Sept. 7, 1943. W. H. MARTIN 2,328,989

GASEOUS ELECTRIC DISCHARGE DEVICE

Filed Oct. 4, 1941

FIG. 1

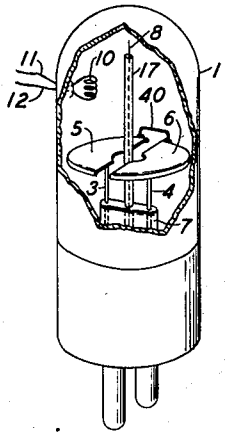



FIG. 2

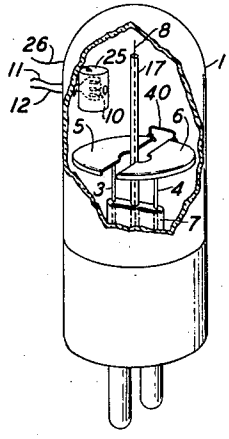



FIG. 3

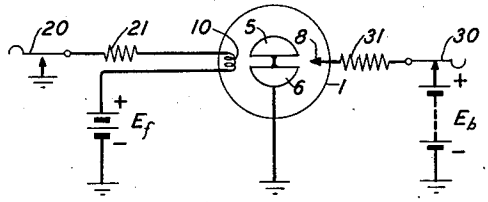
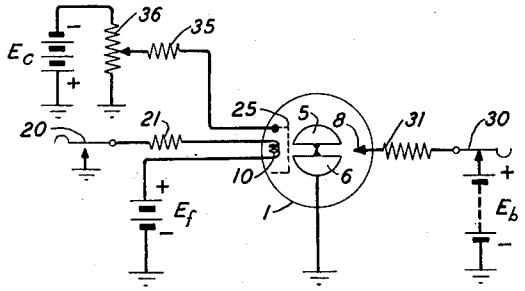



FIG. 4

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## GASEOUS ELECTRIC DISCHARGE DEVICE

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1 Claim. (Cl. 250—27.5)

This invention relates to gaseous electric discharge devices and more particularly to cathode glow discharge devices.

An object of the invention is to facilitate the discharge in electric discharge devices employing a cold cathode.

Another object of the invention is to facilitate the control of the discharge between electrodes in electric gas discharge devices employing a cold cathode.

In accordance with one feature of the invention an auxiliary thermionic emitting cathode or filament is employed to initiate the discharge between the main electrodes of the glow discharge device.

In accordance with another feature of the invention a grid is provided to control the escape of thermionically emitted electrons from the filament to the space around the anode.

The invention will be understood from the following description when read in connection with the accompanying drawing, in which:

Fig. 1 is a perspective view of one embodiment of the invention with a portion of the device broken away to show the internal structure;

Fig. 2 is a modification of the arrangement shown in Fig. 1;

Fig. 3 is a schematic diagram of the device of Fig. 1 together with a schematic diagram of an operating circuit therefor; and

Fig. 4 is a schematic diagram of the device of Fig. 2 together with a schematic diagram of a circuit arrangement therefor.

Referring now to the drawing, the device shown in Fig. 1 comprises an enclosing vessel 1, two semi-circular electrodes 5 and 6 constituting a cathode, an anode 8 and an auxiliary cathode 10. The upper surface of the cathode 5, 6 is coated with a suitable electron emissive material, such as strontium and barium oxides. The cathode is of relatively large area compared to the anode 8. The vessel 1 has a filling of gas, for example, pure argon at a pressure of 1.5 centimeters. A mixture of neon and 1 per cent of argon at a pressure of between 1 to 3 centimeters may be used. Other suitable gases may also be used. The semi-circular electrodes 5 and 6, constituting the cathode, are supported from the press 7 by members 3 and 4, respectively. The members 5 and 6 may be connected together, preferably within the vessel, by a connection, such as the wire 40. Either of the support members 3 and 4 may serve as a lead wire for the cathode. The straight edges of said electrodes 5 and 6 are spaced apart in parallel relation and are slightly grooved at the center to allow space for the anode 8 to pass therebetween.

The anode 8 is in the form of a linear rod, one end of which is embedded in the press and connected to a suitable lead wire. The rod anode is surrounded at all portions except at its upper end by an insulating sleeve 17 which may be of glass.

The auxiliary cathode or filament 10 may be of thoria free tungsten and is sealed in the side wall of the vessel 1 preferably between the anode 8 and the cathode 5, 6.

In Fig. 2 a modified form of the device of Fig. 1 is illustrated, a grid 25 being provided to control the escape of thermionically emitted electrons from the filament 10 to the space around the anode. The grid 25 is shown in the form of a metallic cup with a central aperture, but it may be of mesh material. It is supported in the side wall of the vessel around the filament 10 by a lead wire 26 embedded in the side wall of the vessel.

The operation of the devices of Figs. 1 and 2 will be discussed in connection with the circuit arrangements of the devices shown in Figs. 3 and 4.

Figs. 3 and 4 show schematic circuit arrangements for the devices of Figs. 1 and 2, respectively, with a source of current $E_b$ connected to the cathode and the anode. The anode to cathode spacing is such that no breakdown will occur where a voltage $E_b$ is applied between the anode and the cathode.

Referring now to Fig. 3, by momentarily closing the key 20, current from the battery $E_f$ will be connected to the filament 10 through resistance 21 to cause the filament 10 to be heated to an electron emitting temperature whereby the electrons between the cathode 5, 6 and anode 8 will be accelerated and will ionize the filament to anode space. Resistance 21 limits the current to a value too small to cause appreciable self-heating of the filament, while the filament electron emission is too small to supply the current flowing between the main electrodes 5, 6 and 8. Hence, a glow discharge with a high cathode fall is set up between the anode 8 and the filament 10, which discharge momentarily transfers to the activated cathode 5, 6. As diagrammatically indicated in Fig. 3, the filament is operated several volts positive with respect to the cathode to encourage this transfer. A resistance 31 may be used in the anode circuit to limit the voltage applied to the anode. After the main discharge has been initiated it can be stopped by

opening the key 30, or in any other well-known manner.

Referring now to Fig. 4, by momentarily operating the key 20, current from battery $E_f$ will be connected across the filament 10 through the resistance 21. This will likewise cause the filament to heat to thermionic emission, so that electrons between the cold cathode and the anode will be accelerated and will ionize the filament to anode space. The grid 25 serves to control the escape of thermionically emitted electrons from the filament 10 to the space around the anode. The grid 25 is prevented from operating as a cathode by a high resistance 35. The variable resistance 36 in the grid circuit is for the purpose of regulating the voltage $E_c$ applied to the grid.

It is apparent that this form of device permits the starting of the discharge by the low voltage, high current control member 10.

The devices of Figs. 1 and 2 are particularly suitable for use where a current operated relay is desired, for example, in subscribers' telephone lines. They may be used, however, as rectifiers or regulators.

Although specific embodiments of this invention have been shown and described, it will be understood, of course, that various modifications may be made therein without departing from the scope and spirit of the invention as defined in the appended claim.

What is claimed is:

A gaseous electric discharge device comprising a cathode having an electron emissive coating, an anode in cooperative relationship with said cathode, an auxiliary filamentary cathode intermediate said cathode and anode for initiating the discharge between said cathode and anode, and an electrode surrounding said auxiliary cathode for controlling the escape of electrons from the auxiliary filament to the space around the anode.

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