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K. J. GERMESHAUSEN ET AL

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GAS DISCHARGE TUBE CATHODES

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FIG. 1

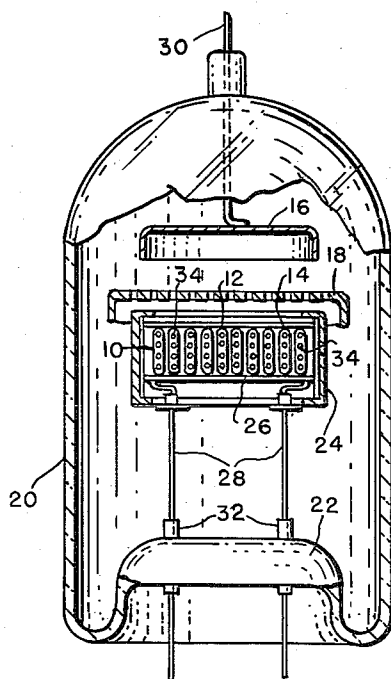
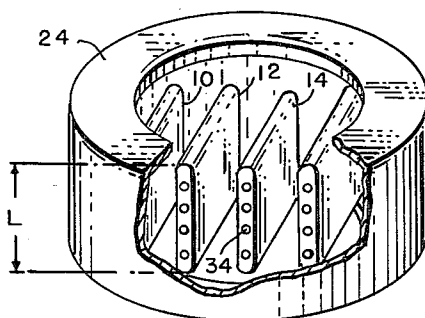


FIG. 2



INVENTOR.

KENNETH J. GERMESHAUSEN.

BY SEYMOUR GOLDBERG

Harry M. Saragovitz
ATTORNEY

ATTORNEY

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GAS DISCHARGE TUBE CATHODES

Kenneth J. Germeshausen, Newton Center, and Seymour Goldberg, Lexington, Mass., assignors to the United States of America as represented by the Secretary of the Army

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2 Claims. (Cl. 313-213)

This invention relates to gaseous discharge devices and more particularly to an improved cathode structure for such devices.

In the use of high power gaseous discharge devices such as hydrogen thyratrons for switching or keying purposes, a cathode having a large electron emission is required. In order that the cathode of such tubes occupy a minimum of space they are customarily constructed in the form of a cup or a cup containing vanes extending perpendicularly to the anode surface. The cathode is surrounded by a heat shield a few millimeters away, leaving a long narrow channel for the electrons to traverse. When such cathodes are examined after a certain period of operation, they are often found to have small dark spots at the ends nearest the anode, indicating the formation of arcs. These spots are sufficiently damaging to the electron emitting surface to result in the deactivation of the cathode.

We have found that such spots result from the fact that all the parts of the cathode are not utilized at the instant that the discharge is initiated by a keying pulse. After the discharge is initiated, the current through the tube rises very rapidly to its final value, but since a finite time is required for the plasma to penetrate to all regions of the cathode, most of the electrons drawn to the anode during the build-up are drawn from the portion of the cathode nearest the anode. Hence when such a tube is pulsed at high repetition rates by sharply rising pulses, the tube operates as above described during a large proportion of its operating life, resulting in rapid deterioration of the cathode. Furthermore, after the current in the tube reaches its final value, there is a voltage drop in the gas which causes non-uniform distribution of current drawn from the cathode, whereby most of the current continues to be drawn from those portions of the cathode nearest the anode. In addition, we have found that under certain operating conditions a portion of a long cathode will not be utilized at all, and will contribute nothing to the electron flow from the cathode.

Accordingly, it is an object of this invention to provide a gaseous discharge device having a cathode of the above type of such dimension that the entire emitting surface of the cathode is utilized more uniformly in furnishing electron current.

Other objects and advantages of the invention will be apparent from the following description, taken in connection with the accompanying drawing, in which:

Fig. 1 is a longitudinal section of a gas discharge tube incorporating the invention; and

Fig. 2 is a perspective view of the novel cathode of Fig. 1 with a portion broken away.

Figs. 1 and 2 show the invention as applied to a gas filled thyratron type of tube, although it may also be applied to gaseous diodes or thyratrons of different construction, comprising a plurality of cathode elements 10, 12, and 14, shown as rectangular in shape although they may be of any other shape, a dish-shaped anode 16, and a grid 18, all these elements being contained within a

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sealed glass envelope 20, having a reentrant portion provided with a glass press 22. The envelope 20 is filled with a suitable gas, such as hydrogen, and is sealed. Only four cathode elements are shown in Fig. 2, but any suitable number may be used, as indicated in Fig. 1, depending upon the total cathode emission required.

The cathode elements have an electron emissive coating applied thereto. Both ends of each cathode element are bonded to a bottom plate 26 of a heat radiation shield 24; and the bottom surface of the heat radiation shield is joined to common supports 28 which are supported by connection 32 extending through the glass press 22. Each cathode element is individually heated in the usual manner by a filament 34, it being understood that connections extending through glass press 22 are to be provided to connect the filaments to an external source of current.

The anode 16 is a shallow cup and is centrally supported by a wire stem 30 extending through the envelope and forming an anode terminal which is to be connected to the positive pole of a source of space current potential through a suitable load (not shown). The anode surface is perpendicular to the surfaces of the cathode elements. Heat shield 24 is a cylindrical shell enclosing the cathode structure and having an opening in its top surface facing the anode.

As thus far described, the anode, grid, and heat shield are conventional. It is the purpose of this invention to provide a cathode structure having an optimum or preferred length of emitting surface in the direction perpendicular to the anode surface in order that the entire emitting surface of the cathode be more uniformly utilized. It is also the purpose of this invention to provide a cathode structure having a maximum emitting surface within the available cathode space.

We have found that the maximum length L_m of actual emitting surface of the cathode in the direction perpendicular to the anode surface to be as given by the following equation:

$$L_m = \sqrt{\frac{2i_T R_o}{P(E_p - \frac{dV_s}{dx})}}$$

where:

L_m =maximum length of cathode element in direction perpendicular to the anode surface

R_o =the specific resistance at said electron emitting surface with a nominal value of 4 ohm-cm.²

i_T =the total current discharged cumulatively to said anode

E_p =electric field in the plasma between said anode and said cathode with a nominal value of 14 volts/cm.²

V_s =potential drop across the cathode sheath

dV_s/dx =potential gradient in the cathode sheath with a nominal value of -7 volts/cm.²

P =total perimeter of the cathode in a plane substantially parallel to the surface of the anode.

It is apparent that all sections of the cathode are not equally utilized. However, a compromise cathode length which gives both a large discharge surface and more uniform utilization is one having axial length approximately equal to one-half of that given by the above equation.

While there has been described what is at present considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

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What is claimed is:

1. A gaseous discharge device comprising an envelope having therein an ionizable medium, an anode, and a cathode, said cathode comprising a plurality of spaced elements having electron emitting surfaces extending in a direction which is substantially perpendicular to the surface of the anode, the length of said electron emitting surface being approximately equal to the value given by the following equation:

$$L_m = \frac{1}{2} \sqrt{\frac{2i\tau R_o}{P \left(E_p - \frac{dV_s}{dx} \right)}}$$

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where the quantities are as defined in the specification.

2. A gaseous discharge device as set forth in claim 1, wherein said ionizable medium is hydrogen.

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