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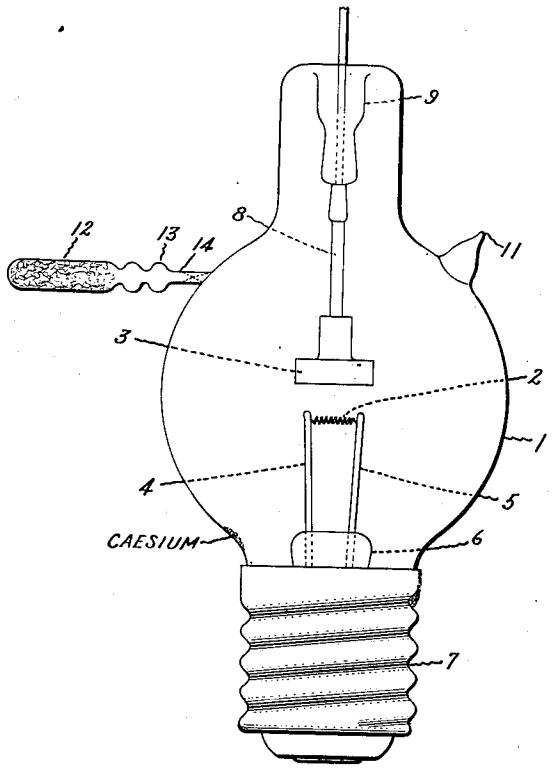
E. E. CHARLTON

ELECTRIC DISCHARGE DEVICE

Original Filed Nov. 29, 1922



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UNITED STATES PATENT OFFICE.

ERNEST E. CHARLTON, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRIC-DISCHARGE DEVICE.

Application filed November 29, 1922, Serial No. 604,088. Renewed September 23, 1927.

The present invention relates to devices containing an ionizable gas, as for example, argon, in which an electric discharge is produced between electrodes one of which preferably operates at incandescence. It is the object of my invention to improve the efficiency and operating characteristics of these devices.

In the manufacture of gas-filled electric discharge devices it has been found desirable to provide a chemical reagent, as for example, metallic calcium or magnesium, which is capable of combining with water vapor, and other deleterious gases, which are unavoidably present as impurities in the gaseous filling or are given off by parts of the device during operation. Whatever may be the action of these chemical additions, their effect is to lower the fall of potential in these devices, thus increasing their efficiency.

I have discovered that the alkali metal cæsium when present in appreciable amounts in thermionic devices containing a gas, not only lowers the voltage drop to a materially lower value than heretofore obtainable with alkaline reagents such as magnesium, but that in addition the current value obtainable with a given voltage is materially increased.

The accompanying drawing shows a rectifier as an example of an incandescent cathode gas-filled device provided with a quantity of alkali metal.

The device illustrated comprises an envelope 1, consisting of suitable refractory glass, a cathode 2 consisting of tungsten, or other suitable highly refractory metal, and an anode 3 consisting of graphite, tungsten, or other suitable conductive material. The cathode is shown as constituted by a heavy, coiled filament connected to leading-in conductors 4, 5, sealed as usual into a stem 6, and contacting with a screw base 7, whereby a heating current may be conveyed to heat the cathode to incandescence. The anode conductor 8 is sealed into a stem 9 at the opposite end of the device. In a thermionic device intended for the rectification of current, such as the device illustrated, the anode is given a sufficiently high heat-radiating capacity to permit of operation continuously at a temperature so low that no appreciable electron emission occurs therefrom.

The container 1 is provided with a filling of argon, neon, hydrogen, helium or other suitable fixed gas at a pressure sufficient to give the discharge the characteristics of an electric arc, say, a pressure varying from several millimeters of mercury to atmospheric pressure. Ordinarily a pressure of about 5 cm. of mercury is preferred. The vapor pressure of the cæsium, or other equivalent alkali metal, constitutes but a tenth or a few tenths of one per cent of the total pressure in the bulb.

The bulb preferably is given a preliminary exhaust by the methods used in exhausting incandescent lamps. Argon or other suitable gas at a pressure of several millimeters to several centimeters then is introduced and a discharge is operated in the bulb to drive gas out of the anode. This preliminary gas filling is pumped out, the desired quantity of alkali metal is introduced, and another gaseous filling at the desired pressure is admitted. The exhaust and gas-admitting connection is indicated as sealed off by fusion at 11.

While the desired quantity of cæsium may be introduced in any convenient way, I prefer to introduce the same from a reaction mixture comprising a reducible compound of the desired metal and a reducing material. For example, cæsium may be supplied from a side tube 12 containing as a preferable source, a mixture of cæsium chloride and an excess of finely divided magnesium. A reaction brought about by heating the tube 12 evolves cæsium. The reduced metal first accumulates in the bulbs 13 and from thence is conveyed by the connecting tube 14 into the main container. Enough alkali metal is introduced to provide an excess over the amount required to combine with water vapor, or other deleterious gases. The tube 12 may remain attached to the main container during the operation of the device, or may be sealed off by fusion, as indicated by dotted lines, within the tube 14. At ordinary operating temperature the pressure of the alkali metal is of the order of magnitude of a micron.

In some cases, the reaction mixture may be applied to a convenient interior part of the device, as for example, to some part of the cathode or anode, thus dispensing with a side chamber. The alkali metal then is evolved by the reaction resulting when heat is applied.

These methods of introducing a desired

alkali metal into an electrical discharge device are described and claimed by me in a co-pending application Serial No. 608,311 filed December 21, 1922.

Whereas magnesium as the active reagent in gas-filled thermionic devices requires operation of the device for several hours in order to secure the full benefit due to the removal of deleterious gases, I find that the benefits due to the addition of cæsium are obtainable at once without ageing. For example, in a rectifier containing a 20 mil tungsten filament as the heated part of the cathode, an anode of graphite and a filling of argon at a pressure of about 5 cm. of mercury, a direct current output of about five amperes is obtained with a voltage drop of about 8.3 volts, this value being materially below the ionization voltage of argon which is about 15 volts. The addition of cæsium in this device increases the direct current output under the same conditions to 7.5 amperes and decreases the voltage drop to 5.7 volts, no ageing being required.

Rubidium may be used in place of cæsium, hence whenever in the appended claims I have specified cæsium, I wish also to include rubidium as an equivalent.

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

1. An electric discharge device comprising a container, a refractory cathode, an anode, a gaseous filling therein at a substantial pressure sufficiently high to permit operation of a thermionic discharge with a voltage between said electrodes below the ionization voltage of said gas and a sufficient quantity of alkali metal having an atomic weight greater than that of potassium in said container to reduce the operation voltage to a value lower than the value characteristic of the gaseous filling under the given conditions.

2. An electric rectifier comprising a container, a thermionic cathode, an anode adapted to operate at a substantially lower temperature than said cathode, a gas filling at a pressure of the order of magnitude of several centimeters of mercury, and a quantity of alkali metal having an atomic weight greater than that of potassium in said container, said device being constructed to operate at a temperature at which cæsium has a vapor pressure of the order of about one micron of mercury.

3. An electric rectifier comprising a container, a thermionic cathode, an anode of solid conducting material, an atmosphere of argon of about five cm. of mercury pressure and a quantity of cæsium sufficient to increase the current-carrying capacity and cause the voltage drop in said rectifier, to be about five volts with a thermonic current of about seven amperes.

In witness whereof, I have hereunto set my hand this 27th day of November, 1922.

ERNEST E. CHARLTON.