

July 10, 1951

W. G. STIERITZ
GLOW DISCHARGE DEVICE

2,560,348

Filed Jan. 11, 1950

FIG. 1

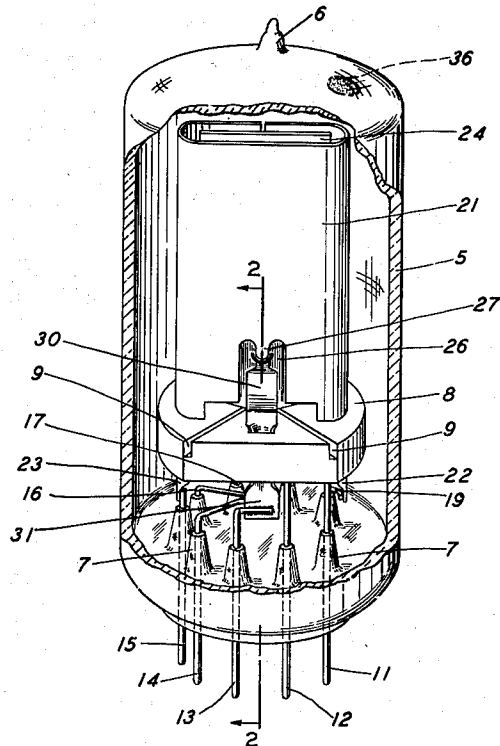


FIG. 2

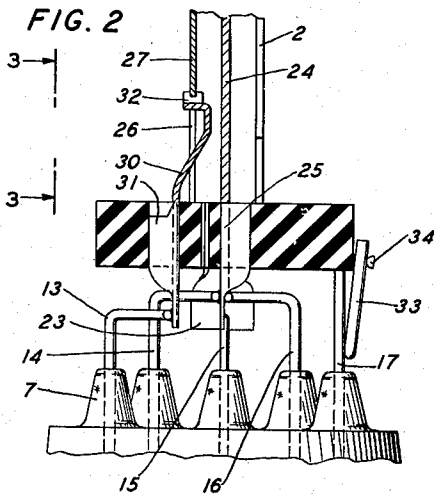
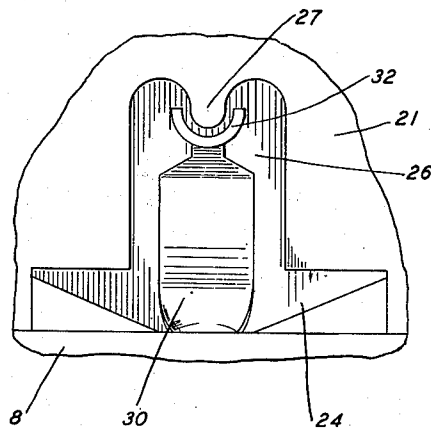


FIG. 3



INVENTOR
W. G. STIERITZ
BY *[Signature]*

ATTORNEY

UNITED STATES PATENT OFFICE

2,560,348

GLOW DISCHARGE DEVICE

William G. Stieritz, Allentown, Pa., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application January 11, 1950, Serial No. 138,037

3 Claims. (Cl. 313—198)

1

This invention relates to gaseous discharge devices and, more particularly, to such devices employing starter electrodes.

This invention pertains to an improvement over the gaseous discharge device disclosed and claimed in the application of D. S. Peck, Serial No. 137,940, filed January 11, 1950.

In such devices, for example, those used as voltage regulator tubes, there may be a maximum value of starter breakdown voltage that may be required between a starter anode and the cathode because of the circuit conditions to be met. For other reasons, it is further desirable to keep this voltage a minimum. At the same time, it is also desirable that the transfer current be kept at a minimum. The transfer current is the minimum current that can flow in the starter circuit to cause a transfer of the glow to the main anode at a given main anode potential.

The breakdown voltage may be defined as that voltage at which the gas suddenly changes from an insulating to a conducting state. The breakdown is affected by the type of gas used and its pressure, the interelectrode spacing, the degree of external ionization by such agents as light, X-rays, radium, and cosmic rays, and the configuration of the electrodes. In the production of such devices, it is not only desirable to have both the breakdown voltage and transfer currents minimum but also to have a consistent value of breakdown voltage from one device to the next.

One object of this invention is to improve the performance of gaseous discharge devices.

A further object of this invention is to improve the starter gap characteristics of such devices.

A further object of this invention is to reduce variations in starter breakdown characteristics between gaseous discharge devices of this type.

In the above-mentioned application of Peck are disclosed means for reducing the transfer current of such devices and means for attaining very accurate spacing between the starter electrodes. It is an object of this invention to further reduce the starter breakdown voltage and to diminish the variances between breakdown voltages of different gaseous discharge devices.

These and other objects are accomplished in accordance with features of this invention by a starter anode of substantially S shape having one portion extending into the main gap adjacent the main anode and its top portion returning back towards the main cathode and adjacent a

2

depending projection from the main cathode, the top of the starter anode and the bottom of the projection being concentrically curved. Specifically, it is a feature of this invention that the top of the S-shaped starter anode be curved to conform to the curve of the depending leg of the main cathode, the two curved surfaces being everywhere equidistant.

In one specific embodiment of this invention, a gaseous discharge device comprises a flattened cylindrical cathode surrounding a central plate anode, the cathode having a cut-out portion in one surface parallel to the anode and a projection depending from the cathode into that portion and having a curved end, and a starter anode having a portion extending into the main gap adjacent the main anode and then turning back toward the main cathode and having its top surface curved adjacent the curved end of the depending projection and conforming thereto.

A more complete understanding of the invention and the features thereof may be gained from consideration of the following detailed description and the accompanying drawing in which:

Fig. 1 is a perspective view of a gaseous discharge device illustrating one embodiment of this invention, a portion of the glass envelope being broken away to show the internal elements of the device;

Fig. 2 is a fragmentary sectional view along the line 2—2 of Fig. 1, showing the auxiliary anode and support assemblies; and

Fig. 3 is a detail view along the line 3—3 of Fig. 2, and to an enlarged scale, showing the cathode cut-out portion and starter gap.

Referring now to the drawing, the glow discharge device illustrated in Fig. 1 comprises an enclosing vessel 5 with an exhaust tubulation 6 at one end. Lead-in conductors 11, 12, 13, 14, 15, 16, 17, and 19 are mounted through seals 7 in the base of the vessel 5. A ceramic spacer 8 rests on the leads 11, 12, and 17, the spacer having slots 9 in the upper surface to reduce electrical leakage between the electrodes. A flattened cylindrical cathode 21 has curved base tabs 22 and 23 extending through the spacer 8 and held thereby. The tab 23 is attached to conductor 15 and tab 22 to conductor 19, the end of which is bent over to the tab. A plane anode 24 is placed at the median plane of the flattened cylindrical cathode 21. Its lower end advantageously is truncated, ending in a curved base tab 25 which extends through the spacer 8 and is held thereby. The conductors 14 and 16 are

bent over and secured to opposite sides of the tab 25.

The cathode 21 has a substantially M-shaped cut-out portion 26 at the base of one side, preferably the integral side, the other side having an end seam closed as by welding or brazing or being left open, as shown in Fig. 1. An extended projection or leg 27 integral with the cathode 21 depends into the cut-out portion 26, the end of the leg 27 being curved. A substantially S-shaped starter anode 30 also projects into the cut-out portion 26, the starter anode 30 having a curved tab 31 extending through the spacer 8 and secured thereby. Lead-in conductor 13 is bent over and attached to the tab 31. The upper end 32 of the starter anode, which is substantially perpendicular to the plane of the cathode, is cup-shaped and contoured to conform to the curved depending leg 27 to which it is directly adjacent.

A spot of radium bromide 36, such as one microgram, is placed on the inner wall of the envelope 5. There may also be advantageously formed on the interior of the glass wall a coating of electrode metal deposited there during the aging process, as disclosed in the application of M. A. Townsend, Serial No. 104,264, filed July 12, 1949, to attain maximum stability in operation, the metal performing a gettering action and imprisoning contaminants in the envelope that might otherwise evolve during the operation of the device and have deleterious effects thereon. A getter 34 is secured across a U-shaped lead 33, which is attached to conductor 17. The vessel is filled with a gas, such as argon, although other gases may be employed, as is known by those skilled in the art.

A lower breakdown voltage is accomplished because of the partial enclosure of the cathode section 27 associated with the starter anode. By limiting the breakdown to a small area and by confining it to a specific small region where the spacing between the electrodes is constant, the range of breakdown voltage values for various devices of this form is greatly diminished. This is because the breakdown does not occur over a large area where the spacing, and hence the value of the breakdown voltage, may be dependent on the location of the most active area of the cathode and its geometry with respect to the starter anode. Instead, the spacing between the two electrodes is constant, the curve of the starter anode conforming exactly to that of the depending leg. It is a further advantage of this configuration that initial discharge does not occur at the back surface of the cathode, at the edges or up the sides, or at other unwanted places, as the starter cathode element 27 is encompassed by the starter anode, and all portions are equally spaced therefrom.

Thus, by this invention, both low breakdown voltages and consistency in the value of that voltage between different devices are attained by eliminating variations of spacing and obviating the problem of the unpredictability of the spot where breakdown will first occur.

In one specific illustrative device constructed in accordance with this invention, the electrodes 21, 24, and 30 are each formed from .010 inch sheet molybdenum, although other refractory metals, such as tantalum or columbium, could be used, and are prepared and cleansed by an acid etching process followed by a heat treatment in wet hydrogen at 1200° C. for 15 minutes, though they may be cleansed by other processes

known to those skilled in the art. No electron emitting coating need be applied to the inner surface of the cathode 21, as molybdenum is sufficiently active to itself supply the electron emission required for the device. However, if desired, a coating of electron emissive material, such as barium and strontium oxides, may be applied to the inner surface of the cathode. The exterior surface of the cathode is calorized to prevent spread of the glow to this surface, as with a coating of aluminum powder or other material known in the art.

The cathode 21 is .518 inch along its major internal axis and .125 inch across its minor. It is also .812 inch from the top surface of the spacer 8 to the upper end. The anode is $\frac{3}{8}$ inch wide and spaced $.057 \pm .010$ inch from the main sides of the cathode. The end of the depending leg 27 has a radius of curvature of .015 inch, and the upper end 32 of the starter anode 30 has a radius of curvature of .025 inch, the spacing between the two being $.008 \pm .002$ inch.

The spacer block 8 is of F-66 steatite and the lead-in conductors of .020 inch nickel wire. The device is filled with argon at a pressure of 23 millimeters of mercury. The assembling and processing whereby the spacing between the starter anode and the depending leg is very accurately controlled are as described in the above-mentioned Peck application.

Such a device, which is merely illustrative of this invention, was found to have operating characteristics similar to those of the device disclosed in the Peck application, i. e., operating current of from 5 to 40 milliamperes, a sustaining voltage of 99-102 volts at 5 milliamperes and 99-103 volts at 40 milliamperes, and a transfer current of approximately 50 microamperes. Further, the starter breakdown voltage for various devices in accordance with this invention were kept within the range of 120 to 127 volts.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A glow discharge device comprising a main anode, a hollow cathode surrounding said anode and having a cut-out portion at one side, an integral extension of said cathode depending into said cut-out portion, said extension having a substantially rounded end, and a substantially S-shaped auxiliary anode extending through said portion and having its upper end extending substantially perpendicular to the plane of said cathode and being curved adjacent said rounded end to follow the contour thereof.

2. A glow discharge device comprising a main anode, a hollow cathode surrounding said anode and having a cut-out portion at one side, a projecting leg of said cathode extending into said portion, the lower end of said leg being semicircular, and an auxiliary anode extending through said portion, said auxiliary anode being substantially S-shaped in cross section and the top surface of the S being semicircular and having the same center of curvature as the end of the leg.

3. A glow discharge device comprising a central flat anode, a hollow cathode surrounding said anode and having a cut-out portion at one side, a projecting leg of said cathode extending into said portion, the end of said leg being semicircular, a spacer block supporting said cathode

d anode, and an auxiliary anode having one end mounted by said block external to said cathode and extending through said cut-out portion into the space between said flat anode and said cathode and turning back towards said cut-out portion, the other end of said auxiliary anode being substantially perpendicular to the plane of said cathode, semicircular in cross section, and following the contour of the end of said leg.

WILLIAM G. STIERITZ. 10

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,120,955	Scofield	June 14, 1938
2,295,569	Depp	Sept. 15, 1942