Sept. 22, 1953 W. W. WATROUS, JR 2,653,261

GAS DISCHARGE DEVICE

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FIG. 1

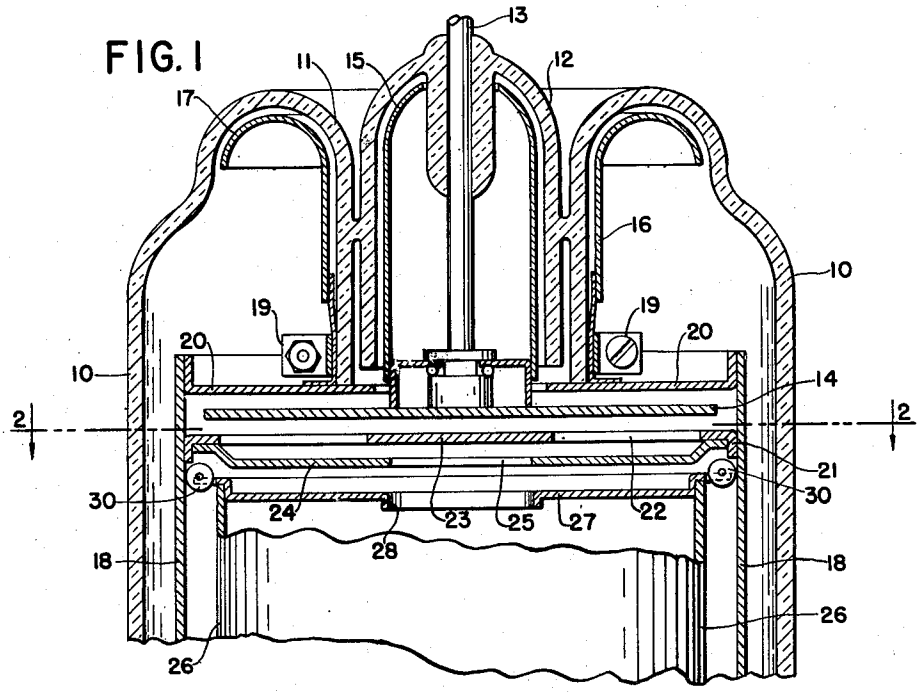
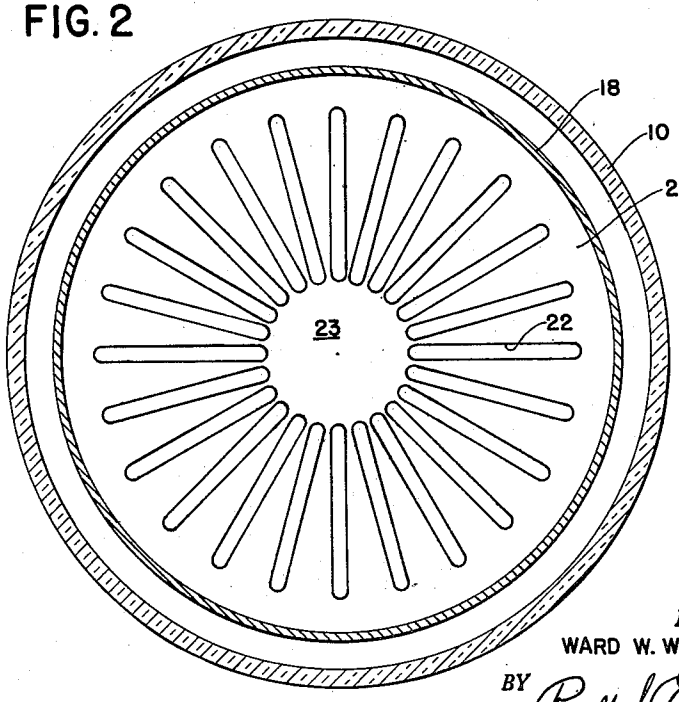


FIG. 2



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FIG. 3

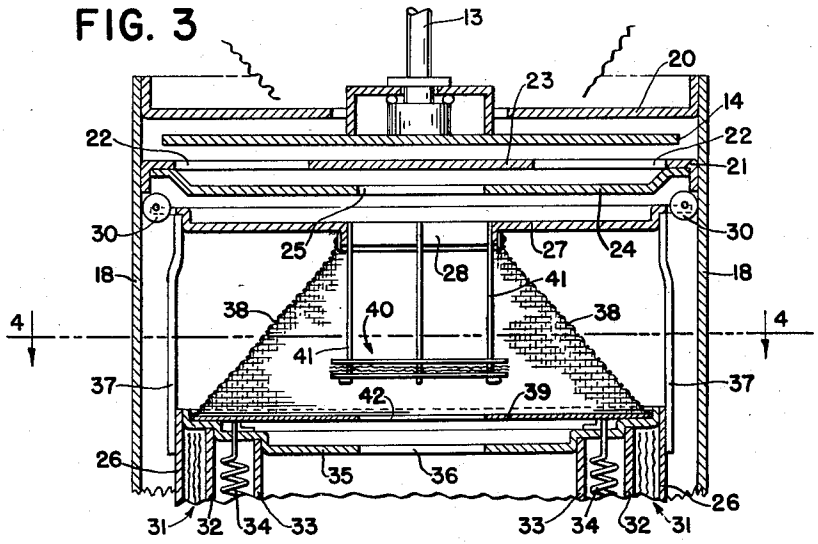
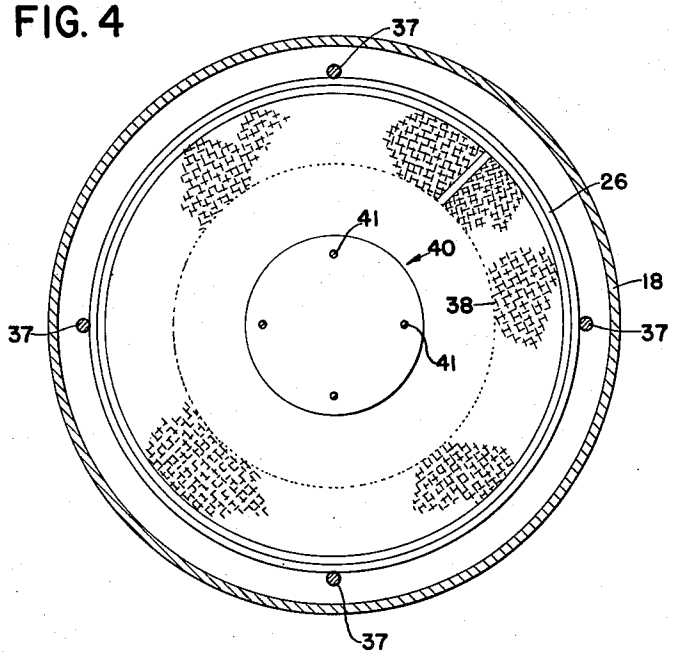


FIG. 4



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UNITED STATES PATENT OFFICE

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GAS DISCHARGE DEVICE

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Application November 8, 1951, Serial No. 255,516

5 Claims. (Cl. 313—33)

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This invention relates to gas discharge devices, and has particular reference to the design and construction of grid electrodes and baffle plates used in conjunction with the grids. The structures are designed primarily for power gas tubes which are supplied with large anode voltages and which generally include anodes and grid electrodes having areas greater than one square inch.

High voltage gas discharge devices are generally subjected to high potentials wherein the anode may be at a potential which is many thousand volts positive with respect to the cathode. In order to prevent a discharge taking place before the "firing" time, extensive shielding of the anode is employed, and a system of baffle plates is usually set up to avoid premature conduction.

In prior art construction, even when the anode is operated at a high positive potential, the shielding and baffle plates require the use of a relatively high positive potential on the grid to start conduction. Because of these conditions, the discharge from the cathode first terminates on the grid and then, a very short time interval later, is transferred to the anode. It has been found by experiment that the above conditions produce a discharge arc which is concentrated on one particular small area of the grid and anode. Operation of the tube continues with a localized discharge although the actual position of the discharge may shift from time to time. The concentration of energy in one particular portion of the tube tends to lower the available power output as neither the dissipation area of the grid or anode can be fully utilized. The localized heating may also warp the electrodes and in extreme cases destroy the tube. Localized discharge increases the grid temperature at the discharge area and enhances undesirable grid current. It is further believed that when one particular path has been established in a gas discharge device having large electrode areas, the discharge reduces the potential gradient along that path in preference to other paths that might be formed between the anode and the cathode. This concentration of the discharge also materially increases the emission from the grid structure and insures that other and subsequent discharges will follow the same path. This action is somewhat similar to the action of a number of discharge tubes in parallel connection when the electrical discharge is started in one tube. Subsequent raising of the voltage only increases the current through the ionized tube and within wide limits does not initiate a discharge in other tubes.

One of the objects of this invention is to provide an improved control electrode structure

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which avoids one or more of the disadvantages and limitations of prior art arrangements.

Another object of the invention is to obtain full utilization of the control electrode action and the conduction of the entire anode area by obtaining a uniform discharge, thereby increasing the power handling capacity of the tube.

Another object of the invention is to reduce the amount of grid current by maintaining the grid at a lower temperature.

Another object of the invention is to limit the buckling of discharge tube electrodes by providing equal and evenly distributed paths through the grid apertures.

Another object of the invention is to obtain a gas discharge high voltage device which is characterized by ease of "firing" and low grid operating potentials.

Another object of the invention is to provide a control electrode which may be easily fabricated by simple punching processes and which may be easily mounted in correct alignment in the tube.

Another object of the invention is to provide a control electrode structure with a baffle arrangement which prevents "fire through" before the control electrode has been raised to its "firing" potential.

The invention comprises a control electrode for gas discharge tubes which includes an opaque solid central portion with radial slots cut in the electrode, disposed evenly about the central portion. Directly adjacent to the grid structure is a baffle plate, the central portion of which has been cut out. This central hole is somewhat smaller than the solid opaque part of the grid. The anode is positioned directly above the grid electrode in the conventional position. The anode is mounted in a manner similar to that described in application S. N. 203,439, filed December 29, 1950, by Ward W. Watrous, Jr. The anode disk is shielded by part of the grid structure. Directly below the grid baffle is a heat-shielded cathode similar to that described in application S. N. 203,438, filed December 29, 1950, by Ward W. Watrous, Jr.

For a better understanding of the present invention, together with other and further objects thereof, reference is made to the following description taken in connection with the accompanying drawings.

Fig. 1 is a cross sectional view of the anode end of a power gas discharge tube showing the general location of the anode, grid, electrode and cathode.

Fig. 2 is a cross sectional view of the tube of Fig. 1, taken along line 2—2 of that figure.

Fig. 3 is a cross sectional view similar to Fig.

1, but showing an alternate arrangement of heat shields.

Fig. 4 is a cross sectional view of the tube of Fig. 3 taken along line 4—4 of that figure.

Referring now to Figs. 1 and 2, the gas discharge device is enclosed by a glass envelope 10. At the anode end of this envelope a reentrant portion 11 is provided which supports a cylindrical-shaped glass tube 12. An anode lead-in conductor 13 is sealed into one end of this tube and the anode 14 is secured to the other end of the conductor. In order to reduce highly concentrated electrical fields and to minimize long path discharges, an anode shield 15 is provided which is cylindrical in form and fits rather closely to the inside surface of tube 12. A similar shield 16 with flared-out portion 17 is secured to the grid structure and is employed to distribute the electrostatic field evenly and to eliminate highly concentrated field areas.

The grid structure is contained within a supporting cylinder 18 on which are mounted all the shields and baffles, in addition to the grid electrode itself. An upper shield plate 20 and the cylindrical shield 16 are secured to a glass cylindrical support by means of a clamp 19. These shields protect the upper portion of the anode 14. A grid electrode 21 is mounted directly below the anode and spaced in parallel relationship to it. The grid is perforated by a number of radial slots 22 through which the discharge passes when the tube is fired. In the central portion of the grid electrode a solid portion 23 is provided which effectively cuts off direct discharge between the cathode and the anode structure along a straight axial path. Directly below the grid electrode is a grid baffle 24 which is mounted in parallel relationship to the grid and is open only in the central portion 25. Below the grid baffle is a cathode structure which produces a large supply of electrons at all times. The cathode structure is surrounded by a shield 26 and is partly closed by a baffle plate 27. A central opening 28 in plate 27 is provided through which the electrons may stream when the tube is fired. The cathode is insulated from the grid by insulating disks 29.

The operation of this tube is as follows:—When the tube is cut off and the grid structure is at a potential which is about equal to that of the cathode, there is no conduction from the anode since there is no electric field which urges the electrons given off by the cathode to move past the baffle plates and grid to the anode disk. A high intensity field exists between the anode and the grid structure, but the spacing between these electrodes is too small to permit ionization by collision. When the tube is fired, the grid structure is raised to a relatively high positive potential and the electrons given off by the cathode are drawn through openings 28 and 25 to the central portion 23 of grid 21. When this occurs the electrons readily move into the anode field, and pass through slots 22 to the anode 14. This action produces ionization in the grid-anode space and permits large current to flow between the anode and cathode. After the discharge has been started and the electric field exists between the anode and cathode, a large supply of electrons may be drawn directly from the cathode structure by the high field intensity. It has been found that by starting the grid discharge in the central region an extremely small amount of grid power is necessary as compared to prior art tubes. Further, it has been found that this structure produces a more even distribution of anode-cathode current than previously known devices, such distribution being due to the fact that the discharge is first started between the cathode and the central portion 23 of the grid structure 21. Since the only exposed grid surface is relatively small in area, the current density is high, thereby initiating a uniform trigger discharge. Therefore, since the gas discharge area is symmetrically positioned with respect to the grid slots, the anode-cathode discharge is evenly distributed through all the slots and does not produce unequal heating of either the grid or the anode.

Referring now to Figs. 3 and 4, the alternate structure contains the same anode mounting and the same shield structure around the anode disk 14. Figs. 3 and 4 do not show the glass envelope or the details of the anode lead-in mounting since these are the same as those shown in Fig. 1. The grid baffle plate 24 and the central opening 25 are the same as the first described structure.

The cathode structure comprises an outer cylindrical wall 26, heat shielding foil sheets 31, inner cylindrical partitions 32 and 33, and heater elements 34. The upper end of the electron emitting space is partly closed by a baffle plate 35 with a central opening 36. A second baffle plate 39 with central opening 42 is placed above the terminals of the heater wires 34 to shield the grid from radiated heat from these wires and to add to the shielding action of baffle plate 35. The upper baffle plate 27 with central hole 28 and insulating disks 30 is the same as the structure in Figs. 1 and 2. It is mounted on four rods 37 which are welded to the outer cathode cylinder 26.

Between baffle plates 27 and 39 a woven wire cone 38 is secured, fitted to a flange at opening 28 at its upper extremity with its lower edge resting on plate 39 and held in place by the outer flange of baffle plate 35. This cone is made of woven wire mesh and provides a neutral surface near the arc to help in quickly dionizing the gas after a discharge has taken place. The cone 38 also confines the discharge to a restricted space and at the same time permits heat to flow from the discharge space to the outer cylinder 18. In addition, the mesh of the cone permits vaporized cathode emissive material to pass into a region of the tube where it cannot cause harmful emission.

Inside cone 38 and between openings 28 and 36 another baffle structure is mounted. It consists of two metal disks separated by one or more pieces of metal foil. This structure is centrally aligned and protects the central portion of the grid 23 from the intense heat radiated by the cathode through opening 36. It also prevents vaporized emissive material from being deposited on the grid surface. Baffle structure 40 is secured by four small rods 41 which are in turn secured to either baffle plate 27, as shown in Fig. 3, or to baffle plate 39.

The operation of this structure is substantially the same as the operation of the device shown in Figs. 1 and 2. When the tube is fired the discharge passes through openings 36 and 42, around baffle plate 40, through openings 28 and 25, then through the slots 22 in grid 21 and to the anode 14.

The above described design, shown in Figs. 3 and 4, is the preferred embodiment of the invention since it incorporates all of the features which produce a uniform discharge, fast deionization, and a restricted discharge space.

From the above description it will be evident that the invention provides a novel arrangement of electrodes and baffle plates which results in lower general temperatures in those

critical regions where a high operating temperature usually produces electron emission and grid current.

While there have been described and illustrated specific embodiments of the invention, it will be evident that various changes and modifications may be made therein without departing from the field of the invention which should be limited only by the scope of the appended claims.

I claim:

1. A gaseous discharge device comprising, an anode, a shielded heated cathode for supplying electrons within a cavity, a control electrode mounted adjacent to the anode for partially controlling the discharge between the anode and cathode, said control electrode formed with a solid central portion and a plurality of openings disposed in the region between the central portion and the periphery, a first baffle plate mounted adjacent to the control electrode and connected thereto having a central hole aligned with the central solid portion of the control electrode, a second baffle plate mounted adjacent to the first baffle plate and connected to the cathode, said second plate having a central hole aligned with the hole in the first plate, and a barrier made of mesh material for confining the discharge mounted on the cathode structure between the opening in the second baffle plate and the cathode cavity.

2. A gaseous discharge device comprising, an anode, a shielded heated cathode for supplying electrons within a cavity, a control electrode mounted adjacent to the anode for partially controlling the discharge between the anode and cathode, said control electrode formed with a solid central portion and a plurality of openings disposed in the region between the central portion and the periphery, a first baffle plate mounted adjacent to the control electrode and connected thereto having a central hole aligned with the central solid portion of the control electrode, a second baffle plate mounted adjacent to the first baffle plate and connected to the cathode, said second plate having a central hole aligned with the hole in the first plate, and a pervious barrier made of a conductive material having a plurality of openings formed therein for confining the discharge and aiding in gaseous deionization, said barrier connected to the cathode and mounted between the opening in the second baffle plate and the cathode shield.

3. A gaseous discharge device comprising, an anode, a shielded heated cathode for supplying electrons within a cavity, a control electrode mounted adjacent to the anode for partially controlling the discharge betwen the anode and cathode, said control electrode formed with a solid central portion and a plurality of openings disposed in the region between the central portion and the periphery, a first baffle plate mounted adjacent to the control electrode and connected thereto having a central hole aligned with the central solid portion of the control electrode, a second baffle plate mounted adjacent to the first baffle plate and connected to the cathode,

said second plate having a central hole aligned with the hole in the first plate; and a pervious barrier made of conductive material connected to the cathode and having a generally cylindrical shape, open at either end, with its upper opening mounted adjacent to the opening in the second baffle plate, and its lower opening mounted adjacent to the cavity in the cathode.

4. A gaseous discharge device comprising, an anode, a shielded heated cathode for supplying electrons within a cavity, a control electrode mounted adjacent to the anode for partially controlling the discharge between the anode and cathode, said control electrode formed with a solid central portion and a plurality of openings disposed in the region between the central portion and the periphery, a first baffle plate mounted adjacent to the control electrode and connected thereto having a central hole aligned with the central solid portion of the control electrode, a second baffle plate mounted adjacent to the first baffle plate and connected to the cathode, said second plate having a central hole aligned with the hole in the first plate, a pervious barrier made of conductive material connected to the cathode and mounted between the opening in the second baffle plate and the cathode shield, and a third baffle plate comprising a solid circular disk mounted between the opening in the second baffle plate and the cathode shield, said third baffle plate held parallel to the second baffle plate and aligned with the hole therein.

5. A gaseous discharge device comprising, an anode, a shielded heated cathode for supplying electrons within a cavity, a control electrode mounted adjacent to the anode for partially controlling the discharge between the anode and cathode, said control electrode formed with a solid central portion and a plurality of openings disposed in the region between the central portion and the periphery, a first baffle plate mounted adjacent to the control electrode and connected thereto having a central hole aligned with the central solid portion of the control electrode, a second baffle plate mounted adjacent to the first baffle plate and connected to the cathode, said second plate having a central hole aligned with the hole in the first plate; a pervious barrier made of conductive material connected to the cathode and having a generally cylindrical shape, open at either end, with its upper opening mounted adjacent to the opening in the second baffle plate, and its lower opening mounted adjacent to the cavity in the cathode and a third baffle plate arrangement comprising one or more solid circular disks mounted within the pervious barrier for shielding the control electrode from the radiant heat from the cathode.

WARD W. WATROUS, JR.

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Number	Name	Date
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