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GLOW DISCHARGE TUBE
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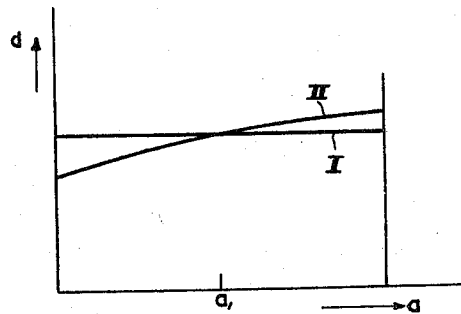


FIG.1

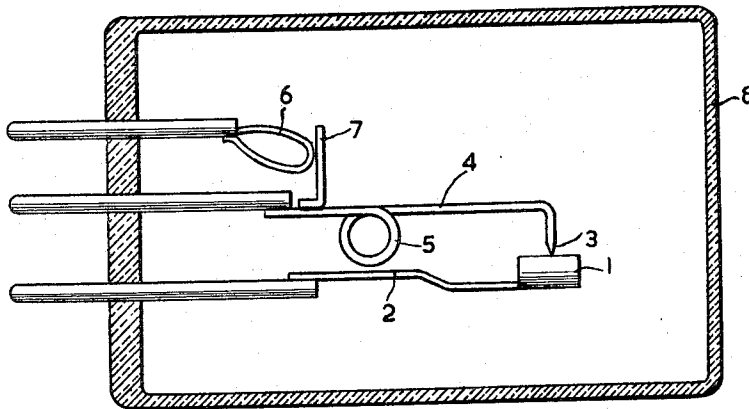


FIG.2

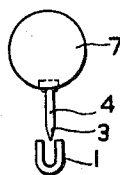


FIG.3

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GLOW DISCHARGE TUBE

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3 Claims. (Cl. 313-198)

The invention relates to a glow discharge tube having only two electrodes in the primary discharge path.

Due to the heat produced by the main discharge in a gas tube, the density of gas in the vicinity of the main cathode will be decreased during operation, with a concomitant change in breakdown voltage. This change between the breakdown voltage of a cold gas tube and the different breakdown voltage of a hot tube produces erratic operation of circuits connected to the tube.

The primary object of the invention is to provide a gas discharge tube which has substantially the same breakdown voltage when it is hot as when it is cold.

The invention comprises a gas discharge tube having a main cathode and anode between which the primary discharge takes place. In addition to the main discharge path electrodes are provided, or shaped, to establish a secondary discharge path somewhat removed from the main discharge path and at a location within the tube where the gas density does not vary appreciably between the cold and hot states of the tube. The electrodes defining the secondary discharge path are fixed relative to each other so that the breakdown voltage of the secondary discharge path is substantially the same when the tube is cold as the breakdown voltage of the main discharge path when the tube is hot. In this way, when the tube is cold, the initial breakdown occurs in the secondary discharge path and this breakdown is immediately transferred to the primary discharge path so that the electrodes which define the secondary discharge path do not heat up, and consequently, the density of the gas in the vicinity is not effected by the brief secondary discharge.

The invention will be described more fully with reference to the accompanying drawing in which:

Fig. 1 shows the variation of density of the gas in a glow discharge tube as a function of the distance of the cathode from the bulb wall, and

Figs. 2 and 3 show a side view and a plan view of an electrode arrangement according to the invention.

In Fig. 1 the gas density d is plotted as a function of the distance a of the cathode from the wall of the bulb. In Fig. 1 the zero point on the abscissa indicates the location of the cathode and the vertical line on the right hand side of the figure indicates the bulb wall. Line I designates the density of the gas in the cold state of the tube and, as would be expected, shows that the density is uniform throughout the tube. Line II indicates the density variation when the tube is hot and particularly when the bulb is comparatively small. As may be seen, the density is lower in the immediate vicinity of the hot cathode than the uniform density of a cold tube, but, because the tube is a closed system with a constant number of gas molecules, the area over curve II must be the same as the area over curve I, so the density near the wall of the bulb is higher for a hot tube than for a cold tube. At some point a_1 (or locus of points)

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between the wall and the hot cathode, the density of the gas is the same whether the tube is hot or cold, and it is at the point a_1 that the secondary discharge path should be located.

In the embodiment of the invention shown in Figs. 2 and 3, the cathode 1 is in the form of a short trough having a U-shaped cross section supported by a conductive rod 2. The main anode is the pointed end 3 of a wire 4 aimed directly at the open side of the cathode trough 1 with the point 3 in the same plane as the edges of the trough. A loop 5 is formed in the wire 4 in order to bring the wire into proximity with the supporting conductive rod 2. An auxiliary cathode 6 is provided adjacent a plate 7 to form an auxiliary discharge of about $1 \mu a$, so as to reduce ignition delay of the main discharge. The plate 7 also serves to shield the auxiliary discharge from the main discharge path. The members 1-7 are supported on contact pin studs extending through the wall of a tube envelope, or bulb, 8.

The secondary discharge path between the bottom end of loop 5 and the adjacent portion of rod 2 is located at a point within the bulb 8 which corresponds to the point a_1 in Fig. 1. When the tube is cold, discharge takes place between the loop 5 and the rod 2 before it takes place between anode 3 and the cathode 1 but is immediately shifted to the main discharge path between anode 3 and cathode 1 so that the loop 5 and the rod 2 do not become unduly heated. If the tube is operated for some time, cathode 1 becomes heated, thereby reducing the density of the gas in its immediate vicinity and lowering the breakdown potential of the main discharge path between cathode 1 and anode 3. When the cathode 1 has been operated for a sufficient length of time, the density of the gas in its immediate vicinity is reduced to substantially an equilibrium level and the breakdown voltage between cathode 1 and anode 3 is reduced to substantially the same as the breakdown voltage between loop 5 and rod 2 so that if the discharge is turned off and on while the cathode 1 is hot, the breakdown will occur between anode 3 and cathode 1 as easily as between loop 5 and rod 2. Because the density of gas in the region of the loop 5 and rod 2 remains constant, the breakdown voltage of the secondary discharge path stays almost constant and the breakdown voltage between anode 3 and cathode 1 falls to this level. It should be noted that if the secondary discharge remained on for very long, i. e., if the discharge did not almost immediately transfer to cathode 1 and anode 3, there would be local heating of elements defining the secondary discharge path, and a resultant local change in gas density similar to the change in the region of the primary discharge path.

If the loop 5 were too close to the cathode 1 so that it was in a region where the density became reduced, there would be a decrease in breakdown voltage as the elements warmed up. If the loop 5 were too far away from the cathode 1, there would be a slight increase in the breakdown voltage as the elements started to warm up and then a decrease as the cathode 1 came up to regular operating temperature.

In order to give a more complete description of an operating embodiment of the invention the following dimensions are listed. These dimensions, however, are not to be considered as limiting the invention in any way. The cathode 1 is made of molybdenum of a thickness of .25 mm., an internal width of .55 mm., a height of 1.6 mm., and a length of 3 mm. The cathode is supported by rod 2 which has a length of 10 mm., a width of .7 mm., and a thickness of .25 mm. The wire 4 has a thickness of .4 mm. and terminates in a point 3 of .05 mm. The diameter of the loop 5 is 2.8 mm. and this loop is located at a distance of about 6 mm. from

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the closest point on cathode 1 and about .5 mm. from the conductive rod 2. The bulb 8 has a volume of about 6 cm. and is filled with neon at a pressure of 48 mm. The internal diameter of the bulb is 18 mm. Without the loop 5, but with all other dimensions as listed, the breakdown voltage between anode 3 and cathode 1 is 186 ± 10 volts but with the loops as shown in the drawings, the breakdown voltage becomes more constant and is 180 ± 4 volts between the hot and the cold states, an improvement of more than 50% in the reduction of the breakdown voltage tolerance.

While this invention has been described in connection with a specific embodiment, modifications therein may be made within the scope of the following claims.

What is claimed is:

1. An electric discharge tube comprising an envelope, an ionizable medium within said envelope, cathode and anode electrodes positioned within said envelope to define a main discharge path therebetween, and means connected in parallel with said anode and cathode electrodes to define a secondary discharge path through said ionizable medium, said means being spaced from said anode and cathode electrodes and positioned where the density of said ionizable medium remains substantially constant irrespective of the temperature of the medium whereby the breakdown potential of said secondary discharge path is substantially the same as the breakdown potential of the main discharge path when said tube is hot and the discharge which initiates in said secondary path is thereby transferred to said main discharge path.

2. An electric discharge tube comprising an envelope, an ionizable medium within said envelope, cathode and anode electrodes positioned within said envelope to define a main discharge path therebetween, a first conductive member supporting the cathode, a second conductive member spaced from and supporting said anode, said

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second conductive member having an extension facing the first conductive member and defining with the second conductive member a secondary discharge path, said extension being positioned relative to said anode and cathode electrodes where the density of the ionizable medium remains substantially constant irrespective of the temperature of the medium whereby the breakdown potential of said secondary path is substantially the same as the breakdown potential of the main discharge path when said tube is hot and the discharge which initiates in said secondary path is thereby transferred to said main discharge path.

3. An electric discharge tube comprising an envelope, an ionizable medium within said envelope, cathode and anode electrodes positioned within said envelope to define a main discharge path therebetween, a first conductive member supporting the cathode, a second conductive member spaced from and supporting said anode, a circular loop-like extension on said second conductive member facing said first conductive member and spaced therefrom thereby defining a secondary discharge path therebetween, said loop-like extension being positioned relative to said anode and cathode electrodes where the density of the ionizable medium remains substantially constant irrespective of the temperature of the medium whereby the breakdown potential of said secondary path is substantially the same as the breakdown potential of the main discharge path when said tube is hot and the discharge which initiates in said secondary path is transferred to said main discharge path.

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