Aug. 27, 1940. G. S. EVANS 2,212,828

ELECTRODE-CATHODE (REPLENISHING COATING)

Filed Oct. 19, 1938

Fig. 1.

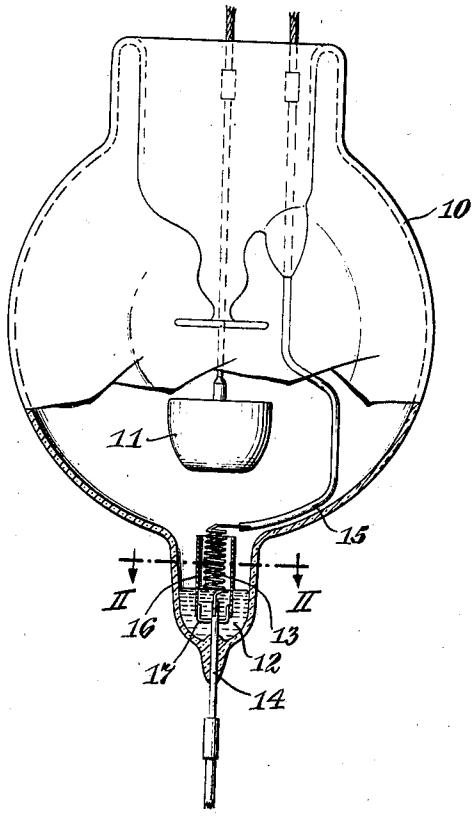


Fig. 2.

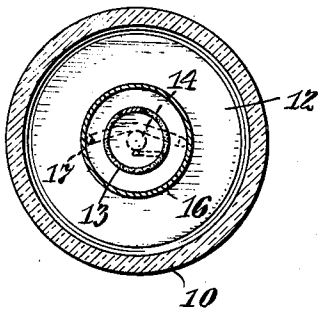


Fig. 3.

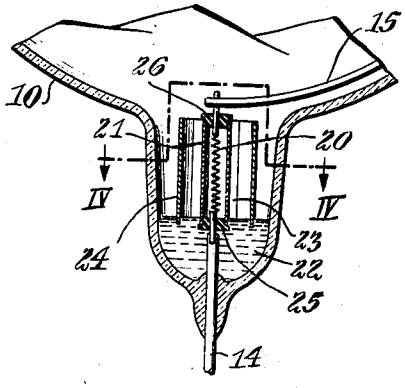
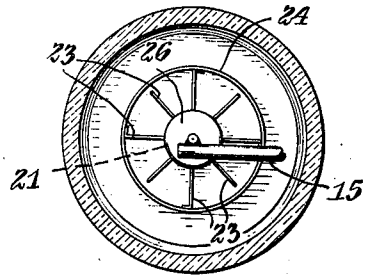


Fig. 4.



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ELECTRODE-CATHODE (REPLENISHING COATING)

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Application October 19, 1938, Serial No. 235,707

2 Claims. (Cl. 250—27.5)

My invention relates to gaseous discharge devices and especially to such devices utilized with high current values.

An object of my invention is to provide a cathode in a discharge device that is capable of withstanding severe overloads.

Other objects and advantages of my invention will be apparent from the following description and drawing, in which:

Fig. 1 is a view in front elevation of a tube with a portion of the container broken away to disclose the anode in elevation and the cathode partly in elevation and partly in cross-section.

Fig. 2 is an enlarged view on lines II—II of Fig. 1.

Fig. 3 is a modification of the cathode structure of Fig. 1.

Fig. 4 is an enlarged view on lines IV—IV of Fig. 3.

Discharge devices of the rectifier and grid-controlled discharge type, either commonly employ an oxide coated base metal which is either directly or indirectly heated, or utilize a mercury vapor pool. The mercury vapor pool provides a problem in coveniently and constantly starting the discharge when desired, but the pool type is capable of standing high currents.

The oxide coated cathode, on the other hand, has a property of starting the discharge easily when desired, but has the difficulty that, at overloads, the cathode is apt to have its oxide coating stripped from the base metal with some violence and rendered useless or practically so.

It is an object of my invention to provide a cathode capable of higher current ratings and capable of withstanding severe overloads.

In particular, the cathode structure of my invention has the properties of the mercury pool cathode of withstanding high values of discharge current by its function of acting as a reservoir for an electron emitting material of a low-work function metal such as the alkaline earth metals and especially barium. The use of the alkaline earth material retains the sensitive initiation of the discharge common to the oxide coated cathode.

A preferred embodiment of the invention is illustrated in the drawing. The container 10 may be of glass to provide an enclosure for the discharge space. Of course, other types of containers may be used, including those of metal with insulated lead-in seals for certain of the electrode or electrodes. Inside of the container is the anode 11 which may be of any suitable form and shape such as that disclosed. The cathode structure comprises a liquid portion 12 and a metal portion to be described later. The liquid 12 comprises mercury containing a percentage of alkaline earth material and the alkaline earth material that I prefer to use is that of barium. The percentage of barium forming the amalgam may vary but in the preferred embodiment illustrated, I prefer to limit the barium to a value at which the malgam retains its liquid form. Even a small percentage of barium such as one-tenth of a percent may be used and I have obtained advantageous results with three-tenths of a percent of barium in the mercury pool.

The metal portion of the cathode comprises in Fig. 1, a coil of wire 13 having one of its ends dipping into the liquid portion of the cathode. The lower end of this coil is connected to the cathode lead-in wire 14 through the bottom portion of the container and the upper end of the coil is connected to another lead-in wire 15 that may leave the tube at any desired portion, such as the top part of the tube as illustrated. I prefer to surround the coil 13 with a hollow tubular member 16 which is partly immersed in the liquid portion of the cathode and connected to the lead-in wire 14 by a connecting support 17.

In operation, a heating current is passed through the coil 13 and the heat from this coil vaporizes the adjacent surface of the mercury. The barium or other alkaline earth metal may evaporate from the amalgam and deposit on the metal cathode surface and emit electrons therefrom. Barium may also migrate from the amalgam to the base metal cathode surface because of the contact between the two. Certain mercurides of barium are formed in the amalgam and may be mechanically carried by the mercury vapor. These mercurides when contacting with the cathode base metal, decompose and leave a barium deposit. Barium metal may also be mechanically carried by the mercury vapor to be deposited on the cathode base metal. Barium may also be liberated from the amalgam and ionized by the discharge in the tube with the result that the barium ions return to the cathode to activate the base metal. The mechanism of getting barium from the amalgam reservoir to the metal cathode surface may be any one or a combination of the above possible ways. Once barium is on a cathode and the cathode is heated, then copious emission of the electrons may be obtained. The barium on the cathode is also being continually replenished. An overload may normally deplete the cathode of its barium, but

an instant later, barium will be deposited on the cathode metal and the cathode will continue to operate as long as the base metal itself is in operable condition.

The coil 13 in the figure is preferably of tungsten, although molybdenum or other refractory material may be used, and is surrounded by one or more refractory radiation shields 16 preferably of molybdenum. The tubular member 16 not only acts as a radiation shield, but also directs the barium laden vapors from the pool to the hot emitting surfaces of the cathode. If the innermost radiation shield is positioned close enough to the coil so that the heat from the coil and the discharge heats it to an emitting temperature, then the discharge between the anode and the cathode may start from either the coil or the radiation shield connected thereto. The discharge device constructed as disclosed in the drawing is simple in construction, easy to out-gas, and has withstood overloads that would irreparably destroy an oxide coated cathode of the same wattage in-put. I prefer to keep the amalgam in a liquid state so that there will always be plenty of mercury condensed on the walls of the container to wash particles of barium back to the liquid cathode.

Many modifications may be made in the form, arrangement, and number of the elements disclosed in the preferred embodiment. One such modification, namely, an indirectly heated cathode surface is illustrated in Figs. 3 and 4 in which the heater wire 20 is enclosed in a tubular metal member 21, partly immersed in the liquid cathode 22. The tubular member 21 has projecting vanes 23 therefrom to provide a greater cathode surface. Some of these vanes may also support a tubular shield 24 similar in purpose to the protecting tube 16 of Fig. 1. In this construction, a more delicate heating wire 20 of any suitable conducting material may be used because it is protected from the discharge by the metal tube 21 and its closure members 25 and 26. The material of the tube 21, vanes 23, and protective tube 24 may be of molybdenum or other material that is capable of withstanding the heat generated by a heavy discharge current. The shape of the coil and shield or shields, may be considerably varied from the ones disclosed in the various figures of the drawing.

Still further modifications may be made without departing from the spirit of the invention.

I claim:

1. A discharge device comprising a container having an alkaline earth liquid amalgam, an anode within said container, a cathode metallic surface partly immersed in said amalgam and directly exposed at said immersion to the discharge path toward said anode, a heater coil adjacent the surface of said amalgam and metallic surface, and cathode connections having a conductive path to said heater coil and metallic surface.

2. A discharge device comprising a container, an anode therein, an alkaline earth liquid amalgam within said container, a metal tube having one end immersed in said amalgam, a heater coil within said tube adjoining the surface of said liquid amalgam, and cathode connections having a conductive path to both said metal tube and said heater coil, said metal tube being the cathode terminal of the discharge path.

GEORGE STARK EVANS.