

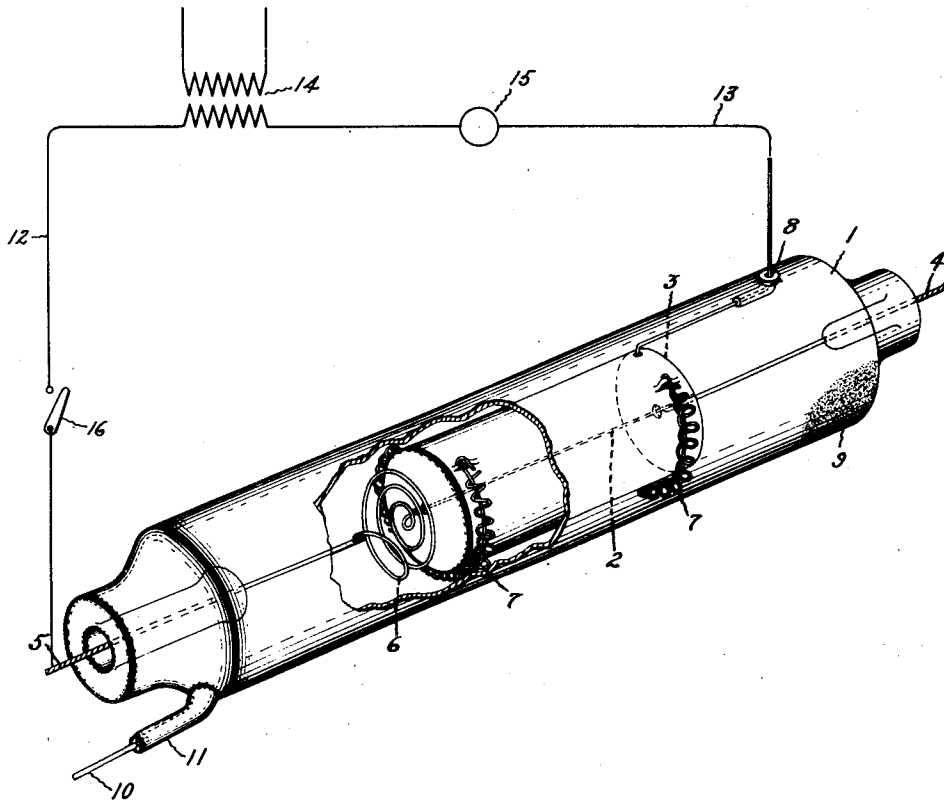
Aug. 20, 1929.

K. H. KINGDON

1,725,281

ELECTRICAL DISCHARGE DEVICE

Original Filed Feb. 26, 1923



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UNITED STATES PATENT OFFICE.

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ELECTRICAL-DISCHARGE DEVICE

Application filed February 26, 1923, Serial No. 621,149. Renewed May 26, 1928.

The present invention comprises a new electrical discharge device. It is the particular object of my invention to improve the operating characteristics of discharge devices such, for example, as rectifiers containing a cathode adapted to form or generate during operation a surface film of high electron emissivity, as for example, a film of thorium as described in Langmuir Patents 1,244,216 and 1,244,217.

Prior to my invention, devices of this character have been provided with a filling of rare gas or alkali metal vapor to improve their current-carrying capacity by the reduction of space charge. It has been found that when the gaseous pressure is maintained within certain limits, say, within the range of about a few microns to a few millimeters of mercury, and the voltage drop at the cathode is maintained below a value which depends on the particular gas or vapor employed, that the film of thorium then remains intact but that at higher gas pressures or at higher voltage drop at the cathode the active electron-emitting film on the cathode is removed by cathodic sputtering, or positive ion bombardment. For example, when using as the ionizable medium argon gas at a pressure of about 100 microns, in a device containing a cathode of the thoriated type, (that is, containing thorium, or its equivalent), the critical voltage below which sputtering does not occur is about 20 to 25 volts. Claims generic to the present invention have been made in an application of Albert W. Hull, Serial No. 226,276, filed October 15, 1927, (as a continuation in part of an application Serial No. 594,370, filed October 13, 1922) on a device and the method of its operation wherein a cathode, which is coated with a material having higher electron emissivity than the main body of the cathode, is operated in the presence of a gas while being protected from the destructive effect of positive ion bombardment. The present application is an improvement of the device covered by the Hull application, which is assigned to the same assignee as the present application.

I have discovered that when hydrogen is used as the ionizable medium, a voltage drop of as high as 125 volts between the cathode and the anode may be used without effect

upon the electron emissivity of a cathode of the thoriated type.

The accompanying diagram shows in perspective one form of apparatus in which my invention may be embodied. The drawing shows a device adapted particularly for the rectification of alternating current although capable of other uses. It comprises an envelope 1 in which is provided a cathode 2 and an anode 3. The figure shows a cylindrical envelope containing a cylindrical anode having closed ends except for perforations through which passes a linear filamentary cathode which is axially located within the anode, the filament preferably being connected to the supporting conductors just outside of the ends of the anode. I wish it to be understood, however, that my invention is not limited in its usefulness to the structural features shown in this particular embodiment. The cathode supply conductors 4, 5 are sealed into the envelope in the usual way and intermediate between the conductor 5 and the cathode 2 is provided a spring support 6 to maintain the filament taut during operation. The anode 3 is supported by coiled resilient wires 7, 7', resting on the container and is connected to a sealed-in conductor 8.

The cathode may consist of tungsten containing an admixture of about $\frac{3}{4}\%$ thorium. A reducing agent, such for example as metallic magnesium preferably also is provided in the bulbs as indicated at 9.

The envelope is given the customary bake-out and high vacuum exhaust and is then filled with dry, pure hydrogen at a pressure preferably of about 100 microns. The pressure may be varied according to circumstances from a few microns to a few millimeters of mercury. In order to avoid a diminution of the gas pressure within the device during operation by the phenomenon known as "electrical clean-up" whereby gas apparently is adsorbed by the envelope, the device is preferably aged while still connected to the source of hydrogen. It is sealed off when the pressure remains constant during operation. In some cases I may also provide, as shown in the drawing, a palladium valve for the admission of hydrogen. As indicated, this device may consist of a palladium tube 10 sealed into a glass side

tube 11 and closed at its outer end. The open end of the palladium tube which communicates with the interior of the tube is free to supply gas to the envelope through the tube 11. When the tube 10 is heated in a flame containing hydrogen, as for example an ordinary gas flame or Bunsen burner, some of the hydrogen is diffused through the walls of the palladium tube into the interior of the device 1.

The drawing shows my device used as a rectifier connected by the conductors 12, 13 to a source of alternating current as represented by the secondary of a transformer

14. A load 15 in circuit with the rectifier is supplied with unidirectional current. The cathode 2 is heated during operation from a suitable source, not shown. When the switch 16 is closed current flows through the rectifier provided that the voltage drop between the cathode 2 and the anode 3 does not exceed the critical voltage of about 125

volts. If for any reason this critical voltage is exceeded, for example, due to a short circuit on the load, then the cathode loses its high electron emissivity by the removal of the adsorbed thorium film by positive ionization bombardment. The filament can be restored by opening a switch 16, or in some cases it may be desirable to expedite the formation of the film of thorium by raising the cathode temperature to about 2100° K. for a short time.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. An electric discharge device comprising electrodes, including a thermionic thoriated cathode, an enclosing envelope and a filling of hydrogen therein at a pressure high enough to reduce space charge by positive ionization.

2. An electric discharge device comprising a container, a cathode therein capable of forming during operation a surface layer of thorium, an anode and a filling of hydrogen in said container at a pressure high enough to reduce space charge by positive ionization.

3. An electric discharge device comprising a container, a cathode therein consisting of tungsten containing several per cent of thorium, an anode and a filling of hydrogen in said container at a pressure within the limits of about several microns to several millimeters of mercury.

4. An electric discharge device comprising a container, electrodes therein, the cathode being adapted to operate at incandescence, means for generating a layer on the surface of said cathode capable of higher electron emission than the main constituent of said cathode, said layer being sensitive to positive ionization, and a filling of hydrogen in said container.

5. An electric discharge device comprising a sealed container electrodes therein, the cathode being adapted to form a surface layer of high electron emissivity, a filling of hydrogen at appreciable pressure, and means for supplying hydrogen to said container during the operation of said device.

6. A rectifier comprising a cathode adapted to be heated to incandescence during operation, an anode, means for generating upon the surface of said cathode a film of thorium material having a high electron emissivity an enclosing envelope and a filling of hydrogen at a pressure of about 100 microns.

In witness whereof, I have hereunto set my hand this 23rd day of February, 1923.

KENNETH H. KINGDON.