Feb. 6, 1934. W. G. MORAN 1,945,749

VAPOR ELECTRIC DEVICE

Filed July 26, 1930

Fig. 1.

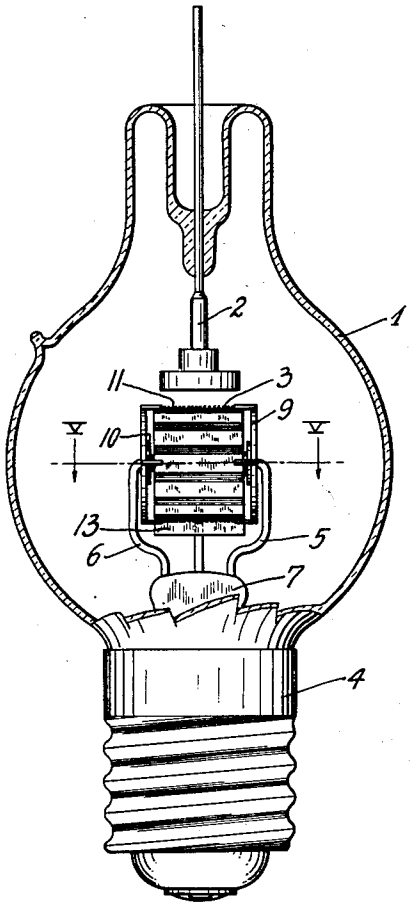


Fig. 2.

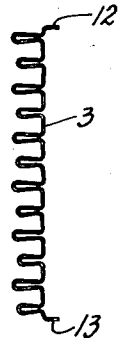


Fig. 3.

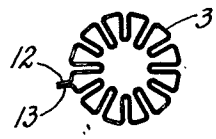
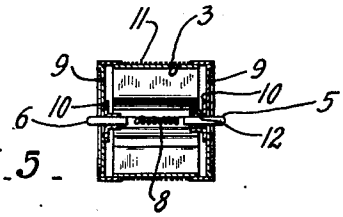


Fig. 4.



Fig. 5.



INVENTOR
W. G. MORAN
BY
ATTORNEY

Patented Feb. 6, 1934 1,945,749

UNITED STATES PATENT OFFICE

1,945,749

VAPOR ELECTRIC DEVICE

William Gregor Moran, Bloomfield, N. J., assignor to Westinghouse Lamp Company, a corporation of Pennsylvania

Application July 26, 1930. Serial No. 470,786

3 Claims. (Cl. 250—27.5)

This invention relates to electric discharge devices and more particularly to electric discharge devices of the vapor electric rectifier type, employing a thermionically active hot cathode, a relatively cold anode, and an electrically conductive gaseous atmosphere.

Heretofore two types of rectifying devices have been devised. Those suitable for the rectification of relatively high voltages and those suitable for the rectification of relatively low voltages. The essential differences in the two types of devices is in the kind of and the pressure of the gaseous atmosphere employed therein. Structural features may also be varied.

In vapor electric devices of the low voltage type wherein relatively high current output was desired it has been customary to augment the thermionic current of the hot cathode by employing relatively high gas pressures, the gas molecules of which by thermionic electron bombardment are in part dissociated into positive and negative electrons. The particular gas pressure and type of gas employed depends upon the contemplated use of the device.

Due to the positive ion bombardment of the filament such an expedient limits the type of cathode permissible in such a device. Due also to the presence of the gas molecules in the device there is a voltage limitation imposed beyond which arc-back effects are obtained. The amount of gaseous ionization obtained depends upon the gas and gas pressure and by varying the gas pressures the arc-back voltage limitation of the device may be varied materially. In a relatively high vacuum high voltage rectification may be obtained.

The disadvantage of high vacuum devices is, however, that substantially all the rectified current must be drawn from the cathode, and that the thermionic emission of the cathode limits the amount of current that may be drawn therefrom.

In the rectification of relatively low voltages it is highly desirable to rectify currents of 5 to 10 amperes. In the rectification of relatively high voltages it is desirable to rectify currents that are measured in milliamperes rather than amperes.

It is desirable to provide a gaseous conduction rectifier device capable of rectifying relatively high currents at relatively high voltages, and it is one of the objects of this invention to provide such a device.

Another object of the present invention is to improve the operating efficiency of vapor electric devices.

Another object of this invention is to provide a vapor electric rectifier device incorporating an indirectly heated cathode.

Another object of this invention is to provide a vapor electric device having a relatively high arc-back potential.

These and other objects and advantages will become apparent as the invention is more fully disclosed.

Heretofore in the art in order to provide a vapor electric device capable of rectifying relatively high currents at relatively high voltages, it has been customary to adjust the gas content and gas pressures with respect to the desired electric potential, so that the arc back characteristics of the device are greater than the voltage to be applied. With increased voltage, in order to maintain the same current output at the necessary decreased gas pressures, the thermionic current of the cathode must be proportionally increased.

In order to increase the thermionic activity of cathodes of the directly heated type the cathode has been comprised of relatively wide strips of electrically conductive material surfaced with thermionically active material such as alkaline earth metal oxides. In order to obtain a concentration of the cathode within a relatively small space, the strip cathode has been folded back and forth in zigzag shape, such as heretofore employed in the forming of the V, W and M type filaments in electric discharge devices, lamps, etc. This type of filament is known in the art as a "crimped cathode." Other types of directly heated cathodes have been employed.

In accordance with the objects of my invention I have devised a cathode of the indirectly heated type embodying the crimped cathode feature of the prior art directly heated cathode. The "crimped" type oxide coated cathode of the prior art device is bent in the shape of a cylinder, and heated to the temperature of active electron emission by means of a heater element centrally positioned therein. This cathode in incorporated in a vapor electric device employing mercury vapor with or without the addition of a proportion of a rare gas as a gaseous conducting atmosphere. The resulting vapor electric device operates with relatively high operating efficiency and is capable of rectifying relatively large electric currents at voltages up to approximately 1000 volts D. C. without deleterious arc-back effects, all as will be more fully disclosed.

Before further disclosing the nature of my in-

vention reference is to be made to the accompanying drawing wherein

Fig. 1 is a side elevational view partly in cross section with the enclosing envelope of a vapor electric rectifier device of the type known in the art as a rectigon;

Fig. 2 is an end view of the cathode sleeve member prior to assembly;

Fig. 3 is an end view of the formed cathode sleeve member prior to mounting;

Fig. 4 is a side elevational view of the cathode sleeve member shown in Fig. 3; and

Fig. 5 is a cross sectional view of the assembled cathode taken along plane V—V Fig. 1.

Referring to Fig. 1 the vapor electric device enclosed therein is substantially what is known in the art as a rectigon, a low voltage rectifier. A rectigon device commonly comprises an enclosing glass envelope 1, an anode 2 sealed in one end of said envelope and a directly heated thermionically active hot cathode sealed in the opposite end of said envelope.

It is customary to provide the cathode end of the device with the base element 4 which is of the common screw socket type. Leading in conductors 5 and 6 extending through press 7 electrically connect the cathode to the base element 4. In such a device it is customary to employ an inert rare gas, such as argon, neon etc. or combinations of these materials as the electrically conductive gaseous atmosphere.

In Fig. 1 I have shown a cathode 3 constructed in accordance with the present invention rather than the directly heated cathode of the prior art devices.

The indirectly heated cathode 3 of the present invention, as more fully disclosed in cross section in Fig. 5 is comprised substantially on an enclosing metal sleeve member 3 of relatively large surface area, an interiorly disposed heater element 8 of relatively low electrical resistivity and end closure members 9 for the cylindrical sleeve member 3 having means 10 associated therewith for centrally positioning and supporting the cathode heater element 8. An insulating bushing 12 is supplied at one end so as to prevent short circuiting of the electric current energizing the heater element 8 to the cathode sleeve member 3.

In order to prevent deleterious electrical discharges between the ends of the heater element 8 the voltage drop across the heater element must be relatived low. For best results the voltage drop must be less than approximately 5.0 volts.

The exterior surface of the cathode sleeve member 3 is preferably coated with thermionically active material 11, known in the art as alkaline earth metal compounds. The cathode sleeve member 3 as is indicated is of the type known in the art as a crimped cathode and comprises essentially a strip of electrical conductive material preferably nickel, nickel alloy, platinum or similar type material heretofore employed, which is bent or waved into a shape such as is shown in Fig. 2.

The ends 12 and 13 of the cathode are then brought together in the manner as shown in Fig. 3. It is apparent that the number of waves or loops or sections and the depth and diameter and configuration of the same is dependent upon the use and application that is to be desired. It is generally preferable to keep the exterior heat radiating surface of the cathode relatively low.

It is also obvious that the sleeve member may be comprised equally as well of metal gauze or of metal mesh strips, if desired, rather than the solid metal strip as shown in the drawing. The fundamental idea being to supply a cathode sleeve member having a relatively large thermionically active surface area as compared to those of the cylindrical type heretofore employed.

As shown in Figs. 3 and 5, the crimped cathode sleeve member 3 is in the form of a hollow crimped shell with its outer surface in the form of depressions and ridges. The ridges are of substantial width and length with the width thereof being greater than the distance between adjacent ridges. The depth of each depression is about four times the width thereof. This construction finds especial application in my device where space charge is not a major consideration because of positive ionization in said device during operation. The heating of those portions of the cathode that form the depressions is readily accomplished because they are relatively close to the heater 8. Moreover, because of the relationship between the width and depth of these depressions, the amount of heat radiated from those portions describing the depressions is also relatively low.

The crimped cathode of the type shown in Fig. 2 subsequent to forming is thoroughly cleansed of surface oxides, greases and other deleterious material by suitable means such as baking or heating same in vacuum or in the presence of hydrogen or mixture of hydrogen with other gases to effect the removal of the impurities. The clean dry cathode is then coated on the exterior surface with the desired thermionically active material. If desired the thermionic efficiency of the cathode may be still further increased by applying the thermionically active material to both inner and outer surfaces of the cathode sleeve member.

The ends 12 and 13 are then electrically connected as by crimping, spot welding and the like, the cathode heater element positioned therein and supported by end closure members in the manner indicated in Fig. 5, one end of the filament being electrically connected to the cathode sleeve member in the customary manner. The assembled cathode is then mounted upon leading in support wires 5 and 6 Fig. 1.

The rectigon device shown in Fig. 1 employing a 2.5 volt, 20.0 ampere cathode will rectify currents up to approximately 6.0 amperes at voltages below approximately 110 volts D. C. Such a device employs argon at 1.0 to 3.0 centimeters mercury pressure.

The device incorporating the indirectly heated cathode of the present invention is designed to give approximately the same current output at voltages up to approximately 1000 volts D. C. For that purpose the gaseous atmosphere comprises mercury vapor approximating less than .5 m. m. pressure. For intermediate voltages I may employ in addition to the mercury a proportion of a monatomic rare gas such as argon, neon, etc. I have found, however, that mercury vapor alone is ordinarily sufficient where the desired current output does not exceed from 5 to 10 amperes.

It is also apparent that the cathode heater element and the cathode sleeve member must be in proper relationship to each other, so that the maximum current input to current output efficiency may be obtained.

In the present illustration the heater element is designed to carry a 2.5 volt 10 ampere current and the sleeve member is designed to give ap-

proximately 50 square centimeters of thermionically active surface. The spacing of heater element to sleeve member is adjusted so as to prevent overheating of the sleeve member at any one point. Such a device, illustrated in Fig. 1, will rectify currents up to 5 amperes at D. C. voltages ranging up to about 1000 volts without deleterious arc-back effects. The output current of this device is comparable to the output current of prior art devices.

Having broadly and specifically set forth the nature and scope of the present invention it is apparent that there may be many modifications and departures made in the specific embodiment herein disclosed without departing essentially from the nature and scope of the invention as may be set forth in the accompanying claims.

What is claimed is:

1. A vapor electric device comprising an enclosing envelope, an electrically conducting atmosphere, an anode and a thermionically active hot cathode, said cathode comprising a crimped cylindrical metal sleeve member having a plurality of depressions and ridges and surfaced at least exteriorly with thermionically active material and an interiorly disposed heater element, the width of said depressions being less than the depth thereof, end closure members for said sleeve member and means in said end closure members to centrally align and position said heater element, and said electrically conducting atmosphere comprising mercury at pressures approximating less than .5 millimeters.

2. A cathode comprising a crimped hollow shell having its exterior surface adapted to emit electrons upon being heated, said shell having a plurality of spaced depressions extending along selected areas thereof, the width of said depressions being no greater than the depth thereof.

3. A cathode comprising a crimped hollow shell having its exterior surface adapted to emit electrons upon being heated, a heater element in said shell, said shell having its outer surface in the form of depressions and ridges, the depth of said depressions being at least as great as the space between adjacent ridges.

WILLIAM GREGOR MORAN.