Dec. 15, 1931. H. W. WEINHART 1,836,829

ELECTRIC DISCHARGE DEVICE

Filed April 17, 1928

FIG. 1.

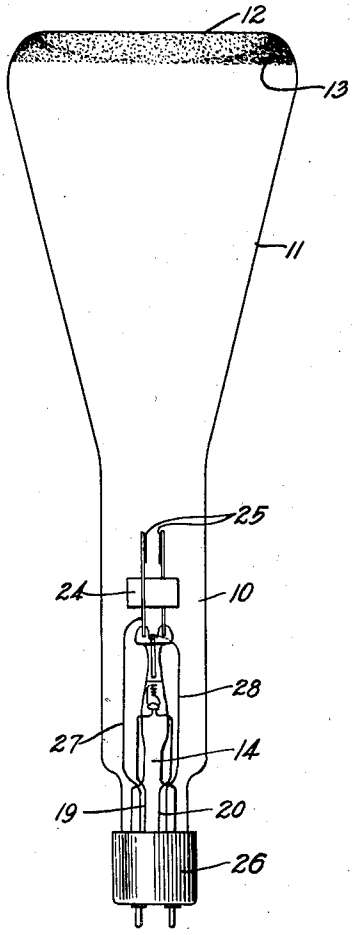


FIG. 2.

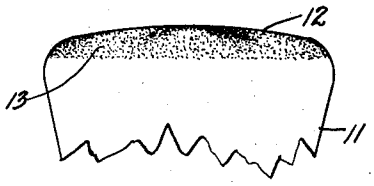
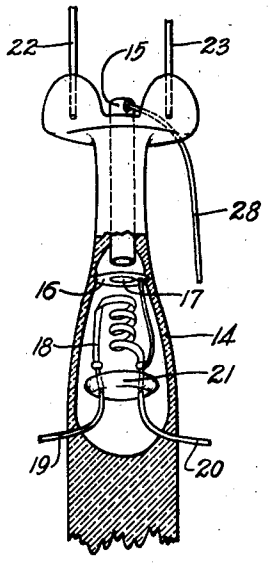


FIG. 3.



INVENTOR
HOWARD W. WEINHART
BY
Walter C. Kiesel
ATTORNEY

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UNITED STATES PATENT OFFICE

HOWARD W. WEINHART, OF ELIZABETH, NEW JERSEY, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

ELECTRIC DISCHARGE DEVICE

Application filed April 17, 1928. Serial No. 270,629.

This invention relates to electric discharge devices and more particularly to an electrode structure for an electric discharge device of the gas containing type.

For convenience, this invention will be hereinafter described in connection with the type of electric discharge devices known in the art as the Braun tube which is used primarily for the measurement of the indication of electric power, the wave form of alternating currents or potentials or similar conditions in electrical circuits.

The chief difficulty with this type of device is its relatively short life due to the filamentary cathode burning out after a relatively short period. When a gas is used in the device for the purpose of focusing or providing a conducting medium for the cathode beam, positive ions are produced in the space discharge between the cathode and anode and cause deterioration of the cathode coating and tend to reduce the operating life of the cathode. Furthermore, the space current density required to emit sufficient electrons from the filament to the cathode is too high and the operating temperature too great to secure a long operating life for the cathode.

The principal object of this invention is to increase the life of discharge devices of this character by reducing bombardment of the filament by positive ions.

Another object of the invention is to increase the efficiency of the device by decreasing the rate of emission of electrons per unit surface of the cathode.

These objects are accomplished in accordance with this invention by forming the cathode into a helix or solenoid of two or more turns. One advantage of this structure is that a larger portion of cathode is active in delivering space current to the anode and the cathode can therefore be operated at a lower temperature. A further advantage results from the more uniform electric field produced by this structure between the cathode and anode. Because of this more uniform field, the electrons travel more nearly rectilinearly toward the anode and a larger fraction of them pass through the aperture in the anode. The total space current can therefore be smaller and the filament operated at a still lower temperature. The reduction of space current also considerably reduces positive ionization between the cathode and anode resulting in a diminishing of the positive ion bombardment of the cathode.

In a preferred embodiment of the invention, the electric discharge device is constructed in accordance with the device disclosed and claimed in J. B. Johnson Patent 1,565,855, issued December 15, 1925 and comprises an enclosing vessel having a coating deposited on one end which is capable of becoming fluorescent when a cathode ray beam is directed toward it, and arranging the electrodes at the other end of the vessel in a vertical line along the axis of the vessel. These electrodes comprise a tubular anode, a thermionically active cathode arranged near one end of the anode, and between the anode and cathode is located a perforated current-directing metallic disc. The cathode is a metallic ribbon coated with alkaline earth oxides and formed into multiple loops such as a helix or solenoid having a configuration substantially the same as the tubular anode. Two pairs of deflector plates are arranged at right angles to each other at the opposite end of the tubular anode, to control the direction of the beam of electrons passing through the tubular anode to the screen or coating. The vessel is filled with an inert gas, such as argon, the ionization of which operates to focus the beam of electrons and prevents electric charges from accumulating in the device.

A more detailed description of the invention follows and is shown in the accompanying drawings, in which

Fig. 1 shows a cathode ray tube employing the special form of cathode made in accordance with this invention.

Fig. 2 illustrates a portion of the enclosing vessel showing the curvature of the coated end when the discharge device of Fig. 1 is rotated 90°, and

Fig. 3 is an enlarged detailed structure of the electrode assembly with parts broken

away to show the relation of the electrodes.

Referring to the drawings, the discharge device comprises an enclosing vessel of glass having a cylindrical portion 10, and a conical portion 11 having the closed end 12 formed into a section of a cylinder as shown by the shading of the coating 13 deposited on the interior of the end portion. The cylindrical end section 12 of the vessel forms a surface on which a photographic film may be placed in close contact with the fluorescent screen or coating 13, to obtain an exposure of the shape of an electric wave produced on the coating by the deflection of the electron beam within the device. The structural shape of the enclosing vessel does not form a part of this invention but is disclosed in U. S. Patent No. 1,750,661 issued March 18, 1930 to Ralph Bown.

The electrode structure is arranged in the axial line of the device and located in the cylindrical portion 10 of the vessel. The electrodes are supported on an inwardly projecting stem 14 and are shown more in detail in Fig. 3 in which the upper portion of the stem is sealed around the tubular metallic anode 15 which extends into the hollow portion of the stem. An apertured focusing disc 16 is sealed into the stem adjacent the anode 15 with the aperture 17 close to and in alignment with the tubular opening in the anode 15. A cathode 18 is supported in the hollow portion of the stem and comprises a filamentary ribbon formed of platinum-nickel alloy or other suitable cathode core material, and coated with alkaline earth oxides. The cathode is formed into a helix or solenoid with the surface of the multiple loops arranged in a cylindrical form and in alignment with the edge of the aperture 17 in the disc 16 and the tubular aperture of the anode 15. The cathode 18 is supported in the hollow portion of the stem by the leading in wires 19 and 20 which are sealed into the glass bead 21 adjacent the cathode. Arranged above the anode 15 are two supporting wires 22 and 23, each wire supporting a pair of plates 24 and 25 arranged at right angles to each other with the plate 25 above the plate 24. These plates are arranged to form opposed parallel surfaces for deflecting the electron beam projected through the tubular anode 15 toward the coating 13 on the end of the vessel, to produce a fluorescent spot thereon. These plates are connected externally to a contact on the base 26 by means of leading-in wire 27. The anode is also connected externally by the leading-in wire 28 while the filament is connected to the terminal contacts on the base 26 by the leading-in wires 19 and 20. The enclosing vessel is filled with an inert gas, such as argon, to a suitable pressure, in order to focus the electron beam traveling along the axial path of the vessel.

While the theory of the electron flow in the device employing the improved form of cathode in accordance with this invention is not definitely established, and while the invention is independent of the theory of operation, it is believed that the following is a correct explanation of the principles which account for the important results obtained with this electric discharge device. In this type of device it is desired primarily to prolong the operating life of the thermionically active cathode and the introduction of a longer length of cathode into the device permits the cathode to be operated at a low temperature. When the cathode 18 is formed into multiple loops of two or more turns, for instance, as shown in the drawings, in which the cathode is in the form of a helix or solenoid winding, with the successive turns in alignment with the tubular anode 15, the convolutions of the cathode are believed to force the electrons emitted from the oxide surface of the ribbon cathode to travel in an axial direction to the tubular anode, and reduce the radial and angular travel of electrons to the outside surface of the tubular anode 15. This results in the flow of electrons to the anode being more concentrated in an axial line along the vessel of the discharge device so that an increased percentage of electrons emitted from the inside surface of the cathode flows through the apertured or tubular anode 15 and therefore produces an intensive beam of electrons flowing to the screen or coating 13 on the end of the vessel. Of course, the radial electron emission from the outside surface of the cathode is also increased but these electrons either return to the cathode or are deflected by the apertured focusing disc 16 so that the percentage of these electrons entering the stream between the cathode and anode is small. This theory of electron emission is partially substantiated by the considerable reduction in the total space current which is necessary to influence the flow of electrons through the tubular anode and beyond the anode to form the electron stream to the fluorescent screen. While the reduction of space current is of itself desirable, the chief advantage resulting therefrom is the reduction in the formation of positive ions in the vicinity of the cathode. These positive ions attack the cathode coating and shorten the life of the cathode by wearing away the thermionic coating. The fluorescent spot produced on the coating of the vessel by the cathode ray beam is also more concentrated and luminous with a considerable reduction in the current in the electron beam.

While the invention has been described particularly to electric discharge devices employing a gas, the invention may also be useful in devices in which positive ionization does not occur. Furthermore, the cathode need not necessarily be formed into a continuous helix

since other forms of multiple loops will produce similar advantageous results.

What is claimed is:

1. An electric discharge device comprising an enclosing vessel having a coating on one end capable of becoming fluorescent, a gaseous atmosphere within said vessel, a tubular anode, an apertured focusing disc adjacent one end of said anode, and a helical cathode comprising a metallic ribbon having its turns wound edgewise in the form of a cylinder in surface alignment with said anode.

2. An electric discharge device comprising an enclosing vessel containing a gaseous atmosphere, a cylindrical tubular anode supported therein, a pair of leading-in wires, and a metallic ribbon having its ends connected to said leading-in wires and its intermediate portion wound edgewise and spirally to form a substantially cylindrical cathode having an interior diameter at least as great as the interior diameter of said anode, said anode and cathode being spaced from and in substantial alignment with each other.

In witness whereof, I hereunto subscribe my name this 16th day of April, 1928.

HOWARD W. WEINHART.