27, 1929

Fig. 1

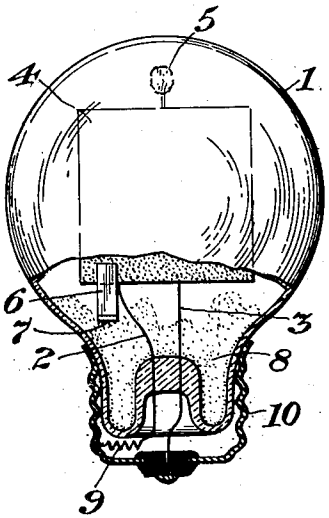


Fig. 2

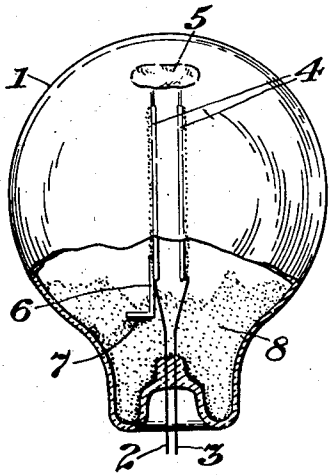
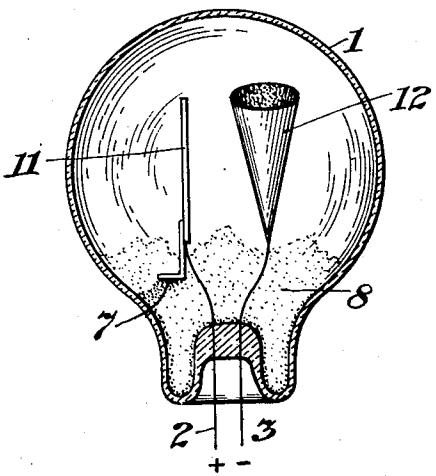


Fig. 3



INVENTOR
Ted E. Foulke
BY
Thos. H. Brown
HIS ATTORNEY

Patented July 10, 1934 1,965,583

UNITED STATES PATENT OFFICE

1,965,583

ELECTRIC DISCHARGE DEVICE

Ted E. Foulke, Nutley, N. J., assignor to General Electric Vapor Lamp Company, Hoboken, N. J., a corporation of New Jersey

Application July 27, 1929, Serial No. 381,425

7 Claims. (Cl. 250—27.5)

The present invention relates to electric discharge devices, and to electrodes therefor. The particular object of the invention is to provide a gaseous discharge device which will have a long life, will start with a cold cathode upon the application of a relatively small potential, will operate at a correspondingly low voltage, and will maintain these characteristics throughout its life. A further object of the invention is to provide a method of producing such a device. Another object of the invention is to provide a concentrated spot of light of relatively high intensity in a device of this character. Still further objects and advantages of the invention will appear from the following particular description of devices embodying my invention and the method of making said devices, or from an inspection of the accompanying drawing.

The invention consists of certain new and novel features of construction and combinations of parts and also in the new and novel steps in the process of manufacture thereof, as hereinafter set forth and claimed.

Considerable difficulty has been encountered in the production of a gaseous discharge device which would function on normal commercial potentials. It has been particularly desired to produce a device of this character which would start and operate on 110 volts D. C. Various expedients have been tried in order to accomplish this, but these have resulted in short life of the device. By the present invention it has been found possible to produce a device which will start upon the application of a potential as low as 50 volts, D. C. and at the same time have a useful life of several hundred to several thousand hours depending upon the current density employed. This has been accomplished by a modification of the activation heretofore used in devices of this type, as fully set forth in the following description.

In the accompanying drawing, which is illustrative of my invention,

Fig. 1 is a front view partly in section of a negative glow discharge device embodying my invention,

Fig. 2 is a side view partly in section of the same device and

Fig. 3 is a view partly in section of another embodiment of my invention, in a negative glow discharge device designed to give a concentrated point of light.

With particular reference to the structure of the embodiment of my invention shown in Figs. 1 and 2, the envelope 1 of glass of conventional shape has sealed therein the leads 2 and 3 which support two similar electrodes 4. Said electrodes 4 are spaced apart at their tops by a vitreous bead 5 into which are fused projections from the tops of said electrodes. These electrodes are preferably of nickel and are coated, on the exterior faces only, with an activating material in a manner which will be fully described later. Near the lower edge of one of said electrodes 4 there is welded a nickel strip 6 which extends downwardly, with a horizontal portion at the end thereof. On the lower side of the horizontal portion there is welded a small piece of magnesium 7, most of which is later driven off, as will be hereinafter described to form a mirror-like film on the lower portion of the envelope, as indicated at 8. The lead 2 may connect through the ballast resistance 9 to one terminal of a conventional screw base 10, while the lead 3 may connect to the other terminal of said base, as shown in Fig. 1.

With reference to the modification shown in Fig. 3 a similar envelope 1 has sealed therein leads 2 and 3. In this case the lead 2 supports an electrode 11, which is preferably a narrow strip of nickel, uncoated, while the lead 3 supports an inverted open cone 12 preferably of nickel, and having an activating coating on the inside thereof similar to that used on the electrodes 4 in Figs. 1 and 2. Since the glow is substantially limited to the coated area this results in a high intensity light source of small area, as viewed from above. The electrode 11 carries a nickel strip 6, as in Figs. 1 and 2, with magnesium 7 thereon, and there is also the same coating 8 of magnesium on the lower part of the envelope.

Either of these devices may contain an atmosphere of argon, helium, neon, or mercury vapor, or mixtures thereof. A combination of neon with about .25% of argon, for example, has proved very satisfactory.

The method of preparing and activating the electrodes in these devices is important if a low breakdown and maintaining potential is to be obtained. The preferred method is as follows.

The electrodes are first carefully cleaned and then raised to a high temperature either in a vacuum, or in an atmosphere of hydrogen. In the latter case the electrodes become saturated with hydrogen to the exclusion of all other gases which may have been contained therein, and somewhat better results have been obtained with such electrodes than with electrodes which have been vacuum fired. The portions of the electrodes which are to support the discharge are then coated with an alkali or alkaline earth com-

pound. This compound can be the oxide, but since it is difficult to maintain the purity of the oxide in air it is preferably one which will decompose to the oxide under the influence of heat, such as the carbonate or nitrate. Barium or strontium carbonate have proved very satisfactory for this purpose. This activating compound is most conveniently applied by mixing it with a vehicle, preferably one which will decompose when heated in a vacuum leaving a carbonaceous residue, collodion or a solution of celluloid in amyl acetate being examples of suitable vehicles, and sprayed or painted upon the electrode surface. Dipping is, of course, precluded when light is desired from only one side of the electrode since the material is selectively applied to only one side of the electrode. The magnesium 7 or other similar metal having a high affinity for oxygen is welded or otherwise applied to the lower side of the tab 6, after which the electrodes are sealed into the envelope 1, as shown in any of the figures. The device is then connected to a vacuum pump in a well known manner, and the envelope evacuated. During this process the envelope is subjected to a high temperature, as by placing in an oven, to drive all occluded gases and moisture from the walls of the envelope. After the vacuum is substantially complete the electrodes are raised to a bright red heat to decompose the activating compound, leaving the oxide, and to drive off any occluded gas. This is most conveniently done by placing the device in a high frequency inductive field. After the gases evolved have been removed and the vacuum is again restored the tab 6 is heated, preferably by the application of the high frequency inductive field, to volatilize the magnesium thereon. This magnesium then condenses in a thin mirror-like film 8 on the walls of the envelope. This reduces the transparency of the envelope, but it has been found that by locating the source below the electrodes, as on the tab 6, and on the lower side of such a tab, the coating can be substantially confined to a portion of the envelope where such opacity is unimportant, as indicated at 8 in the drawing. The device is then filled with the desired gaseous atmosphere and sealed off, after which a high frequency, high potential electromotive force is applied to the electrodes resulting in a discharge between said electrodes. The surface of the alkali or alkaline earth oxide coating on the electrodes is reduced under the action of this discharge, many of the free oxygen atoms combining with the magnesium film, or with the carbonaceous residue, so that after a short time the surface of the electrode or electrodes is entirely covered with a thin coating of pure alkali or alkaline earth metal, under which is a layer of the oxide of the same metal.

It is well known that these metals, which because of their low work function produce a low breakdown potential between electrodes so coated, heretofore have more or less rapidly sputtered off from the electrodes during discharge. By the present process a continuous supply of such metal is supplied throughout a long period of operation of the device in that the same discharge which tends to sputter away the metal is in my new lamp availed of to reduce more of the oxide to the metallic form to take the place of the sputtered metal, the liberated oxygen either uniting with the magnesium or reuniting with some of the previously thrown off alkali or alkaline earth metal on the walls of the envelope. As a result the operating characteristics remain reasonably constant throughout the life of the tube, which is many times the life of any tubes heretofore made with as low a breakdown potential as is obtained with devices made in this manner.

Considerable advantage is derived from the fact that the maintaining voltage in these devices is so much lower than would be required between uncoated nickel electrodes, for the electrodes may be spaced as shown in Figs. 1 and 2 without any intervening insulation, the discharge being entirely confined to the activated surface. In Fig. 3 this effect is further utilized to obtain a high intensity source of light, all of the discharge taking place within the cone, which appears very bright when viewed end on. Such a device is particularly useful in the television field, although its usefulness is not confined to that branch of the art.

For direct current devices only the negative electrode needs to be activated, but by activating both of the electrodes, as in Figs. 1 and 2, several advantages are obtained in that the lamp may then be used on alternating current if desired; the direct current polarity is unimportant; and the life of the lamp on direct current may be greatly extended by reversing the polarity of the applied potential after the activation on one electrode becomes exhausted.

The term "alkaline" as used in the claims is intended to refer to metals of both the alkali and the alkaline earth groups.

Although I have shown and described and have pointed out in the annexed claims certain novel features of the invention it will be understood that various omissions, substitutions and changes in the several steps of the process, and in the form and details of the product illustrated and described may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is,

1. A gaseous discharge device comprising an envelope, a gaseous atmosphere within said envelope, electrodes sealed into said envelope, one of said electrodes being coated with an oxide of a metal having a low work function, an activated coating of said metal on the surface of said oxide coating and an extended area of a reducing agent within said envelope.

2. A gaseous discharge lamp comprising an envelope, a gaseous atmosphere within said envelope, electrodes sealed into said envelope, one of said electrodes being conical in shape, the interior of said conical electrode being visible, and means to confine the discharge to the interior surface of said conical electrode comprising a coating of a low work function material on said surface.

3. The method of preparing an electrode for a gaseous discharge device comprising producing an oxide coating on said electrode and reducing the surface only of said coating to the metallic form.

4. The method of preparing electrodes for a gaseous discharge device which consists in producing an alkaline compound coating on one of said electrodes, supplying a gaseous atmosphere about said electrodes, and producing a discharge between said electrodes in the presence of a reducing agent until the surface of said compound coating has been reduced to the metallic form.

5. The method of producing a gaseous discharge device, which comprises coating the electrodes with an alkaline compound which is reducible to the oxide, sealing said electrodes into

an envelope, evacuating said envelope, heating said electrodes to a temperature sufficient to reduce said compound to the oxide, producing an extended film of a reducing agent within said envelope, introducing a desired gaseous atmosphere into said envelope, sealing said envelope, and bombarding said electrodes with an electrical discharge to reduce the surface only of said oxide coating.

6. The method of producing a gaseous discharge device which comprises coating the electrodes with barium carbonate, sealing said electrodes into an envelope, evacuating said envelope, heating said electrodes to a temperature sufficient to reduce said carbonate to the oxide, producing an extended film of a reducing agent within said envelope, introducing a desired gaseous atmosphere, sealing said envelope, and bombarding said electrodes with an electrical discharge to reduce the surface only of said oxide coating.

7. The method of producing a gaseous discharge device which comprises coating the electrodes with barium carbonate and a carbonaceous binder, sealing said electrodes into an envelope, evacuating said envelope, heating said electrodes to a temperature sufficient to reduce said carbonate to the oxide and said binder to carbon, producing an extended film of magnesium within said envelope, introducing a desired gaseous atmosphere, sealing said envelope, and producing a high frequency electrical discharge between said electrodes to reduce the surface of said oxide coating.

TED E. FOULKE.