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GASEOUS ELECTRIC DISCHARGE DEVICE AND METHOD OF MAKING THE SAME

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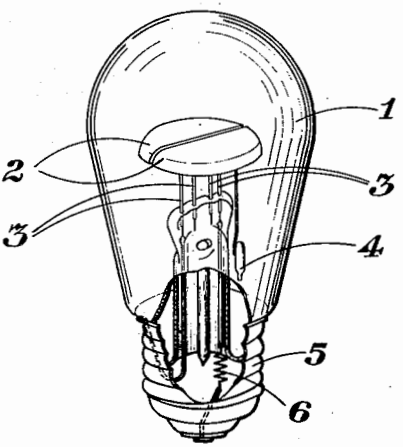

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GASEOUS ELECTRIC DISCHARGE DEVICE AND METHOD OF MAKING THE SAME

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12 Claims. (Cl. 176—122)

The present invention relates to electric gaseous discharge devices of the cathode glow type, and to the method of producing the same.

A particular object of the invention is to provide a cathode glow lamp having a blue color characteristic which will operate on potentials of less than 110 volts D. C. throughout a useful life of several thousand hours. A further object of the invention is to provide a gaseous discharge device which will be an efficient generator of ultraviolet radiations. Another object of the invention is to provide a novel method of producing a discharge device having the foregoing characteristics. Still other objects and advantages of the invention will appear from the following detailed description thereof, or from an inspection of the accompanying drawing.

The invention consists in a new and novel electric gaseous discharge device, and in the novel method of producing the same, as hereinafter set forth and claimed.

In the manufacture of cathode glow lamps I have found it extremely desirable to coat the electrodes thereof with an alkaline earth metal, such as barium, in order to insure operation of the lamp on potentials of less than 110 volts D. C., such as may be encountered on ordinary commercial circuits, throughout a useful life of several thousand hours. Where argon has been used as the discharge supporting gas, however, in order to produce a lamp emitting blue light, I have found that this alkaline earth coating was so rapidly destroyed that such a lamp had a useful life of but a few hours. I have now discovered that if the alkaline earth coating is produced on said electrodes under conditions such that the particles thereof can become intermixed with molecules of a gas, such as nitrogen, this coating can be maintained intact in an argon lamp throughout a long useful life of at least several thousand hours, provided that there is an additional quantity of the same gas admixed with the argon in the gas phase. As a result of this discovery I am now able to produce for the first time a commercially practical long life argon lamp of the cathode glow type. The addition of the nitrogen to the argon has also been found to result in an improved blue color radiation from the lamp, and the ultraviolet radiation therefrom is also vastly increased.

For the purpose of illustration I have shown in the accompanying drawing a perspective view of a lamp embodying my invention. This lamp has a vitreous envelope 1 which is preferably made of lime glass, although corex, pyrex, uviol, fused silica or the like may be used if the shorter ultraviolet lines are desired. Two semi-circular electrodes 2 are supported by the inleads 3, the latter being sealed into said envelope through a conventional pinch seal. These electrodes are preferably of nickel and are coated with an alkaline earth metal, preferably barium, the particles of which are bonded to each other and to the electrodes with nitrogen in a manner which will be more fully described hereinafter. The back of these electrodes is preferably coated with aluminum powder, as disclosed in my co-pending application, Serial No. 506,849, filed January 6, 1931, in order to confine the glow to the desired front surface. The inlead 3 to one of said electrodes 2 is connected to the shell of the base 5, while the inlead to the other of said electrodes is connected through a resistance 6 (schematically shown) which is conveniently housed within said base 5 to the tip of said base. Said resistance has a value of about 3200 ohms in a 2 watt lamp. Within said envelope 1 there is sealed an atmosphere of argon containing 5–20% of nitrogen at a pressure of from 6 to 20 m. m. of mercury. A preferred mixture, giving exceptionally good results, has been found to be argon containing 10% of nitrogen at a pressure of 10–12 m. m. of mercury.

In the manufacture of these devices according to the novel method of my invention the glow supporting surfaces of the electrodes 2 are coated with an easily reducible compound, such as the carbonate, nitrate, nitride, azide or the like, of an alkaline earth metal, such as barium or strontium. In practice, however, I prefer to use a mixture of equal parts of barium carbonate and strontium carbonate, since I find that such a coating, if treated as hereinafter described, results in a very uniform surface of extremely low work function. This mixture of carbonates is preferably mixed with a 5% solution of nitrocellulose in cellulose acetate and sprayed onto the electrodes 2 as a thin film. After being thus coated the electrodes 2 are sealed into the envelope 1, which is then exhausted in the usual manner. While said envelope is still connected to the exhaust pump the electrodes are heated up, as by means of a high frequency field, to reduce the carbonate to the oxide and to decompose the nitrocellulose binder to carbon, the evolved gas being completely exhausted. The getter pellet 4, which contains a metal, such as magnesium, having a high affinity for oxygen, is then heated in any convenient manner to vaporize said metal. Said pellet is designed to direct this

vapor toward the stem portion of the envelope, where it condenses as a film, it being essential that none of this vapor should deposit on the electrode 2. It is, of course, also desirable that the vapor should not condense on those portions of the envelope 1 from which light is to be radiated. The desired gaseous atmosphere, such as the argon-nitrogen mixture set forth hereinbefore, is then admitted to said envelope, after which said envelope is sealed off. The lamp is then connected to a source of energy, such as a spark gap oscillator generating steep wave front, highly damped oscillations, or an equivalent source of steep wave front surges, the resulting discharge within said device producing a series of periodic high speed ionic and electronic bombardments of short duration of the alkaline earth oxide coating on the electrodes. This bombardment does not appreciably heat the electrodes, but it does break up the oxide into free oxygen and the alkaline earth metals. A little of the evolved oxygen is adsorbed by the electrodes, while the remainder thereof is cleaned up by the magnesium film. When the alkaline metals are thus produced by a steep wave front discharge in the presence of nitrogen they form a unique surface in which the particles of barium and strontium are bonded to each other and to the electrode by nitrogen particles with which they are intermixed. This intermixture, which is to be distinguished from a chemical combination of these elements, forms a film having a dark gun-metal appearance which has been found to have an extremely low work function, of the order of 1.3 volts, which remains substantially constant throughout a useful life of several thousand hours. As a result of this low work function these devices have a breakdown potential of the order of 45 volts A. C. and only slightly higher on direct current, so that they may be operated with certainty throughout their long life on circuits having a nominal potential of 110 volts D. C. The presence on the electrodes of the carbon residue from the nitro-cellulose has been found to result in a more even production of this film than would otherwise result, so that the use of nitrocellulose or its equivalent forms a part of my preferred method. The light radiated from this lamp has a very desirable blue color, containing lines of both the argon and the nitrogen, and the luminous efficiency thereof is of the order of three times that of a similar lamp containing pure argon. Furthermore the radiation includes numerous lines of appreciable energy in the near-ultraviolet region of the spectrum.

While I have described my process in connection with the preferred use of carbonates of alkaline earth metals, the use of various other compounds, such as nitrates, nitrides, azides and the like of either the alkali metals, or the alkaline earth metals, will be readily understood. Furthermore in some cases the alkali or alkaline earth metal can be distilled onto the electrodes. In each of these cases the process includes as a novel and essential step a final bombardment of the coating in the presence of nitrogen with a steep wave front discharge, since it has been found that such a bombardment of the electrodes in the presence of nitrogen results in a reduction in the work function of the surface to at least 0.3 volt below that of a surface bombarded by a discharge from any of the usual sources of energy. My new surface also has a much longer useful life than a surface produced by any of the methods heretofore used.

Other sizes and shapes of electrodes may obviously be used and various other changes, substitutions, and omissions, within the scope of the appended claims, may also be made in the structure of the discharge device, or in the steps of the process, without departing from the spirit of my invention.

What I claim as my invention:

1. The method of treating a surface coated with an alkaline metal to reduce the work function thereof which consists in bombarding said coating with a steep wave front discharge in the presence of nitrogen.

2. The method of producing an electric gaseous discharge device which comprises producing a coating of an alkaline earth compound on the electrodes of said device and then bombarding said electrodes in the presence of nitrogen with a discharge of steep wave front.

3. The method of producing an electric gaseous discharge device which consists in coating the electrodes of said device with an oxygen-containing compound of an alkaline earth metal, reducing said compound to the oxide by the application of heat, reducing said oxide to the metallic form by a bombardment of steep wave front in the presence of nitrogen, and cleaning up any oxygen which is evolved into the gas phase.

4. The method of producing an electric gaseous discharge device which consists in coating the electrodes of said device with barium carbonate, heating said electrodes in a vacuum to reduce said carbonate to the oxide, bombarding said electrodes in the presence of nitrogen with a discharge of steep wave front to reduce said oxide to the metal, and cleaning up any free oxygen which is evolved.

5. The method of producing an electric gaseous discharge device which consists in coating the electrodes of said device with barium carbonate, heating said electrodes in a vacuum to reduce said carbonate to the oxide, providing a gaseous atmosphere comprising substantially 90% argon and 10% nitrogen at a pressure of 10–12 m. m. of mercury, sealing the envelope of said device, bombarding said electrodes with a discharge of steep wave front to reduce said oxide to the metal, and cleaning up any oxygen evolved into the gas phase.

6. The method of producing an electric gaseous discharge device which consists in coating the electrodes of said device with barium carbonate, strontium carbonate and a carbonaceous binder, heating said electrodes in a vacuum to a temperature sufficient to decompose said carbonate to the oxide and said binder to carbon, evacuating the evolved gas, producing a film of magnesium within said device, admitting argon containing 10% nitrogen at a pressure of 10–12 m. m. of mercury to said device, sealing said device, and thereafter bombarding said electrodes with a high frequency discharge of steep wave front to reduce said oxide to the metal.

7. An electric gaseous discharge device comprising a sealed envelope, electrodes sealed into said envelope, a coating of barium on said electrodes, said coating having a work function of less than 1.6 volts, and argon containing 5–20% of nitrogen at a pressure of 10–12 m. m. of mercury within said envelope.

8. An electric gaseous discharge device comprising a sealed envelope, electrodes sealed into said envelope, a coating of barium on said electrodes, said coating having a work function of approximately 1.3 volts, and argon containing

5–20% of nitrogen at a pressure of 10–12 m. m. of mercury within said envelope.

9. An electric gaseous discharge device comprising a sealed envelope, electrodes sealed into said envelope, a coating of barium and strontium on said electrodes, said coating having a work function of approximately 1.3 volts, and argon containing 5–20% of nitrogen at a pressure of 10–12 m. m. of mercury within said envelope.

10. An electric gaseous discharge device comprising a sealed envelope, electrodes sealed into said envelope, each of said electrodes having an activating coating thereon which consists of an alkaline metal intimately intermixed with nitrogen, and argon containing 5–20% of nitrogen at a pressure of 6–20 m. m. of mercury within said envelope.

11. An electric gaseous discharge device comprising a sealed envelope, electrodes sealed into said envelope, each of said electrodes having an activating coating thereon which consists of barium intimately intermixed with nitrogen, and argon containing 10% of nitrogen at a pressure of 10–12 m. m. of mercury within said envelope.

12. An electric gaseous discharge device comprising a sealed envelope, electrodes sealed into said envelope, each of said electrodes having an activating coating thereon which consists of barium intimately intermixed with nitrogen, an extended film of magnesium within said envelope, and argon containing 10% of nitrogen at a pressure of 10–12 m. m. of mercury within said envelope.

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