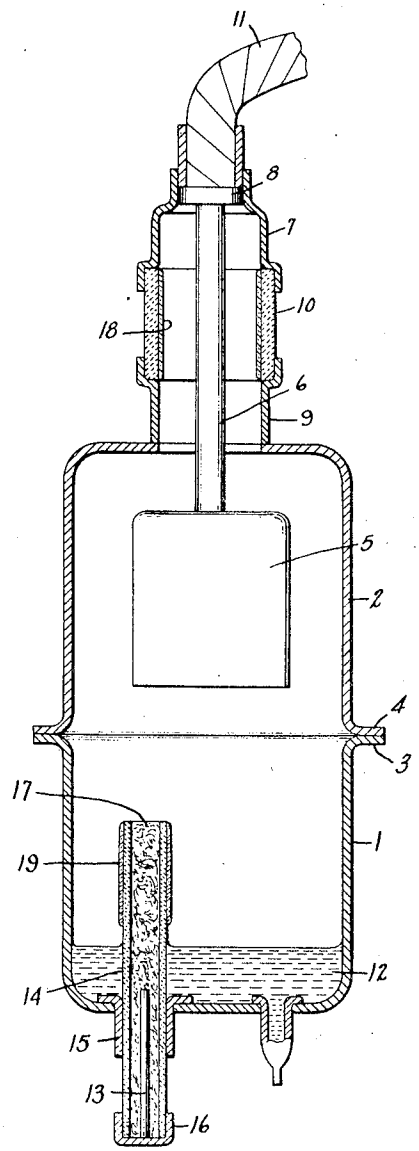
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ELECTRIC DISCHARGE DEVICE

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ELECTRIC DISCHARGE DEVICE

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My invention relates to improved electric discharge devices of the type employing an ionizable medium and particularly to improved devices of this type employing a pool cathode and an immersion type of starting electrcde.

Electric discharge devices employing a pool-type cathode and an immersion-type starting electrode are known. In one form of such device that has met with considerable commercial success a starting electrode composed of a sintered carbide or mixture of carbides is employed in combination with a mercury pool cathode. Devices of this character have been widely used and have been quite successful, particularly in applications where the substantial arc-drop of the mercury vapor, e. g., ten or more volts, is not objectionable. In lower voltage applications, however, this substantial arc drop has been a serious limitation in the use of mercury arc devices. The present invention has for an important object, the provision of an electric discharge device of the above type which retains the desirable characteristics of the ignitron, as the above devices are called, and at the same time operates with a substantially lower voltage drop in the arc.

It is known that cesium vapor provides an ionizable medium through which an arc discharge of low voltage may be maintained. Cesium vapor has been employed in hot cathode, electric discharge devices. Prior to my invention, cesium has not been employed as a pool type cathode in combination with an immersion type of starting electrode; and starting electrodes, such as the sintered carbides, mentioned above would be inoperative in the cesium tube since electrodes of this character do not operate to initiate a cathode spot when they become wetted as they would in a cesium pool. Starting electrodes of this type are also attacked by the cesium and could not be used. I have found, however, that by utilizing a dielectric starter and preferably a ceramic starter in combination with a pool of cesium that a successful pool-type of tube utilizing an immersion starter is provided. Metals other than cesium may be employed to advantage and these include alloys of cesium and potassium or cesium and sodium. Alloys of sodium potassium may also be employed. The alloys have the advantage that they are liquid at a lower temperature than the metals alone and may be in the liquid state at ambient temperature normally encountered in tube applications.

In accordance with another feature of my invention the surface of insulates employed in the discharge devices are treated to improve their

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surface resistance characteristics when subjected to vapor of the cathode metal or alloy.

My invention will be better understood from a consideration of the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims. In the drawing, the single figure is an elevational view partially in section of an electric discharge device embodying my invention.

Referring now to the drawing, I have shown my invention embodied in an electric discharge device of the metal-envelope type in which the envelope is made up of a pair of cup-shaped members 1 and 2 which are provided at their open ends with flanges 3 and 4. The members 1 and 2 are assembled with the flanges 3 and 4 in contact. These flanges are hermetically joined together in any suitable manner such as by seam welding. The anode 5 of the device which may to advantage be formed in a metal such as copper is supported within the envelope in insulated relation with respect thereto by an anode supporting conductor 6 which is joined to a metal sleeve 7 by a flanged portion 8. The sleeve 7 is supported from the upper end of the cup-shaped envelope member 2 by means of a metal sleeve 9 which is hermetically sealed to the member 2 at its lower end and bonded at its upper end to an insulating sleeve 10. The lower end of the sleeve 7 is bonded to the upper end of the insulating sleeve 10. A suitable flexible conductor 11 is received within the sleeve 7 and bonded thereto to provide a suitable terminal for the anode. The insulating sleeve 10 is preferably a ceramic material and may to advantage be bonded to the metal sleeves 7 and 9 by the use of a solder metal and a metal hydride as described and claimed in copending Kelley application Serial No. 36,289, filed June 30, 1948.

The cathode is provided by a pool of conducting liquid designated by the numeral 12. In accordance with the present invention, this liquid is cesium or a cesium alloy such as a cesium potassium or a cesium sodium alloy or an alloy of sodium and potassium. A starting electrode for initiating a cathode spot on the cathode surface and thereby initiating an arc discharge between the anode 5 and the cathode 12 is provided by a conductor 13 which extends into the cathode 12 and is separated therefrom by a dielectric sleeve 14. As illustrated in the drawing, the sleeve 14 is received within a collar 15 extending from the lower end of the envelope and supported therefrom. The sleeve 14 is preferably of a ceramic material such as an oxide or silicate of zirconium

or an oxide of aluminum. These materials are preferred since they not only function in accordance with the present invention to initiate a cathode spot in the cesium, as will be explained in more detail at a later point in the specification, they are also very resistant to attack by the cesium. In its broader aspects, however, the present invention contemplates the use of any refractory dielectric material for the sleeve 14 which is sufficiently resistant to attack by the cesium to have a satisfactory commercial life. The diclectric sleeve 14 is suitably bonded to the sleeve 15, as by the hydride method mentioned above, and is sealed at its lower end by a metal cap 16 which also provides a support and terminal for the conductor 13 of the starting electrode. The conductor 13 is preferably welded to the central portion of the cap 16. In the preferred embodiment illustrated, the sleeve 14 is of substantially larger diameter than the conductor 13 and the space between these members is filled with a conducting material 17 which to advantage may be a metallic wool. The region of contact between the sleeve 14 and the conductor 13 should extend above the cathode surface regardless of variations in the cathode surface level.

I have found that in the operation of the discharge device described above employing a ceramic starting sleeve 14 and a ceramic insulating sleeve 10 that condensed cesium or alloy of the pool on the surface of these members thoroughly wets the surface thereof and tends to destroy the surface insulating properties of the ceramic. In the case of the sleeve 10 this short circuits the anode to the cathode and in the case of the sleeve 14 short circuits the exposed metallic wool 17 of the starting electrode to the cathode. In accordance with another feature of my invention this difficulty is eliminated by applying a thin layer of glass to the inner surface of the sleeve 10 as shown at 18 and to the portion of the starting sleeve 14 above the level of the cathode liquid as shown at 19. Preferably, the glass on the sleeve of the starting electrode is spaced approximately ¼" from the surface of the pool cathode. The glass surface may be applied by melting a powdered glass on these surfaces or by melting a suitable ring of glass into contact with the surfaces.

It is apparent that these glasses should be reasonably resistant to attack by cesium and for this purpose I have found that a glass having the following composition is satisfactory: SiO_2—37%; B_2O_3—18%; Al_2O_3—10%; BaO—35%. Other glasses having reasonable resistance to attack by cesium are known and any of these may be employed. It has been known for a long time that glass insulators could not be used satisfactorily in cesium pool tubes since they were readily attacked by the cesium. This attack, however, resulted primarily from the presence of the oxide at the metal-to-glass seal. The use of a glass coating in the manner described above has made it possible to use the ceramic to metal seals and at the same time to preserve the surface insulating properties of the glass.

While the melting point of cesium metal is 28.5° C., cesium potassium; cesium sodium or sodium potassium alloys have a lower melting point and may be a liquid state at room temperature. Even with the metallic cesium, sufficient cesium oxide is normally present to depress the melting point below 28.5° C. and to provide a liquid pool at room temperature.

As will be readily understood by those skilled in the art and as more fully described in my copending application Ser. No. 135,987, now Patent No. 2,523,789, filed concurrently herewith, initiation of discharge in a device of the character described above is accomplished by impressing a voltage pulse of relatively short duration between the conductor 13 of the starting electrode and the cathode 12. If the voltage is of sufficient magnitude, a cathode spot will be formed in the region around the dielectric sleeve 14 on the cathode surface. If the device is filled with cesium vapor and a voltage is applied between the anode 4 and the cathode 12 while there is a cathode spot, a discharge between the anode and cathode will take place. The cesium vapor will provide an ionizable medium when the temperature of the cathode is in the neighborhood of 150° C. At the time of initial starting of the device the cathode may be heated to a suitable tempertaure in the order of 125° C. to 150° C. to produce the required cesium vapor for initiation of the discharge. It is preferable, however, to provide within the envelope a filling of an inert gas such as xenon, argon, crypton, neon or the like to provide an ionizable medium when the temperature of the cathode is substantially below that required to produce an adequate cesium vapor pressure. The inert gas may have a pressure in the order of 5 to 100 microns at 20° C. Since the conductor 13 of the starting electrode assembly is electrically exposed to the exterior of the device above the cathode pool, it will be apparent that as soon as ionization is present a low impedance path in shunt with the sleeve 14 is provided. This serves to remove the voltage stress from the sleeve as soon as possible after the cathode spot is formed.

A discharge device constructed in accordance with my invention possesses the desirable characteristics of accurate control of the initiation of discharge, the ability to handle currents of large magnitude and at the same time to operate with a voltage drop in the order of 5 volts which renders it particularly desirable for low voltage applications.

While I have shown and described a particular embodiment of my invention, it will be apparent to those skilled in the art that changes and modifications may be made without departing from the features of my invention, and I, therefore, aim in the appended claims to cover all such changes and modifications that fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electric discharge device comprising an envelope, means providing an anode surface within said envelope, a pool cathode within said envelope in insulated relation with respect to said anode surface and comprising cesium, a starting electrode including a conductor extending into said pool cathode and insulated therefrom by a body of ceramic material, and an inert gas filling within said envelope to facilitate starting of an arc discharge within the device when the vapor pressure of the cesium is insufficient for that purpose.

2. An electric discharge device comprising an envelope, means providing an anode surface within said envelope, a pool cathode within said envelope in insulated relation with respect to said anode surface and comprising cesium, a starting electrode including a conductor extending into said pool cathode and insulated therefrom by a body of cesium resistant dielectric ma-

terial, and an inert gas filling within said envelope to facilitate starting of an arc discharge within the device when the vapor pressure of the cesium is insufficient for that purpose.

3. An electric discharge device comprising an envelope, means providing an anode surface within said envelope, a pool cathode within said envelope in insulated relation with respect to said anode surface and comprising an alloy of metals selected from the group consisting of cesium, sodium and potassium, a starting electrode including a conductor extending into said pool cathode and insulated therefrom by a body of ceramic material.

4. An electric discharge device comprising an envelope, means providing an anode surface within said envelope, a pool cathode within said envelope in insulated relation with respect to said anode surface and comprising an alloy of metals selected from the group consisting of cesium, sodium and potassium, a starting electrode including a conductor extending into said pool cathode and insulated therefrom by a body of cesium resistant dielectric material.

5. An electric discharge device comprising an envelope, means providing an anode surface within said envelope, a pool cathode within said envelope in insulated relation with respect to said anode surface and comprising cesium, a starting electrode including a conductor extending into said pool cathode and insulated therefrom by a body of ceramic material, and an inert gas filling within said envelope at a pressure of five to 100 microns to provide an ionizable medium within said envelope when the vapor pressure of said cesium is insufficient to support ionization.

6. An electric discharge device comprising an envelope, means providing an anode surface within said envelope, a pool cathode within said envelope in insulated relation with respect to said anode surface and comprising an alloy of cesium and a metal selected from the group consisting of sodium and potassium, a starting electrode including a conductor extending into said pool cathode and insulated therefrom by a body of ceramic material, and an inert gas filling within said envelope at a pressure of five to one hundred microns to provide an ionizable medium within said envelope when the vapor pressure of said cesium is insufficient to support ionization.

7. An electric discharge device comprising an envelope, means providing an anode surface within said envelope, a pool cathode within said envelope in insulated relation with respect to said anode surface and comprising cesium and a starting electrode including a conductor extending into said pool cathode a sleeve of ceramic material of substantially larger inside diameter than said conductor surrounding said conductor and insulating said conductor from said pool and conducting material interposed between said conductor and the inner wall of said sleeve.

8. An electric discharge device comprising an hermetically sealed envelope including spaced

metal, parts exposed to the interior of the device and electrically insulated by a member of ceramic material, said device including within the envelope an ionizable medium which when condensed on the ceramic wets the surface and destroys the surface insulating properties thereof and a layer of glass on the surface of the ceramic member exposed to the interior of the device.

9. An electric discharge device comprising an hermetically sealed envelope, an electrode sealed through the envelope and supported in insulated relation therewith by a ceramic member having a surface exposed to the interior of the device, an ionizable medium within the device which when condensed on the surface of the ceramic member wets the surface and destroys its electrical insulating properties and a layer of glass on the surface of a ceramic member.

10. An electric discharge device comprising a hermetically sealed envelope, a liquid pool cathode within the envelope, a starting electrode including a conductor sealed through the envelope wall and extending into the pool cathode, a member of ceramic material surrounding the conductor to insulate the electrode from the cathode, said ceramic member extending substantially above the surface of said cathode and having an opening electrically exposing the starting conductor to the interior of the device, and a layer of glass on the exterior wall of said ceramic member in the region above the surface of the cathode pool to prevent the destruction of the surface insulating properties of the ceramic member by condensed liquid from the cathode and the resultant shorting of the conductor and cathode.

11. An electric discharge device comprising a hermetically sealed envelope, a liquid pool cathode within the envelope, a starting electrode sealed through the envelope wall and extending into the pool cathode, a member of ceramic material surrounding the starting electrode to insulate the electrode from the cathode, said ceramic member extending substantially above the surface of said cathode, said conductor being electrically exposed to the interior of the device above the level of said cathode and a layer of glass on the exterior wall of said ceramic member in the region above the surface of the cathode pool to prevent the destruction of the surface insulating properties of the ceramic member by condensed liquid from the cathode.

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