Nov. 24, 1925. 1,562,959

E. L. HARRINGTON

ELECTRIC ARC DEVICE

Filed March 22, 1921

FIG. 1.

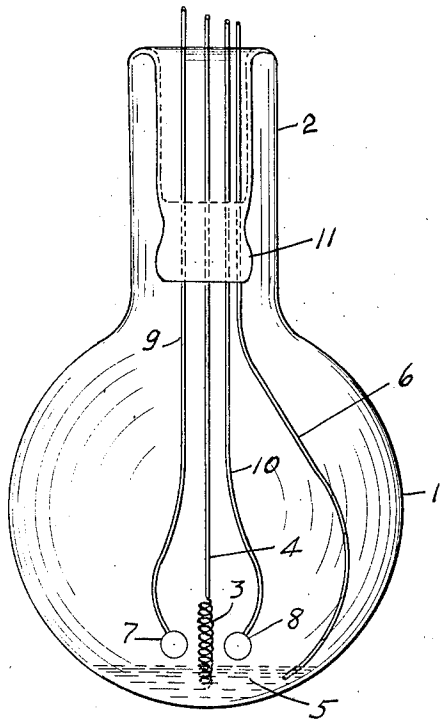


FIG. 2.

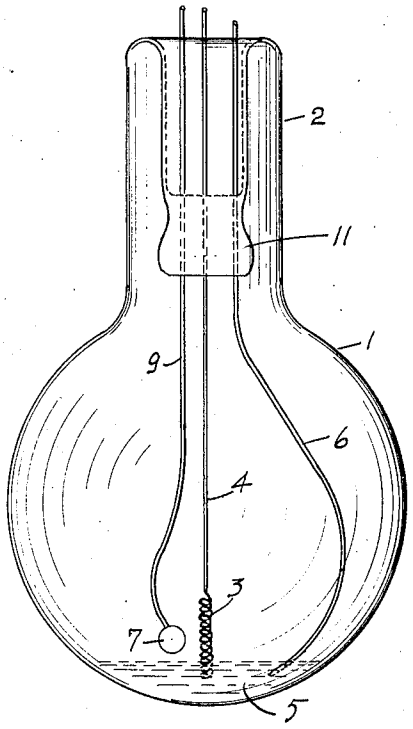
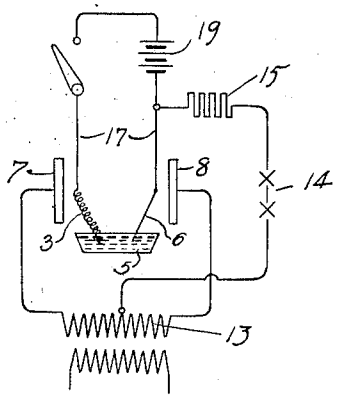


FIG. 3.



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UNITED STATES PATENT OFFICE.

ERTLE LESLIE HARRINGTON, OF SASKATOON, SASKATCHEWAN, CANADA, ASSIGNOR TO WESTINGHOUSE LAMP COMPANY, A CORPORATION OF PENNSYLVANIA.

ELECTRIC-ARC DEVICE.

Application filed March 22, 1921. Serial No. 454,387.

To all whom it may concern:

Be it known that I, ERTLE LESLIE HARRINGTON, a citizen of the United States, and a resident of Saskatoon, Saskatchewan, Canada, have invented a new and useful Improvement in Electric-Arc Devices, of which the following is a specification.

My invention relates to devices for rectifying alternating currents and more especially to the type of rectifier employing enclosed arcs.

An object of this invention is the provision of a rectifier which will have a long operating life.

Another object is the provision of a rectifier which may be started at normal voltage and requires simple auxiliary apparatus for maintaining its operation.

My invention is embodied in a device containing a cathode of highly refractory material, such, for example, as tungsten, which serves when incandescent as the starting cathode, a cathode of a vaporizable material such as mercury which serves as the operating cathode, and anodes having a heat dissipating capacity sufficient to enable them to operate at a temperature below that at which electron emission is appreciable, this device being filled with an inert gas at an appreciable pressure, preferably of the order of magnitude of atmospheric pressure.

Prior devices which employ some of the principles of the present invention have a number of disadvantages such as the necessity for a complicated starting equipment, non-automatic starting and a cathode which is electrically disintegrated by the action of the arc during the operation of the device.

The device embodying my invention provides means whereby an arc may be readily started between electrodes, one of which, the cathode, is adapted to be independently heated by passage of current analogous to a lighting filament, but this arrangement possesses a limitation in the fact that electrical disintegration causes the filament to wear away locally and break if the filament is used as a cathode throughout the life of the device. However, my device provides for the transfer of the arc soon after starting, from the corrodible to a non-corrodible cathode. The present invention thereby provides a device having a very long life.

My invention is more fully set forth in the following description taken in connection with the accompanying drawings, of which Fig. 1 illustrates a device embodying my invention containing an inert gas and capable of full-wave rectification; Fig. 2 illustrates a form of my invention adapted for half-wave rectification and Fig. 3 is a diagram of suitable electrical connections for the full wave rectifier shown in Fig. 1.

Referring to the drawings and more particularly to the construction as shown in Fig. 1, the full wave rectifier comprises a sealed envelope 1 which preferably consists of glass and has a tubular neck 2 provided for facilitating the sealing in of the leading in conductors 4, 6, 9 and 10 into the press of the stem 11.

A starting cathode comprises a filament 3 of tungsten or other refractory material, shown in the form of a coil, one end of which is connected to a conductor 4, the other end contacting with a pool of mercury 5, which constitutes the operating cathode. The starting cathode 3 is adapted to be heated to incandescence from any convenient source of current, for example, a battery as indicated at 19 Fig. 3.

The lower end of a conductor 6 is immersed in the mercury and constitutes a lead-in wire for both the starting cathode 3 and the operating cathode 5.

A pair of electrodes 7 and 8 are located within the envelope 1 and serve as anodes in the operation of the device. These electrodes are conveniently supported on the lower end of the dependent conductors 9 and 10.

The construction shown in Fig. 2 is substantially identical with the construction shown in Fig. 1 except that an anode 8 is omitted, thus adapting it for half wave rectification.

The envelope 1 is exhausted of gases and water vapor. Gases occluded in the materials of the device are largely eliminated by heating the latter to a temperature higher than the temperature to which they will be subjected in practical use and evacuating the evolved gases and vapors. One method of doing this is to operate the device while it is on the exhaust pump and bofore sealing the envelope.

After the tube has been freed from deleterious gases and vapors, an inert gas, such as argon, neon or nitrogen, is admitted into the bulb at a considerable pressure. Argon

gas of substantially one hundred per cent purity is preferred and I have been accustomed to use a pressure of nine tenths of an atmosphere, but my device is practical using a wide range of pressures.

As shown in Fig. 3, the anodes 7, 8 may be connected to the terminals of a source of alternating current, such as the secondary of a transformer 13, the operating cathode 5 and a terminal of the starting cathode 3 being connected to an intermediate point of potential in series with a load 14, and a series resistance 15.

In starting the device the necessary connections are made by which the starting cathode 3 is heated to incandescence and an arc started between the electrodes 7, 8 and cathode 3. Rectification of the alternating current takes place by reason of the fact that an arc exists between a hot body such as the incandescent cathode 3 and a comparatively cool one as anode 7, which allows the alternating potential to send a current from the cool body to the hot body but not in the reverse direction.

Heat from the incandescent cathode 3 and from the arcs between electrodes as well as the heat generated by the passage of current through the mercury, vaporizes part of the mercury. Conditions are then existent which cause arcs to originate between anodes 7, 8 and the mercury cathode 5. Theoretically, it may be that the electron emission from the filament breaks down the negative electrode reluctance around the mercury and thus makes it possible for the arc to start. The heating current of the cathode 3 is then cut off by opening circuit 17, whereby the arcs are totally transferred to the operating cathode 5. In the half wave modification as illustrated in Fig. 2, it is necessary, during the operation of the rectifier, to maintain the cathode 3 at incandescence electrically. The current in both forms of the device is carried between the anode 7 or the anodes 7, 8 and the mercury cathode 5 partly by mercury vapor and partly by argon. Although the current is carried largely by mercury vapor the presence of the argon as another conducting medium aids in stabilizing the arc at low current values.

It is to be understood that, while I have herein described and illustrated an embodiment of my invention illustrating specifically the principles thereof, the invention is not to be limited to the details herein shown or described: that many modifications therein will readily suggest themselves without departing from the spirit thereof, and that I desire to be limited only by the scope of the appended claims.

What is claimed is:

1. An electric arc device comprising a sealed envelope containing a gas inert with respect to the operating elements of the device and of such pressure as to stabilize the arc, an anode, an incandescible starting cathode, a vaporizable operating cathode, a stem for said device and an independent electrical connection for each of said electrodes sealed through said stem in a single press, the circuit to said incandescible cathode being completed through and dependent upon the vaporizable cathode.

2. A rectifier comprising a sealed envelope, a gaseous atmosphere within said envelope at such pressure as to stabilize the arc at low current values, said envelope also containing an anode having a heat dissipating capacity sufficient to permit it to be operable below the temperature at which appreciable electron emission occurs, a starting element, an operating vaporizable cathode, an electrical connection between the starting element and the vaporizable cathode and a separate conductor for each of said electrodes extending inwardly from a common portion of the envelope.

3. A rectifier comprising a sealed envelope, a gaseous atmosphere within said envelope at such pressure as to stabilize the arc at low current values, said envelope also containing an anode having a heat dissipating capacity sufficient to permit it to be operable below the temperature at which appreciable electron emission occurs, a conducting incandescible starting element, an operating vaporizable cathode and a separate leading-in conductor for each of said electrodes extending downwardly from a common portion of the envelope.

4. A rectifier comprising a sealed envelope containing a gas inert with respect to the operating elements, and at such a pressure as to cause stabilization of the arc, an anode having a heat dissipating capacity sufficient to permit it to be operable below the temperature at which appreciable electron emission occurs, a starting element, an operating vaporizable cathode and separate leading-in conductors for each of said electrodes sealed through a common portion of the envelope.

5. A rectifier comprising a sealed envelope containing a gas inert with respect to the operating elements and at such a pressure as to cause stabilization of the arc, an anode having a heat dissipating capacity sufficient to permit it to be operable below the temperature at which appreciable electron emission occurs, a conducting incandescible auxiliary cathode, means for heating said cathode, an operating cathode of vaporizable material, a stem for said device and separate leading-in conductors for each of said electrodes sealed through said stem in a common press.

6. A rectifier comprising a sealed envelope having a neck and body portion and con-

taining a rare gas of the atmosphere at a considerable pressure, an anode having a heat dissipating capacity sufficient to permit it to be operable below the temperature at which appreciable electron emission occurs, an incandescible metallic auxiliary cathode of refractory material, a self-reconstructing cathode of vaporizable material, a stem within said neck portion and separate leading-in wires for each of said electrodes sealed through said stem in a common press.

7. A rectifier comprising a sealed envelope containing a filling of argon at a considerable pressure, an anode having a heat dissipating capacity sufficient to permit it to be operable below the temperature at which appreciable electron emission occurs, an incandescible metallic auxiliary cathode of refractory material, and an operating metallic auxiliary cathode of refractory material, and an operating metallic cathode of vaporizable material, the circuit for said incandescible cathode being completed through and dependent upon the operating cathode.

8. A rectifier comprising a sealed envelope containing a filling of argon at a considerable pressure and containing at the operating temperature of the device the vapor of mercury, an anode having a heat dissipating capacity sufficient to permit it to be operable below the temperature at which appreciable electron emission occurs, an incandescible metallic auxiliary cathode of refractory material, and an operating cathode of mercury, the auxiliary cathode dipping into the mercury cathode and having its circuit completed through and dependent upon said mercury cathode and conductors for each of said electrodes extending into the envelope from above the surface of said mercury cathode.

9. A rectifier comprising a sealed envelope, a filling of argon therein and containing at the operating temperature of the device the vapor of mercury, said envelope also containing an anode having a heat dissipating capacity sufficient to permit it to be operable below the temperature at which appreciable electron emission occurs, a starting cathode of tungsten, and an operating cathode of mercury, said tungsten cathode contacting with the mercury cathode and having its circuit completed through and dependent upon the mercury of said cathode.

10. A rectifier comprising a sealed envelope, a stem therefor, a plurality of conducting elements extending through said stem, an anode supported by one of said elements, an incandescible starting cathode supported by another of said elements and a pool of vaporizable material in contact with another of said elements and with said incandescible cathode.

11. A rectifier comprising a sealed envelope, a plurality of conductors extending through one portion thereof, a plurality of anodes secured to certain of said conductors, an incandescible cathode secured to another of said conductors and positioned between said anodes, a pool of a conducting vaporizable material within said envelope and in contact with another of said conductors and said incandescible cathode.

12. A rectifier comprising an envelope having a body portion and a single neck portion, a stem having a press within said neck portion, a pair of anodes and a pair of cathodes in said body portion and a leading-in conductor for each of said electrodes sealed through the stem in a single press.

13. A rectifier comprising an envelope having a stem, said envelope containing a pair of anodes, an incandescible cathode, and a vaporizable cathode, a current conductor being provided for each of said electrodes sealed through said stem in a single press.

14. A mercury vapor rectifier comprising an envelope containing a pair of anodes, a mercury cathode, and an incandescible starting cathode dipping into said mercury cathode and having its circuit completed thereby and a plurality of leading-in conductors extending into said envelope from a common portion thereof and joined to each of said electrodes.

15. A mercury rectifier comprising an envelope containing a filling of argon gas, an anode and a plurality of cathodes, one of said cathodes consisting of a mercury pool and another of an incandescible element dipping into said pool and a leading-in conductor for each of said electrodes extending into the envelope from a common part thereof above said mercury pool, one of said conductors extending into the mercury pool and another being joined to the free end of said incandescible element.

In testimony whereof, I have hereunto subscribed my name this seventeenth day of February 1921.

ERTLE LESLIE HARRINGTON.