July 15, 1941. E. O. SEITZ 2,249,094

ELECTRIC DISCHARGE TUBE

Original Filed Aug. 2, 1937

Fig. 1

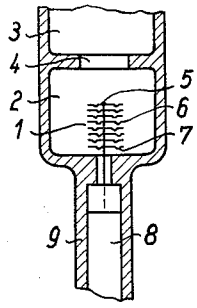

Fig. 2

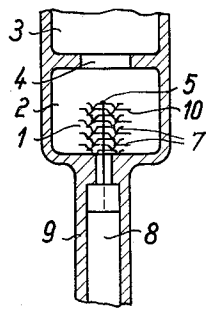

Fig. 3

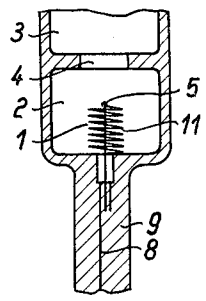

Fig. 4

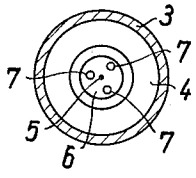

Fig. 5

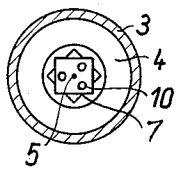

Fig. 6

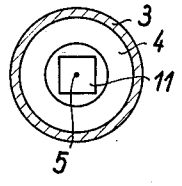

Fig. 7

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Patented July 15, 1941 2,249,094

UNITED STATES PATENT OFFICE

2,249,094

ELECTRIC DISCHARGE TUBE

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Continuation of application Serial No. 157,062, August 2, 1937. This application February 6, 1940, Serial No. 317,603. In Germany August 3, 1936

10 Claims. (Cl. 176—126)

Oxide electrodes are subjected to very severe loads in high pressure mercury tubes, especially when they are heated to the necessary emission temperature by the discharge per se. The discharge in such cases concentrates itself usually at localized points on the electrode, so that the oxide readily volatilizes where the arc strikes and the electrodes thus become inoperative due to the ensuing impoverishment of the activating material. It has, therefore, been proposed to provide a reserve supply of the activating material in recesses and corners of the cathode so as to secure a longer life thereof. Furthermore, the heat imparted to the electrodes by the arc where it strikes must be conducted away in order to prevent overheating and hence volatilization of the activating material which would render the cathode inoperative. These drawbacks are obviated in the case of high pressure mercury lamps in accordance with the present invention by constructing the electrodes, preferably the cathode, of a plurality of small lamella which are mounted on a rod, while at the same time the rod is made to extend a trifle beyond the lamella where they face the discharge chamber. For this purpose the lamella are disposed in such relation to each other that spaces are left between them which serve for the reception of the electron emitting material.

A cathode provided with these features possesses the required characteristics to a marked degree; this is because owing to the good thermal contact between the disks and the rod, the heat will be readily and rapidly conducted away from each individual disk to the rod. Furthermore, relatively large amounts of activating material can easily be placed on the electrode owing to the fact that the lamella are mounted above each other with small spaces between them, so that impoverishment of the said activating material can only occur after very long periods of use. Due to the presence of the rod, which extends through the lamella, there is, however, produced a supplementary effect which will be discussed hereinafter together with the description of the individual embodiments of the invention.

The distance between the lamella is preferably produced by means of protuberances on the lamella. In accordance with a further development of the invention the electrode consists of a single zig-zag folded sheet. In this case also the hollow spaces between the individual layers serve for the reception of the activating material.

The invention will be described in detail in conjunction with the drawing which illustrates a number of embodiments thereof.

Figs. 1 to 3 show longitudinal sections through three different types of the electrodes of the invention.

Figs. 4–6 are transverse sectional views of the several embodiments.

Fig. 7 shows one of the electrode lamella on an enlarged scale.

In Figs. 1 and 4 the electrode 1 is disposed in the pole chamber 2 of a discharge tube which chamber connects with the illuminating tube 3. Between both of these there is an annular constriction 4. The electrode consists of a rod 5 of refractory metal, e. g. tungsten or molybdenum, positioned coaxially within the pole chamber and upon this rod is mounted a large number of circular metal lamella 6 made, for example, of molybdenum, the holes in the lamella being of such size that they fit just snugly upon the rod 5. For a load of 1 ampere, a diameter of 2 to 3 millimeters, and a thickness of .1 millimeter has been found suitable when 15 to 20 lamella are used. The lamella 6 are centrally perforated and, furthermore, are provided with a number of protuberances which are pressed out by an embossing operation. These are for the purpose of preventing the lamella from stacking tightly against each other. In accordance with the invention, a small space is produced between the individual lamella so that a large amount of activating material can be carried by the electrode without fear of flaking off. The protuberances 7 can be dispensed with if the individual lamella are bent up in irregular fashion or are provided with an embossed edge, irregularly disposed, so that at the time they are assembled they will not be able to lie against each other without leaving a space.

In lieu of this, the necessary space between them can also be produced by initially positioning the individual lamella loosely and in spaced relation on the rod, and then dipping the structure into a paste and then forcing the lamella together. In this manner an adequate but not excessive amount of activating material will be provided on the electrodes. The lamella are held together by the rod 5 which at its upper end is notched, or bent over, or provided with a lug. In this case, it is preferable to keep them slightly pressed together so that they will make good contact between themselves and with the rod and act as good conductors both for the electric current as well as for heat. The rod is preferably used as a conductor, e. g. as a fused-in "lead-in" insofar as this is possible.

However, if the wall of the tube is not made of glass but rather of quartz, it is more advantageous to use thin foils 8 made of molybdenum and less than 20 microns thick which are fused in vacuum-tight relation into a capillary tube 9 of suitable size. In that case, it is necessary to provide for a suitable connection between the rod and the foil. This can be effected, for example, by folding over the upper end of the foil 8. Prior to fusing the foil in place, the rod 5 is inserted into the fold through a hole in the folded portion. The pressure of the atmosphere alone is sufficient during the fusion to effect positive connection between rod 5 and foil 8. In lieu of this type of lead-in, obviously any other type may be used.

The action of the cathode of the invention will be understood from a consideration of the ensuing description of the method of starting the lamp.

When a voltage is applied to the lamp, a glow discharge sets in at the barium particles present on the disks, and this discharge soon changes to an arc if, starting at individual points, the entire cathode becomes heated to redness. When this is accomplished, the low pressure mercury arc spreads uniformly over the entire surface of the cathode insofar as the latter is activated, although preferably it spreads on the edges of the lamella. In proportion as the vapor pressure increases, the potential gradient in the gaseous discharge will also increase. The arc, therefore, has the tendency, instead of starting sidewise at the edges, of starting at the widest portion of the cathode facing the illuminating tube. This, however, is where the slightly projecting point of the rod 5 is located. As soon, therefore, as the vapor pressure has reached a definite value, the arc strikes over towards the rod since this offers a somewhat shorter path to the arc. At the same time as the arc strikes to the rod, the operating voltage decreases about 20 volts. From this time on the arc plays exclusively on the rod. The heat produced by the arc can, therefore, be conducted away without requiring a thermal path between two metal parts on the cathode, and which would interpose a certain amount of resistance to the heat conduction. Since the rod extends only slightly beyond the surface of the lamella, its supply of activating material can be continually replenished from the lamella. On the other hand, the heat imparted to the cathode by the arc (as soon as the arc has become a high pressure arc) need no longer find its way over the thin lamella but rather solely through the rod, and without hampering the outflow of heat which would otherwise be caused by a thermal path on the cathode produced by two contacting metal portions.

In Figs. 1 and 4 the lamella are shown as resting against the bottom of the pole chamber. In case this is not permissible, for example, due to excessive heat conduction, a space can be left between the lamella and the bottom of the pole chamber. In that case, a tube may be inserted to keep the lamella at a distance from the bottom of the pole chamber, or else the rod can be bent in the form of a loop, or the rod may be squeezed flat between the lamella and the bottom of the pole chamber to hold the lamella spaced from the bottom of the pole chamber.

An individual lamella 6 is shown in section in Fig. 7 by itself on an enlarged scale. It can be seen that the protuberances 7 are embossed out of the metal. Nevertheless, the separation can be effected in other ways.

The activating mass consists essentially of barium oxide to which other oxides or metals may be added in order to prolong its life. A certain amount of mercury is introduced into the discharge tube and this is completely converted to vapor during operation with the formation of a highly superheated pressure vapor. Argon under a pressure of a few millimeters may be placed in the tube to serve as a starter.

Figs. 2 and 5 differ from the preceding in that in lieu of the circular lamella 6, square shaped ones 10 are used. Stacking the squares irregularly results in providing the necessary large surface for the reception of the oxide so that, if desired, the use of protuberances or similar separatory means may be dispensed with, although in Fig. 2 embossed spacing protuberances 7 similar to those shown in Fig. 7 are illustrated.

In Figs. 3 and 6 a plurality of individual lamella are not stacked in superposed relation as in the preceding figures. The electrode 1 rather consists of a strip of refractory metal folded up in zig-zag fashion and forced upon rod 5. Here also, the spaces between the individual layers permits the housing of a large quantity of oxide. The advantage of this arrangement is that the conduction of heat from the point at which the arc strikes and the transmission resistance offered to the electric current from the sheet metal to the rod are very low. In Fig. 3 the foil 8 is turned 90° with respect to that shown in Figs. 1 and 2 so that it is obvious how the rod rests within the folds. Otherwise what has been said in respect of Figs. 1 and 4 applies equally well to Figs. 2 and 3.

By arranging the cathode in accordance with the present invention a centric position of the arc at the electrodes is insured. This property is of advantage when the discharge tube is made of glass in which case heretofore care had to be taken to protect the glass by providing a sufficiently large distance between the wall and the electrode or to use other means to prevent the glass from being heated too much by the arc.

Since the electrodes of the invention will operate satisfactorily even if they are only a few millimeters in size, they are adaptable for use in the so-called "super high pressure lamps." In such lamps the amount of space available in the pole chambers is very small.

The invention may be used especially for such discharge tubes as are employed as ultra violet ray producers intended for therapeutic or technical purposes, or as light sources.

This application is a continuation of application Serial No. 157,062, filed August 2, 1937.

I claim:

1. In a high pressure electric arc discharge tube, walls forming a chamber, an electrode extending into the chamber from a wall and comprising a rod of refractory metal to serve as a current lead, a plurality of lamella of refractory metal mounted on said rod with their faces slightly spaced apart from the adjacent faces of adjacent lamella, the spaces between said lamella containing oxide, said rod extending through central portions of said lamella in heat transfer relation thereto, and the rod extending inwardly slightly beyond all parts of the end lamella at the chamber end of the electrode to serve as a terminal for the arc in operation, and the lamella serving to substantially uniformly dissipate the heat radially from the rod.

2. In a high pressure electric arc discharge tube, walls forming a chamber, an electrode extending into the chamber from a wall and comprising a rod of refractory metal adapted to serve as a current lead, a plurality of lamella of refractory metal mounted on said rod, said lamella having protuberances maintaining the adjacent faces of adjacent lamella slightly spaced apart, the spaces containing oxide, and the rod extending slightly beyond the end lamella at the chamber end of the electrode to serve as a terminal for the arc in operation and the lamella serving to dissipate the heat from the rod.

3. In a high pressure electric arc discharge tube, walls forming a chamber, an electrode extending into the chamber from a wall and comprising a rod of refractory metal adapted to serve as a current lead, a thin sheet of refractory metal folded to zig-zag form mounted on said rod with the rod extending through central portions of the several plates of said sheet, the spaces between the faces of the zig-zag formation containing oxide, and the rod extending slightly beyond all parts of the end plate face of the zig-zag formation at the chamber end of the electrode to serve as a terminal for the arc in operation and the zig-zag metal sheet serving to substantially uniformly dissipate the heat radially from the rod.

4. In a high pressure electric arc discharge tube, an electrode comprising a rod of refractory, electroconductive material of high heat conductivity, and sheet-like elements having large surface areas spaced apart and mounted on said rod with said rod extending through central openings thereof and in heat transfer connection therewith, the spaces between said elements containing an activating oxide and the rod extending inwardly beyond all parts of the innermost of said elements and serving as a terminal for the arc in operation while said elements serve for substantially uniformly dissipating the heat radially from the rod.

5. In a high pressure electric arc discharge tube, walls forming a chamber, an electrode extending into the chamber from a wall and comprising a rod of refractory metal adapted to serve as a current lead, a plurality of lamella of refractory metal mounted on said rod in stacked relation, said lamella having embossed protuberances on their faces maintaining the faces of said lamella slightly spaced apart, the spaces between said lamella containing activating oxide, and the rod extending inwardly slightly beyond the inner end lamella, said rod serving as a terminal for the arc in operation and the lamella serving to dissipate the heat from the rod.

6. In a high pressure electric arc discharge tube, walls forming a chamber, an electrode extending into the chamber from a wall and comprising a rod of refractory metal adapted to serve as a current lead, a plurality of lamella of refractory metal mounted on said rod, said lamella being of non-circular form and being non-coaxially positioned so that large surface areas of said lamella are free of contact with each other, the spaces between the free surface areas of the lamella containing oxide and the rod extending slightly beyond the inner lamella within the chamber, the rod serving as a terminal for the arc in operation and the lamella serving to dissipate the heat from the rod.

7. A high pressure electric arc discharge tube according to claim 1, and in which the lamella have large surface areas spaced apart, the spaces between said elements containing barium oxide as an activating substance.

8. A high pressure electric arc discharge tube according to claim 1, and in which the chamber contains mercury.

9. A high pressure electric arc discharge tube according to claim 1, and in which the chamber contains mercury and argon.

10. In a high pressure electric arc discharge tube, walls forming a chamber, an electrode extending into the chamber from a wall and comprising a rod of refractory metal to serve as a current lead, a plurality of lamella of refractory metal mounted on said rod in stacked relation, said lamella having protuberances on their faces serving to maintain their faces slightly spaced apart from the adjacent faces of adjacent lamella, the spaces between said lamella containing oxide, and the rod extending inwardly slightly beyond all parts of the end lamella at the chamber end of the electrode to serve as a terminal for the arc in operation, and the lamella serving to dissipate the heat from the rod.

ERNST OTTO SEITZ.