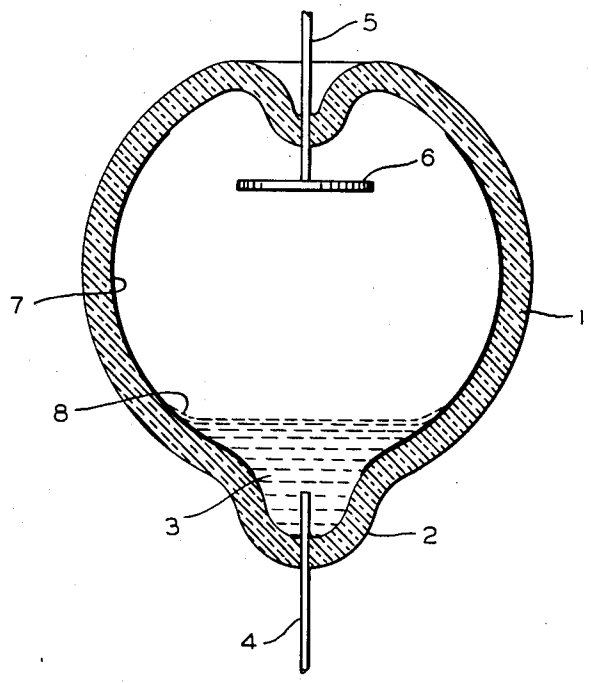
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CATHODE

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CATHODE

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This invention relates to the formation of a cathode, and has for one object to provide an improvement in a cathode and in the means and method for producing or forming the cathode.

The invention is applied preferably to cathodes which include a metal pool formed of mercury or other metal which is in generally liquid condition at operating or room temperatures.

In connection with cathodes of the type where the cathode is present within a closed envelope of glass or equivalent material, it is desirable to provide a condition on a surface by which, for example, a mercury pool can be caused to "wet" the glass or other material of the envelope within which the metal pool is present.

It is therefore one of the objects of the present invention to provide means within an envelope and adjacent a cathode pool to accomplish a treatment of the envelope which will provide a surface or a surface-coating by means of which "wetting" of the glass by the metal of the cathode pool is greatly facilitated.

Another object is to provide means for lowering the work function of the cathode pool.

Another object of the invention is to provide a method for treating the envelope within which the cathode pool is to be located to render the surface which is in contact with the mercury or other metal of the pool more readily "wettable" than is the case with glass or other equivalent envelope forming materials, and to reduce the work function of the mercury in the region which is in contact with the envelope.

A still further object is to provide a coating on the inner surface of the glass or other material which forms the envelope which increases the "wettability" of the surface, that portion of the surface of the envelope with which the mercury or other metal pool comes in contact.

Other objects will appear from time to time throughout the specification and claims.

In carrying out the invention, steps are taken to provide a coating of metal on the inner face of the envelope. The metal should be chosen from the group which bonds satisfactorily with glass. Among these are titanium, thorium, cerium and barium.

The invention is illustrated more or less diagrammatically in the accompanying drawings, wherein:

1 is an envelope of glass or comparable insulating material. After proper treatment, when the device is complete, the envelope is closed and the air is exhausted from it. It may be formed to produce a relatively small depression 2. Within the envelope, filling the envelope 2 and in the particular form here shown, extending above that depression, is a pool 3 of metal which is liquid at operating temperatures.

4 is a lead-in wire in communication with the cathode pool 3. 5 is a lead-in wire communicating with an anode which it may also support and which is positioned within the envelope 1 and above the level of the cathode pool 3. 7 is a coating or layer of material which may

be metal and which, as above pointed out in the statement of objects, renders the surface which is in contact with the cathode pool more readily wettable by the metal of the pool. 8 indicates the result at the edges of the cathode pool. This result is caused by the wetting of the surface 7 by the mercury or other metal of the pool and indicates that the metal about the edges of the pool tends to wet or climb up the surface of the envelope of the pool.

Like parts are indicated by like characters in the specification and drawings.

When the envelope has been initially formed and evacuated and the coating or film or inner surface treatment is to be applied, the metal is applied to the inner surface in almost any suitable manner. It may be applied by rubbing or other mechanical application and it may be applied by vaporization.

Metallic barium has been applied satisfactorily. When an envelope with metallic barium on its inner face adjacent the cathode pool is used, the barium lowers the work function of the mercury and also causes the latter to wet the glass. When a tube so constructed is operated and an arc is formed within it, the wetting of the glass by the cathode pool metal causes the cathode spot to occur and to be, in effect, "anchored" at a given location, and thus to stabilize the arc and this occurs at low currents; that is to say, at currents lower than those at which it would occur without the barium coating or film on the inner surface of the envelope.

Other metals may be used and some of them may be applied by vaporization under vacuum. Among those which may be applied by vaporization are cerium and calcium which vaporize easily and form a film on the glass of the envelope.

One method of forming and stabilizing the film is as follows:

Barium or a source of barium is put into a spiral of tungsten inside the tube which is heated in a vacuum by current of electricity which is passed through it. In this way the metal is vaporized and it is then condensed and deposited on the inner surface of the wall of the tube. When, thereafter mercury, is distilled into the tube, after the tube containing mercury is put into operation or otherwise, it may remove a part of the barium film, but the mercury in combination with the other metal, whether it be cerium, calcium or barium, will nonetheless wet the glass or the material of which the envelope is formed, and the cathode spot is generally confined to the line of contact between the cathode pool and the wall of the envelope.

Under these circumstances, the arc operates and is maintained at very low current.

It has been found that certain specific procedures are advantageous in the processing of barium films; that is to say, in the formation of barium films upon the inner surface of the envelope of the tube and upon the conditioning or treatment of the barium film. If the tube or envelope has a barium film initially formed upon it and air is admitted thereafter, the characteristics of the tube will improve radically when the tube, after reevacuation, is operated over a period of many hours, and the arc may be started readily by the usual glow to arc transition. In the barium-treated tube to which air had been admitted and pumped out, the arc was especially stable. In this condition the arc had a unique appearance. The color was a delicate pink. When 8,000 ohms were in series with the arc across the source of current, the arc was observed to persist until the current was reduced to only slightly above 5 ma., and very stable arc operation takes place at 15 ma.

Several metals have been referred to as suitable for

film formation. Misch metal has been used, as well as the metals above mentioned, and in forming the coating, a coating of cerium may be first applied. Thereafter, a coating of barium may be added, and finally the tube with the mercury cathode pool is used. When the cerium, barium or other metal is applied by vaporization in a thin film, it may form a chemical bond with the glass or other material of the envelope or tube.

It is thus generally fundamental to all forms of the invention that there be a thin conducting film of low work function on the inner surface of the envelope on which the cathode spot is established. The heat loss from the cathode spot is thus less than in the case of a massive cathode pool where the coating is not present. Thus with a given energy input, a higher temperature is attained than would be possible with the massive pool without the wettability of the surface of the envelope.

The metals which have been referred to as suitable for application by vaporization include barium, cerium and thorium. They have in common at least two properties. Each combines with mercury and each lowers the work function of the mercury with which it has combined below that of the mercury alone.

Reference has been made to the possibility of adding metals to provide the film of coating of the envelope by methods other than vaporization. Certain of the metals, for example thorium, are available in powdered form and can be added in this fashion. When the tube is operated, they combine with the mercury to produce the suitable wettability. Generally when introduced in powdered form, they go directly into combination with the mercury.

In the application of the metals to provide the film or coating, it is not essential that they be added in pure metallic form. A source of the metal may be used, such as misch metal as a source of cerium, and the ore or any other source of the metals is within the contemplation of the invention.

Reference has been made to metals which may be added by "rubbing" on the inner surface of the envelope. Certain metals will rub off or otherwise cling to the inner surface of the envelope to form a coating. Among these are titanium, zirconium, and hafnium. These metals bond to the glass securely and serve as a useful base to which thorium, cerium, calcium, or barium may be added to reduce the work function at the junction with mercury. Metals such as zirconium, titanium and hafnium bond securely to the glass. They do not, however, combine readily with mercury to reduce the work function of the mercury. If they are used, generally another metal from the group of metals including cerium, barium and thorium will be added as well.

We claim:

1. The method of forming a mercury receptive surface on the inner face of an electrical discharge tube, which is formed of glass, which method comprises the steps of evacuating said tube, subjecting the inner surface of said tube to a metal chosen from the class of metals consisting of cerium, thorium and barium, vaporizing said metal and causing said vaporized metal to be deposited on the inner surface of said tube; thereafter, subjecting said tube and said deposited metal to vaporized mercury and sealing it with a quantity of liquid metal enclosed within said tube.

2. The method of forming a mercury receptive surface on the inner face of an electrical discharge tube, which is formed of glass, which method comprises the steps of evacuating said tube, subjecting the inner surface of said evacuated tube to vaporized barium, causing said vaporized barium to be deposited on the inner surface of said tube; thereafter, subjecting said tube and said barium to vaporized mercury and sealing it with a quantity of liquid metal enclosed within said tube.

3. In combination, in an electrical discharge tube, an air tight envelope of glass from which air has been exhausted, an anode within said tube, a cathode pool within said tube comprising a metal which is liquid at operating temperatures, said tube having on its inner surface a coating of a metal of the class of metals consisting of cerium, thorium and barium, said anode and said cathode comprising the entire means of establishing and maintaining an arc.

4. In combination in an electrical discharge tube, an air tight envelope of glass from which air has been exhausted, an anode within said tube, a lead-in wire extending through the wall of said tube and connected to said anode, a cathode pool within said tube comprising a metal which is liquid at operating temperatures, a lead-in wire in contact with the said cathode pool and terminating below its upper surface, said tube having on its inner surface a coating of a metal of the class of metals consisting of cerium, thorium and barium, said anode and said cathode comprising the entire means of establishing and maintaining an arc.

5. In combination in an electrical discharge tube, an air tight envelope of glass from which air has been exhausted, an anode within said tube, a lead-in wire extending through the wall of said tube and connected to said anode, a cathode pool within said tube comprising a metal which is liquid at operating temperatures, a lead-in wire in contact with the said cathode pool and terminating below its upper surface, said tube having on its inner surface a coating of one or more metals of the class of metals consisting of cerium, thorium and barium, said anode and said cathode comprising the entire means of establishing and maintaining an arc.

6. In combination, in an electrical discharge tube, an air tight envelope of glass from which air has been exhausted, an anode within said tube, a cathode pool within said tube comprising a metal which is liquid at operating temperatures, said tube having on its inner surface a coating of a metal which has the property of combining with mercury and of lowering the work function of the mercury, said anode and said cathode comprising the entire means of establishing and maintaining an arc.

7. The method of forming a mercury receptive surface on the inner face of a glass electrical discharge tube which includes the steps of applying by rubbing upon the inner surface of said tube, a metal of the class of metals consisting of titanium, zirconium and hafnium, and thereafter applying to the surface of said tube a film of a metal having the property of combining with mercury and producing therein a low work function.

8. The method of forming a mercury receptive surface on the inner face of a glass electrical discharge tube which includes the steps of applying by rubbing upon the inner surface of said tube, a metal of the class of metals consisting of titanium, zirconium and hafnium, and thereafter applying to the surface of said tube a film of a metal having the property of combining with mercury and producing therein a low work function, said last mentioned metal being selected from the class of metals consisting of cerium, thorium and barium.

9. The method of forming a mercury receptive surface on the inner face of a glass electrical discharge tube which is formed of insulating material, which method includes the steps of placing a pool of mercury in said tube, adding to said pool powdered thorium, exhausting the air from said tube, sealing it with said mercury and thorium within it, and vaporizing the mercury.

10. The method of operating an electrical discharge tube having a cathode pool of mercury confined by the walls of a glass tube which includes the steps of reducing the effect of surface tension of the mercury by providing on the confining walls a film which the mercury wets in such a manner as to spread upon it to provide metallic areas on the wall of the tube having low work function and low heat loss, and initiating a low current arc to a said area.

11. The method of operating an electrical discharge

tube having a pool of mercury confined by the walls of a glass tube and an anode spaced from the surface of said mercury, including the steps of extending the boundary edge of the upper surface of said mercury pool upwardly toward said anode and along said walls to provide locations of low work function and low heat loss adjacent the walls of said tube, and forming an arc from said anode to one of said locations.

12. The method of forming an electrical discharge tube having a pool of mercury therein confined by the walls of an exhausted glass tube, including the step of: forming a relatively thin film of mercury on the confining walls of the tube and above the major surface of the pool of mercury to thereby provide locations of low work function and low heat loss which are capable of sustaining a low current arc.

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