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ELECTRIC DISCHARGE DEVICE HAVING PRIMARY  
AND SECONDARY ELECTRODES  
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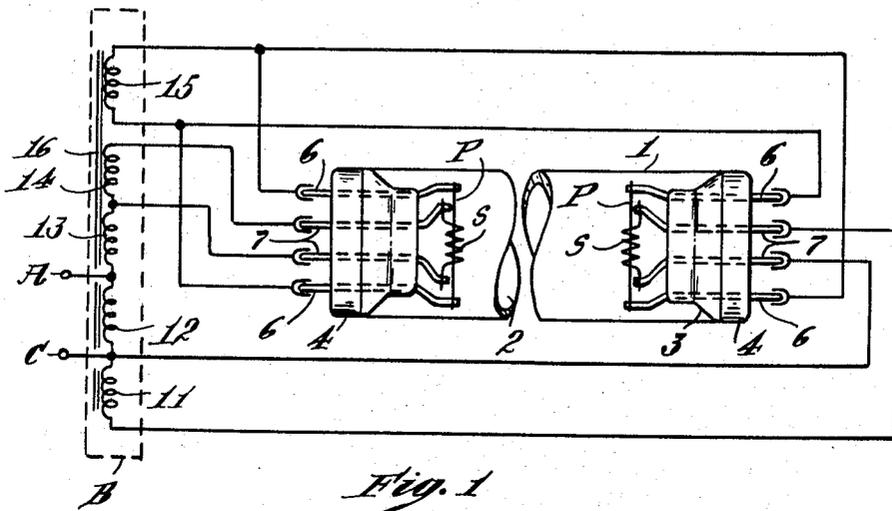


Fig. 1

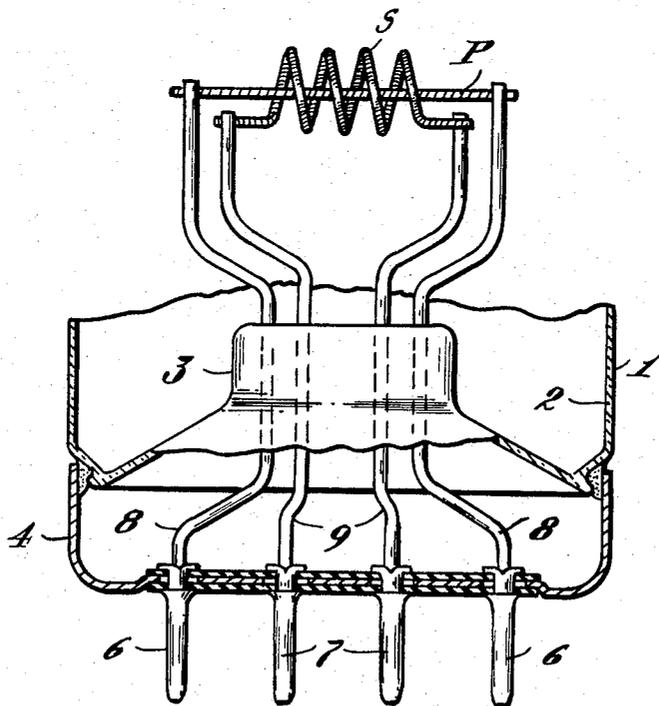


Fig. 2

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**ELECTRIC DISCHARGE DEVICE HAVING PRIMARY AND SECONDARY ELECTRODES**

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 5 Claims. (Cl. 313—213)

This invention relates to electric discharge devices such as fluorescent lamps, and particularly to an electrode structure for supporting an electron discharge and an ion counterflow in such devices.

Florescent lamps, for example, typically comprise an elongate glass envelope filled with mercury and an inert gas and having electrodes at each end of the lamp connected to outside terminals. A high voltage alternating current is applied through the terminals across the lamp, and usually, but not necessarily, heating current is supplied through the electrodes to heat them resistively to electron emissive temperature. In operation each electrode acts alternately as a cathode emitting electrons and being bombarded by ions, and as an anode collecting electrons. It is customary to form the electrodes as coiled coils or triple coils and to coat them with a mixture of alkaline earth metals and their oxides which imparts a low work function to the electrodes and promotes electron emission.

A disadvantage of using oxide coated electrodes results from bombardment of the electrode with heavy mercury ions during its cathode phase. Ion bombardment erodes the coating, and in fact the life of a fluorescent lamp is largely limited by the life of the coating, failure usually occurring by removal of all the coating in normal operation.

The main object of the present invention is to provide an electrode structure which greatly reduces or eliminates erosion of the oxide electrode coating and thus increases the lamp life.

Further objects are to reduce the operating temperature of the lamp, improve electron emission and lower the heating current required.

According to the invention an electric discharge device comprises an envelope containing an ionizable fill material and spaced electrode structures for supporting an alternating electron discharge and an ion counterflow, each electrode structure comprising a primary electrode having a substantial coating of electron emissive material and a secondary electrode of substantially bare refractory metal, terminal means connected to respective secondary electrodes for applying alternating current therebetween, and means isolating each primary electrode from said alternating current, each secondary electrode being disposed close to a primary electrode for activation by emissive material evaporated from the primary electrode.

For the purpose of illustration, a typical embodiment of the invention is shown in the accompanying drawing in which

FIG. 1 is a schematic diagram of a fluorescent lamp and circuit including an electrode structure according to the invention; and

FIG. 2 is an enlarged vertical section of the lamp.

The fluorescent lamp shown in the figures comprises a glass envelope 1 having a phosphor coating 2 on its inner surface. The lamp is sealed at each end with a stem press 3 and provided with a base 4 carrying insulated terminals 6 and 7. Lead wires 8 connected to the terminals 6 support a primary electrode P. Lead wires 9 connected to terminals 7 support a secondary electrode S.

As shown in FIG. 1 the lamp terminals 6 and 7 are adapted to be connected to a ballast B in the fixture in which the lamp is mounted. A suitable ballast comprises conventional alternating current power terminals A and

C and windings 11, 12, 13, 14 and 15 wound as an autotransformer on a common core 16. Such a ballast is generally conventional except that winding 15 is not electrically connected to the other windings. Windings 11 and 14 supply heating current through terminals 7 to the secondary electrodes S, while winding 15 supplies heating current through terminals 6 to the primary electrodes P. A high voltage discharge current is applied across the lamp between the secondary electrodes S which alternately emit electrons and support the arc discharge across the lamp.

The primary coil P is preferably a coiled coil of coated refractory metal wire. By way of example, a primary coil was prepared by winding a 6 milligram tungsten wire at 220 turns per inch on a mandrel consisting of a 110 milligram tungsten wire and a 0.006 inch molybdenum wire. This first coiling was then wound on a 0.021 molybdenum mandrel at 42 turns per inch. The molybdenum mandrels were removed in a known manner and a 15 mm. length of the coiled coil was coated with barium oxide.

The secondary electrode was formed by coiling the above coiled coil stock, prior to removal of the molybdenum mandrels on a 0.090 inch steel pin to make four turns at 18 turns per inch with a coil length of about 5 mm. and straight ends of about 8 mm. each. The molybdenum mandrels were removed, but no coating was deposited on the secondary electrode.

As shown in the figures, the electrodes are mounted on the lead wires 8 and 9 with the coated primary electrode P disposed axially of the uncoated secondary electrode S. When heated by a current from ballast coil 15 to a temperature in the range of 600° C. to 1100° C. the primary electrode evaporates barium and barium oxide substantially in a region which encompasses the four coils of the secondary electrode. A mixture of barium and strontium and their oxides are deposited on the uncoated secondary electrode imparting a low work function to the secondary electrode and activating it to high electron emission. Surprisingly the secondary electrode S has, at the relatively low operating temperature of about 900° C., efficient thermionic emission, in the order of 300 to 800 milliamps, when activated by a primary electrode operating in the temperature range given above. Possibly this efficient operation at lower temperatures is due to the fact that bare tungsten with barium deposited as a film rather than diffused provides a better condition for emission than does the usual oxide coating.

Further, although the thermionic emission of the secondary electrode efficiently supports the alternating electron discharge and ion counterflow across the lamp, the uncoated secondary electrode is not subject to deterioration since its deposited coating is continuously replaced by evaporation from the primary electrode.

On the other hand, the primary electrode is not subject to deterioration by ion bombardment since it is isolated from the alternating current between the secondary electrodes.

While I have shown an exemplary electrode coil structure, coils of other dimensions and spacing may be used if the secondary uncoated electrode is disposed within the substantial evaporation region of the primary electrode. It is possible to dimension and dispose the primary coil so as to heat the secondary coil thus obviating or reducing the need of the separate heating winding for the secondary electrode S. It is also possible to isolate the secondary coil from the primary coil by a diode connection between the two which permits heating of the secondary electrode by electron bombardment on the anodic phase only of the arc discharge. Thus it will be understood that the present invention includes these and other modifications which fall within the scope of the appended claims.

I claim:

1. An electric discharge device comprising an envelope containing an ionizable fill material and spaced electrode structures for supporting an electron discharge and an ion counterflow, each electrode structure comprising a primary electrode having a substantial coating of electron emissive material and a secondary electrode of substantially bare refractory metal, terminal means connected to respective secondary electrodes for applying discharge current therebetween, and circuit means for electrically isolating each primary electrode from said discharge current, each secondary electrode being disposed close to a primary electrode for activation by emissive material evaporated from the primary electrode.

2. An electric discharge device comprising an envelope containing an ionizable fill material and spaced electrode structures for supporting an alternating electron discharge and an ion counterflow, each electrode structure comprising a primary electrode having a substantial coating of electron emissive material and a secondary electrode of substantially bare refractory metal, circuit means for electrically isolating said primary electrode from the secondary electrode, and the secondary electrode being disposed close to the primary electrode for activation by emissive material evaporated from the primary electrode.

3. An electric discharge device comprising an envelope containing an ionizable fill material, heating current terminals at each end of the envelope, and high voltage terminals for applying alternating current across the lamp, and spaced electrode structures for supporting an alternating electron discharge and an ion counterflow, each electrode structure comprising a primary electrode connected to heating current terminals and having a substantial coating of electron emissive material, and a secondary electrode of substantially bare refractory metal connected to a high voltage terminal, circuit means for electrically isolating said primary electrode and high voltage terminals from the secondary electrode and heating current terminals, and the secondary electrode being disposed close to the primary electrode for activation by emissive material evaporated from the primary electrode.

4. An electric discharge device comprising an envelope containing an ionizable fill material and spaced electrode structures for supporting an alternating electron discharge and an ion counterflow, each electrode structure comprising

5. A fluorescent discharge lamp comprising an elongate sealed envelope, and a fill of inert gas therein, an electrode structure and an associated set of terminals at each end of the envelope, each set of terminals including a pair of heating terminals adapted to be connected to a supply of heating current and a pair of high voltage terminals adapted to be connected to one side of a supply of high voltage, alternating current thereby to apply alternating current across the lamp, each electrode structure comprising a primary electrode and a secondary electrode, each said primary electrode being connected to a pair of heating current terminals and having a substantial coating of electron emissive alkaline earth metal oxide, and said secondary electrodes being connected respectively to high voltage terminals and being of substantially bare refractory metal, circuit means for electrically isolating the primary electrodes and heating current terminals from the secondary electrodes and high voltage terminals, the emissive coating on each said primary electrode being adapted to be evaporated by heating current therethrough into an evaporation region about the primary electrode, and each said secondary electrode being disposed in the evaporation region of a primary electrode thereby to activate the secondary electrode to emission with low work function by continuous deposition of the evaporated coating thereon, whereby only the secondary electrodes support said ion counterflow and the primary electrodes serve as a supply of activating material for the secondary electrodes.

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