Nov. 14, 1944. W. G. SHEPHERD 2,362,937

ELECTRIC DISCHARGE DEVICE

Filed Sept. 15, 1942

FIG. 1

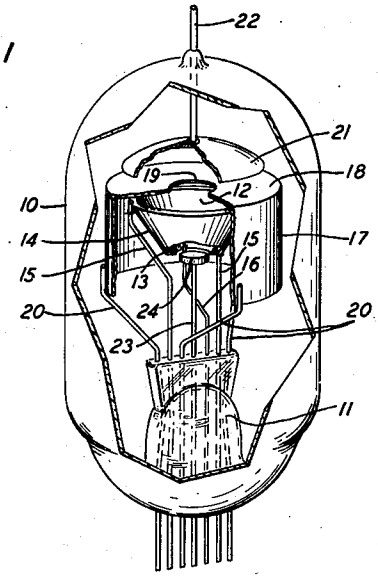
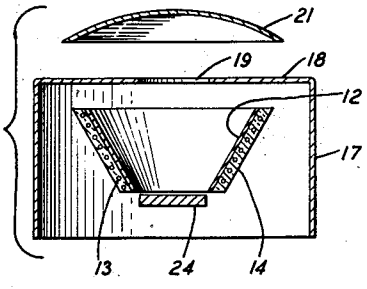


FIG. 2



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ELECTRIC DISCHARGE DEVICE

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5 Claims. (Cl. 250—27.5)

This invention relates to electric discharge devices and more particularly to gaseous discharge devices of the grid controlled type.

One object of this invention is to decrease the deionization time of gaseous discharge devices of the grid controlled type whereby the operating frequency range thereof is increased and their efficacy in pulse generating systems and the like, for example in harmonic producers for carrier supply in telephone systems such as disclosed in my Patent 2,314,739, granted March 23, 1943, is enhanced.

Another object of this invention is to increase the operating life of gaseous discharge devices of the grid controlled type.

In one illustrative embodiment of this invention, a gaseous discharge device comprises a cathode, an anode and a control electrode or grid having an apertured portion between the cathode and the anode.

In accordance with one feature of this invention, the cathode is an open-ended hollow member, for example frusto-conical in form, the inner surface of which is electron emissive and in axial alignment with the anode, and an auxiliary or deionization electrode is provided adjacent the end of the cathode furthest from the anode. The auxiliary or deionization electrode is maintained at a fixed negative potential with respect to the cathode during operation of the device and serves to decrease the deionization time of the device and also to reduce positive ion bombardment of the cathode emissive surface and thus to increase the operating life of the device.

The invention and the above-noted and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is a perspective view of an electric discharge device illustrative of one embodiment of this invention, portions of the enclosing vessel and of the control electrode and cathode being broken away to show the internal structure more clearly; and

Fig. 2 is a sectional view of the electrode structure in the device illustrated in Fig. 1.

Referring now to the drawing, the electric discharge device there illustrated comprises an enclosing vessel 10 provided with a stem 11 and having an ionizable filling, such, for example, as argon at a pressure of the order of 0.25 millimeter of mercury.

Supported from the stem is a cathode structure comprising a frusto-conical metallic member 12, the inner surface of which is coated with a thermionic material, and a heater filament 13 embedded in an insulating, preferably ceramic, body 14, the cathode structure being mounted by the leading-in conductors 15 for the heater filament 13 and the leading-in conductor 16 for the cathode. The cathode is encompassed by a control electrode or grid having a cylindrical wall 17 coaxial with the cathode and a disc end wall 18 having therein a central aperture 19 axially aligned with the emissive surface of the cathode and of materially smaller diameter than the adjacent end of the cathode. The control electrode or grid is supported by a plurality of rigid metallic supports 20 embedded in the stem 11.

Mounted opposite the end wall 18 and in axial alignment with the cathode is a dished anode 21, which is supported by the leading-in conductor 22 therefor sealed in and extending through the end of the vessel 10.

Adjacent the smaller end of the cathode, coaxial with the cathode and supported by a rigid leading-in conductor 23 embedded in the stem 11 is an auxiliary or deionization electrode 24, which may be a metallic disc of substantially the same diameter as the smaller end of the cathode.

The initiation of the discharge between the cathode and the anode is effected by the application of a suitable potential to the control electrode or grid 17, 18. Because of the form of the cathode emissive surface, the electrons emanating therefrom are directed toward the opening 19 and a concentrated electron flow is realized. Inasmuch as the cathode emissive surface is out of direct line with the anode 21 through the aperture 19, it is shielded to some extent by the disc 18 from bombardment by positive ions produced in the region between the control electrode or grid and the anode. The auxiliary or deionization electrode 24, which is maintained at a negative potential with respect to the cathode during operation of the device, attracts positive ions and thus protects the cathode emissive surface from bombardment whereby deterioration or destruction in this surface by bombardment is substantially prevented and the operating life of the device is increased. This protection of the cathode emissive surface by the auxiliary or deionization electrode is particularly effective when ionization is first initiated in the device. During the period of, and immediately following initiation of ionization, the ions acquire large energies inasmuch as the voltage across the device is high and their bombarding effect upon the cathode

emissive surface would be correspondingly large.

In gaseous discharge devices having a thermionic cathode, the deionization, after the main discharge is interrupted, is effected principally by neutralization of the positive ions, upon the electrodes. It has been found that the anode has but little effect upon the deionization time and that the important region for deionization lies between the cathode and the control electrode.

In conventional devices, deionization does not begin until the potential of the control electrode becomes negative with respect to the cathode and this condition may not occur until some time interval after the main discharge has been interrupted so that a relatively long deionization time results. The auxiliary or deionizing electrode in devices constructed in accordance with this invention provides an additional deionizing surface which is negative with respect to the cathode so that it is effective immediately upon cessation of the main discharge for deionization purposes whereby the deionization time is reduced.

It may be noted also that the deionization electrode obviates the use of large negative biases upon the control electrode to realize short deionizing time. The use of large biases upon the control electrode results in impingement of positive ions upon this electrode with large energies and this in turn may result in sputtering of material from the control electrode and consequent deterioration of the cathode and emissive surface.

Although a specific embodiment of the invention has been shown and described, it will be understood that it is but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electric discharge device comprising an enclosing vessel having an ionizable medium therein, a hollow cathode within said vessel and having its inner surface electron emissive, an anode opposite one end of said cathode, a control electrode adjacent said cathode, and a deionization electrode immediately adjacent a portion of said inner surface remote from said one end of said cathode.

2. An electric discharge device comprising an enclosing vessel having an ionizable medium therein, a hollow cathode within said vessel and having a flaring inner surface coated with electron emissive material, an anode opposite the larger end of said surface, a control electrode adjacent said cathode, and a deionization electrode adjacent the other end of said surface.

3. An electric discharge device comprising an enclosing vessel having an ionizable medium therein, a hollow cathode within said vessel and having its inner surface electron emissive, an anode opposite one end of said surface, a control electrode having a portion between said anode and said one end of said surface provided with an aperture of smaller diameter than said end of said surface, and a deionization electrode adjacent a portion of said surface removed from said end.

4. An electric discharge device comprising an enclosing vessel having an ionizable medium therein, a cathode within said vessel and having a flaring inner surface coated with electron emissive material, an anode opposite the larger end of said surface, a control electrode having a portion between said anode and said end and provided with an aperture in alignment with said surface and of smaller diameter than said end, and a deionization electrode adjacent the other end of said surface.

5. A electric discharge device comprising an enclosing vessel having a gaseous filling therein, a hollow open-ended thermionic cathode within said vessel, the inner surface of said cathode being frusto-conical and coated with electron emissive material, an anode opposite the larger end of said surface, a control electrode including a cylindrical portion encompassing said cathode and an end portion extending between said anode and said end of said surface, said end portion having therein an aperture in alignment with said cathode and said anode and of materially smaller area than said end of said surface, and a disc-shaped deionization electrode adjacent the other end of said surface.

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