Aug. 8, 1933. A. L. SAMUEL 1,921,004

GASEOUS DISCHARGE DEVICE

Filed July 1, 1930

FIG. 1

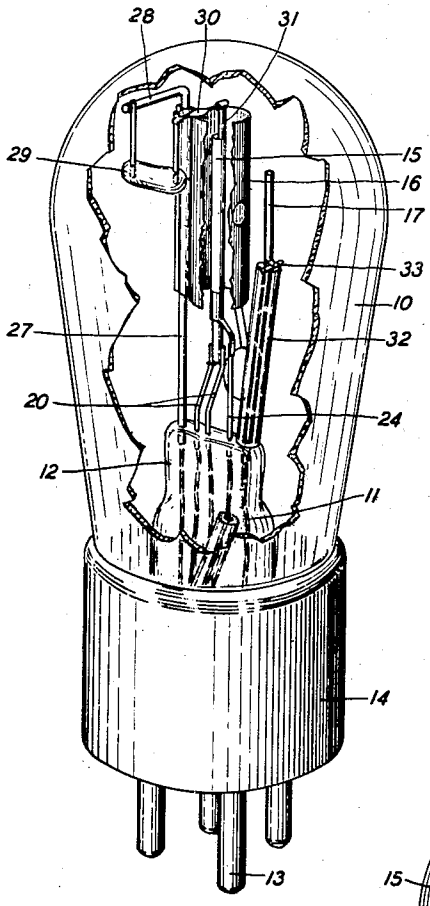


FIG. 4

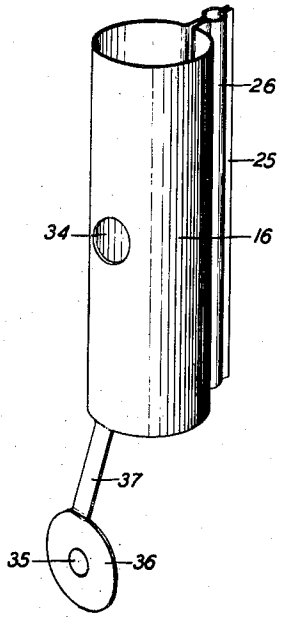


FIG. 2

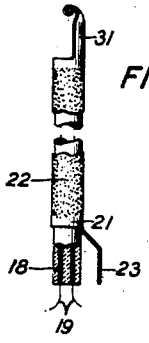
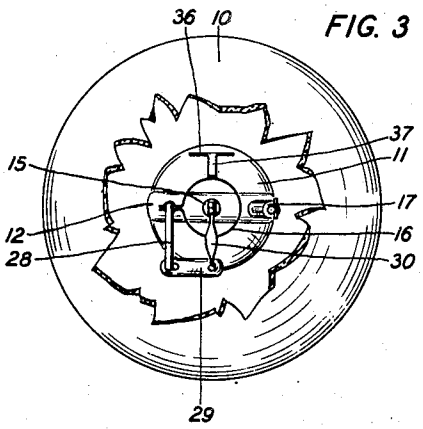


FIG. 3



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GASEOUS DISCHARGE DEVICE

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13 Claims. (Cl. 250—27.5)

This invention relates to gaseous discharge devices and more particularly to such devices in which the cathode is heated to emit electrons.

In the usual three-element device filled with an inert gas at a low pressure, it is known that the starting of the discharge between the cathode and anode may be controlled by the grid potential. After the discharge starts, the grid normally loses control and the discharge continues until the cathode or anode voltage supply is disconnected. The device can therefore function as a trigger valve having a number of advantages over mechanical devices.

The determining factor of the controlling action of the grid in such a device is the ratio of anode voltage to grid voltage, which is commonly known as the amplification constant.

An object of this invention is to accurately determine the amplification constant of gaseous three-electrode discharge devices.

In accordance with this invention the discharge device comprises a cathode adapted to be heated to emit electrons, a control electrode or grid consisting of a metallic cylinder concentric with the cathode and having a single opening in its lateral surface, and an anode consisting of a single wire placed outside the cylindrical grid near the opening, all of the electrodes being supported from a glass stem and enclosed in a vessel containing an inert gas at low pressure. The construction of the electrodes and their relation to each other provide an arrangement in which the amplification constant can be accurately determined, depending on the anode-grid potential applied to these electrodes. By providing a single large opening in the grid structure, the controlling action of the grid can be easily predetermined, since this action is governed by the largest effective opening in the grid in contra-distinction to the controlling action of a grid in an electron discharge device which is determined by the average effective opening in the grid structure.

Furthermore, the grid structure completely shields the anode from the cathode except through the opening therein which serves as a focusing means for the discharge from the cathode to the anode. Another advantage of this construction is the ability to observe the character and visibility of the discharge occurring between the cathode and anode since the single opening in the grid tends to increase the visibility of the discharge.

These and other features of the invention will be clearly understood from the following detailed description in connection with the accompanying drawing.

Fig. 1 is a perspective view of a gaseous discharge device embodying this invention having a portion of the containing vessel broken away to clearly illustrate the assembly of the electrodes.

Fig. 2 is an enlarged view partly in section to illustrate the detail structure of the equi-potential cathode.

Fig. 3 is a top view of the discharge device shown in Fig. 1 with the glass vessel broken away to show the coaxial relation of the cathode and grid and the offset anode and also to show the flexible centering support for the cathode, and

Fig. 4 is an enlarged view in perspective of the grid electrode embodied in the device shown in Fig. 1.

Referring to the drawing, the discharge device of this invention comprises an enclosing vessel 10 having an inwardly projecting stem 11 and a press portion 12 in which the leading-in wires for the electrodes are sealed. These leading-in wires are connected externally to contact pins 13 supported on a cup-shaped base 14, preferably of insulating material, fastened to the enclosing vessel 10 adjacent the stem 11. The electrodes supported in the vesel may consist of an equipotential cathode, or other electron emitting electrode 15, an enclosing electrode 16 in the form of a cylindrical plate having an opening in its surface, and a wire anode 17. The cathode 15 is adapted to emit electrons and is of the indirectly heated type. The construction of the cathode comprises a quartz rod 18 having two parallel drillings in which is located a hairpin heater wire 19 which is connected to the terminal wires 20. A cylindrical metallic cathode surface 21 is supported on the quartz rod 18 and may be formed of a tubular sleeve member or a sheet metal member wrapped around the quartz rod. The cathode surface 21 is coated with thermionically active material 22, such as alkaline earth oxides, which emit electrons when heated by conduction from the internal heater wire 19. The cathode sleeve or surface 21 is provided with an integral extension 23 at one end which is attached to a terminal wire 24 which may be attached to a separate terminal on the base 14 or attached to one of the terminals 13 to which the wires 20 are attached. The wires 20 and the terminal wire 24 for the cathode support the cylindrical cathode 15 from the glass stem coaxial with respect to the axis of the enclosing vessel.

The control electrode or grid as shown in accordance with this invention comprises a metallic tubular member 16 which is shown more clearly in Fig. 4. This electrode may be formed of a single sheet of metal, such as nickel, having a large diameter tubular portion with the ends of the sheet material joined together to close the cylinder and a smaller diameter tubular sleeve portion 26 which surrounds a supporting wire 27 and is welded thereto to rigidly fasten the control electrode 16 to the supporting wire. The spacing of the supporting wire 27 on the stem and its attachment to the electrode 16 through the offset sleeve 26 accurately positions the control electrode 16 in coaxial relation to the cylindrical cathode 15. The upper end of the supporting wire 27 is bent at right angles as shown at 28 and carries a glass bead 29 which supports a flexible metallic member 30 parallel to the right angle portion 28 of the supporting wire 27. The free end of the flexible metallic member 30 is surrounded by the end of an integral extension 31 on the cylindrical cathode by rolling the end of the extension 31 around the end of the flexible member 30. This arrangement serves to maintain the cathode structure under a suitable tension and allow expansion during heating and also to maintain the cylindrical cathode coaxially spaced from the cylindrical surface of the electrode 16 which surrounds it.

The anode 17 is formed of a small diameter wire which is sealed in the press 12 and connected externally to one of the pins 13 on the base 14. This wire is arranged in an offset position with respect to the coaxial arrangement of the cathode 15 and grid 16 but lies in a plane through one diameter of the cathode and grid. As shown in Fig. 1, the lower surface of the anode 17 is covered with a length of insulating tubing 32 which is held thereon by a stop member 33 intermediate the ends of the anode 17 and at the lower end by the glass press 12 on which it rests.

The solid metallic surface of the grid or control electrode 16 serves as a barrier between the discharge from the cathode to the parallel anode 17. In order to allow the discharge from the cathode to follow a direct path to the anode, a large sized opening 34 is cut in the lateral surface of the control electrode 16 intermediate the ends thereof and diametrically opposite the supporting connection for the electrode 16. This opening serves as a focusing means for the discharge from the cathode to the anode and is primarily proportioned to accurately determine the amplification constant of the device. The discharge passing through the opening 34 from the cathode to the anode is controlled by the grid electrode 16 in proportion to the size of the single opening 34 since the opening determines the ratio of anode voltage to grid voltage forming the discharge path between these electrodes.

After the electrodes are supported on the stem 11 and the vessel evacuated to a high degree, a filling of a gaseous atmosphere is allowed to enter the vessel to form the conducting medium for the discharge. This gaseous atmosphere may be any of the inert gases such as argon, helium or nitrogen. The pressure of the gaseous atmosphere is relatively low, being of the order of 0.25 to 0.1 millimeters of mercury. A cleanup agent or getter such as magnesium is also inserted in the vessel to absorb residual deleterious gases and impurities. This magnesium is in the form of a pellet 35 supported on a metallic disc 36 having an arm 37 which is welded to the lower edge of electrode 16 as shown in Fig. 4.

It is to be understood that the specific structure of the electrodes in accordance with this invention and the shape of the large opening in the control electrode may be widely varied in accordance with the desired characteristics which are to be produced, and such variations do not depart from the spirit and scope of this invention as covered in the appended claims.

What is claimed is:

1. A gaseous discharge device comprising an electron emitting cathode, an anode, and a control electrode co-extensive with said cathode and anode substantially segregating said cathode from said anode, said control electrode having a single lateral opening to form a focusing discharge path between said cathode and anode.

2. A gaseous discharge device comprising an electron emitting cathode, a solid metallic cylindrical electrode surrounding said cathode and having a single opening along its surface, and an anode outside said cylindrical electrode.

3. A gaseous discharge device comprising an electron emitting cathode, a hollow metallic electrode surrounding said cathode and having a single opening in a side wall thereof, and a wire anode supported in relation to said other electrodes and adjacent the exterior of the opening in said hollow electrode.

4. A gaseous discharge device comprising an electron emitting cathode, a cylindrical control electrode coaxial with said cathode and having a single opening in its lateral surface, and an anode offset from said coaxial electrodes and adjacent to the opening in said control electrode.

5. The combination in a discharge device of a pair of spaced cooperating electrodes, and a tubular electrode intermediate said cooperating electrodes, said tubular electrode having a single lateral opening therein intermediate its ends through which the discharge takes place between said cooperating electrodes.

6. The combination in a discharge device of an axial electron emitting cathode, an anode in spaced relation to said cathode, and a hollow metallic control electrode segregating said cathode from said anode, said control electrode having a single opening in a side wall thereof to direct the discharge from said cathode to said anode.

7. A discharge device comprising a cathode, an anode, and a grid electrode, said grid electrode surrounding said cathode and forming a discharge barrier between the cathode and anode except for an opening in the side thereof, said opening being so proportioned as to accurately determine the ratio of anode voltage to grid voltage.

8. A discharge device comprising a cathode, an anode, and a control electrode therebetween, said control electrode having a single aperture in a plane parallel to the longitudinal axis of the device and intermediate the ends of said cathode and anode to permit observation of the discharge from the cathode to the anode.

9. In a discharge device, an open ended grid electrode of cylindrical form having a single opening extending through its wall.

10. In a discharge device, an electrode of sheet metal having a large hollow cylindrical portion with the ends joined together, and a small hollow cylindrical portion between the ends and

the large portion, said large cylindrical portion having an aperture in its surface diametrically opposite the joined ends thereof.

11. A gaseous discharge device comprising a vessel having a stem, a cathode axially supported from said stem, an anode supported from said stem parallel to said cathode, a tubular electrode surrounding said cathode, a support extending from said stem attached to said electrode at a point removed from said anode, and means carried by said support attached to said cathode to maintain alignment of said cathode with respect to said tubular electrode.

12. A gaseous discharge device comprising a vessel having a stem, a cathode supported from said stem, an anode supported from said stem parallel to said cathode, a tubular grid electrode surrounding said cathode and forming a barrier intermediate the cathode and anode, said electrode having a single lateral opening to restrict the discharge in a certain path between said cathode and anode, and a getter supporting shield extending from said grid electrode.

13. A gaseous discharge device comprising a vessel containing an inert gaseous atmosphere, an inwardly projecting stem in said vessel having leading-in wires sealed therein, a cylindrical equi-potential cathode axially supported from said stem, a sheet metal tubular grid coaxially surrounding said cathode and supported from said stem by a leading-in wire, and a wire anode supported in an offset position by another leading-in wire, said grid having an aperture in its surface between said cathode and anode to cause the discharge from said cathode to follow a defined path to said anode.

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