

C. V. FERGUSON.
 INCANDESCENT CATHODE ARC DEVICE.
 APPLICATION FILED SEPT. 20, 1915.

1,267,199.

Patented May 21, 1918.

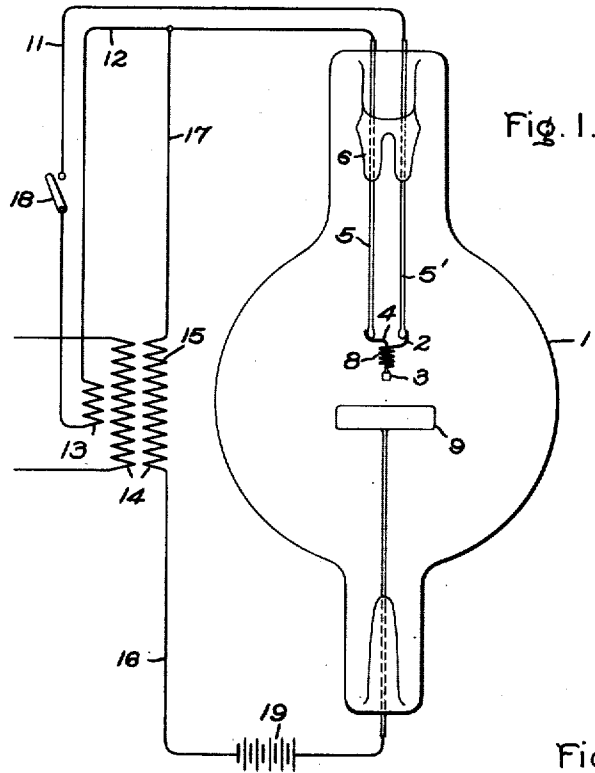


Fig. 1.

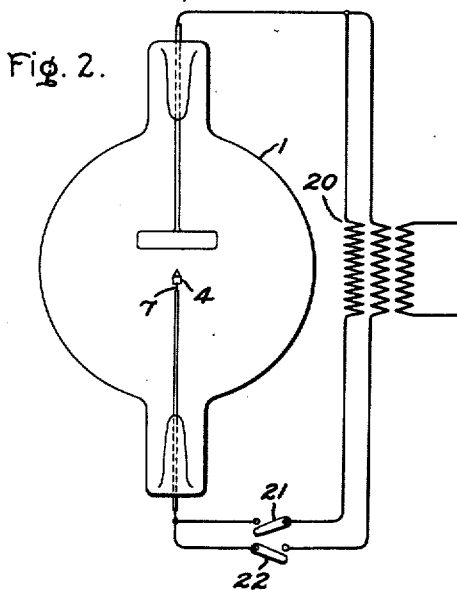


Fig. 2.

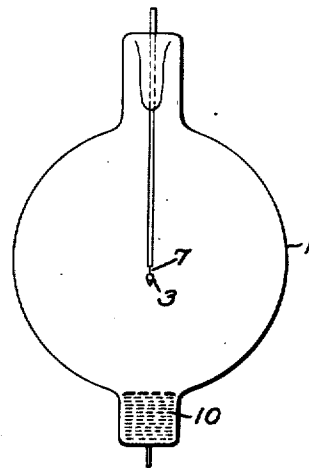


Fig. 3.

Inventor:
 Charles V. Ferguson,
 by *Alfred H. Davis*
 His Attorney.

UNITED STATES PATENT OFFICE.

CHARLES V. FERGUSON, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

INCANDESCENT-CATHODE ARC DEVICE.

1,267,199.

Specification of Letters Patent.

Patented May 21, 1918.

Application filed September 20, 1915. Serial No. 51,661.

To all whom it may concern:

Be it known that I, CHARLES V. FERGUSON, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Incandescent-Cathode Arc Devices, of which the following is a specification.

The present invention relates to electrical discharge devices of the incandescent cathode type having a gaseous filling, and its object is to provide a simple, rugged device having a commercially long life.

My invention is particularly applicable to devices having an asymmetrical conductivity, such, for example, as rectifiers for alternating current.

When an arc is operated in an inert atmosphere of gases or vapors from a cathode adapted to be independently heated by passage of current analogous to a lighting filament the starting of the arc can be conveniently accomplished, but this arrangement possesses a limitation in the fact that electrical disintegration may cause the filament to wear away locally and break.

In accordance with one embodiment of my invention, I have provided a discharge device having a cathode comprising a rugged electrode, adapted to be heated only by passage of current through the gas, such, for example, as a rod having a tip which is proportioned to operate at incandescence, together with means for initially starting an arc between the electrodes of the device whereby the cathode will be heated to incandescence. The incandescent tip may be made large enough to make electrical erosion negligible. My invention also includes the specific arrangement of cathode and starting filament, the latter being electrically connected to the cathode and in close thermal relation thereto while being located at a greater distance from the anode than the arcing tip of the cathode so as to avoid having the arc emanate from the filament instead of from the arcing tip of the cathode.

In the accompanying drawings, Figure 1 illustrates diagrammatically a discharge device suitable for rectifying alternating current and provided with a starting filament; Fig. 2 illustrates a modification in which the starting filament is omitted and the arc is started by means of a high voltage discharge from the cathode which preferably

is pointed; and Fig. 3 illustrates a device having a mercury anode.

Referring to Fig. 1 the discharge device consists of a sealed envelop 1 which consists of glass, quartz or the like, and the cathode 2 and anode 9, both of these electrodes being sealed into the container in the usual manner and consisting of highly refractory substances such, for example, as tungsten, tantalum, carbon and the like. The cathode 2 consists of several parts, namely, an arcing tip 3, connected to a stem 4 having a diameter small enough to afford enough resistance to the conduction of heat to enable the arcing tip 3 to operate at incandescence. The stem 4 is connected to a current-conveying conductor 5 sealed into a stem 6. The arcing tip should be so arranged and supported that the heat lost by conduction through the supporting stem consists of such a small fraction of the total heat developed by the cathode that the arcing tip is maintained at a uniformly high temperature by a comparatively small amount of energy. Consequently with a given current the total voltage across the arc is lower than it would be if no section of reduced diameter were provided. This result can be conveniently obtained by reducing the diameter of a small section 7 of the supporting stem adjoining the arcing tip as shown in Figs. 2 and 3. In some cases the cathode has a pointed or sharpened tip, as shown in Figs. 2 and 3 to facilitate starting and secure greater stability of the arc.

Near the arcing tip of the cathode is provided the starting filament 8 consisting of refractory material such as tungsten, tantalum or carbon spirally spaced about the cathode stem and connected to the cathode stem 4 at one end near the tip 3 as indicated, the end remote from the arcing tip of the cathode being attached to a separate lead 5' sealed into the stem 6 of the device in the usual manner. By this construction the starting filament is located a greater distance from the anode 9 than the arcing tip of the cathode in order to guard against the arc deserting the tip 3 and running to the starting filament either entirely or in part.

The anode 9 may have any convenient shape and may consist of refractory material such as tungsten or carbon or volatilizable material, such as mercury, as shown at 10 in Fig. 3. In a rectifier the anode should

have a materially greater heat dissipating capacity than the cathode to enable it to remain below a temperature of about 700° C. at the normal operating current of the device.

In the preparation of the device the space within the envelop should be carefully exhausted of all gases and vapors, care being taken to remove electro-negative gases, such as oxygen or chlorine, or substances yielding electro-negative gases, for example, water vapor. A trace of oxygen does little harm when the electrodes consist of oxidizable metal, such as tungsten or molybdenum as the oxygen combines chemically with the heated electrodes to form non-volatile oxides. The envelop is filled with a gas inert to the electrodes, as, for example, argon, nitrogen, krypton, neon, hydrogen, at a pressure which may be between several millimeters and atmospheric pressure or more. These gases should be substantially free from electro-negative gaseous impurities. For low voltage rectifiers a gaseous pressure of 5 to 12 millimeters of mercury is desirable but no definite limit of gas pressure can be given as it will in general vary with the voltage upon which the device is operated and the character of the service required of the device. In some cases the gaseous filling may be constituted by the vapor of a material ordinarily a liquid, for example, mercury. The envelop should be properly proportioned with respect to the energy consumed during the operation of the device to dissipate heat at a rate which will result in an operating temperature at which the vaporizable material has the desired vapor pressure.

The arc is started by heating the filament 8 to incandescence by suitable current introduced through the leads 5, 5' by the conductors 11, 12, from any convenient source, such, for example, as the secondary 13 of a transformer 14. When the filament has been heated to incandescence, a current of suitable voltage is impressed between cathode and anode. As shown in the drawing the device may be used to rectify alternating current supplied from the transformer secondary winding 15 through conductors 16, 17. The arc initially runs from the incandescent filament 8 to the anode and serves to heat the starting tip 3 to incandescence both by heat conduction from the filament which is connected to the tip and by reason of the proximity of the tip of the arc as well as the heated filament. The circuit of the starting filament may then be opened by a switch 18. The arc will continue to operate from the incandescent tip 3 to the anode, only half waves of current being conducted by the device illustrated. The rectified current may be used for any desired purpose, such, for example, as charging the storage battery 19.

As the arcing tip 3 has a relatively greater

mass than the filament electrical erosion or disintegration will have but very little deleterious effect. The filament 8 is used only for a very short time when the device is started, hence the electrical disintegration of the filament is negligible. For these reasons the device will have a commercially long life.

In some cases, as shown in Fig. 2, the starting filament may be entirely dispensed with when the device is to be used only for relatively high voltages. In that case the arcing tip 3 is made sharp or pointed to such an extent that the arc will be certain to start from the point of the electrode as cathode when a relatively high voltage is applied to the terminals of the device, for example, as by means of an auxiliary transformer winding 20. After the main cathode has been heated to incandescence the switch 21 may be again opened and the switch 22 closed. I have found that by thus using a pointed electrode an arc may be started at a potential of about 60% as great as the voltage required to start with a large surface as cathode. In other respects the device shown in Fig. 2 is the same as that already described in connection with Fig. 1.

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

1. A refractory cathode for an electric arc device comprising a supporting stem, an arcing tip therefor of greater diameter than said stem, and a refractory conductor connected to said stem near said arcing tip and extending away from said tip.

2. A rectifier comprising a sealed container, a filling of inert gas therein, a cathode, the tip of said cathode being proportioned to operate at incandescence and having electrical connections at one terminal only, a cooperating anode and means constituting part of said cathode for assisting the starting of an arc in said device whereby the tip of said cathode will be heated to incandescence.

3. An electrical arc device comprising a sealed container, a filling of gas therein having at the operating temperature of the device a vapor pressure materially in excess of several millimeters of mercury, a cathode comprising a rod-shaped conductor of refractory metal, comprising a stem and a tip of greater diameter to permit electrical erosion without deleterious effect, a cooperating anode having a materially greater heat-dissipating capacity than the cathode, and means constituting part of said cathode for assisting the starting of an arc in said device.

4. A rectifier comprising a sealed container, a filling of inert gas therein, a refractory sharp-pointed cathode proportioned to operate at incandescence, comprising a supporting stem and an arcing tip of greater

mass than said stem to permit electrical erosion without deleterious effect, and a co-operating anode of larger mass than the cathode, said electrodes being proportioned
5 to enable an arc to start from cathode to anode at a materially lower voltage than in a reverse direction.

5. An electrical arc device comprising a sealed container, a filling of gas therein, a
10 cathode, the tip of which is proportioned to operate at incandescence and having an electrical connection at one end only, an anode, a refractory conductor electrically connected
15 at one end to the cathode near the arcing tip and extending away from the anode, and connections for conducting current to said electrode.

6. An electrical arc device comprising a sealed container, a filling of inert gas therein at a pressure exceeding several millimeters
20 of mercury, a cathode, the tip of which is proportioned to operate at incandescence and is electrically connected at one end only, an anode, a refractory auxiliary electrode electrically connected at one end to the cathode
25 near the arcing tip, extending away from the anode, and spirally spaced about the cathode, and electrical connections for conducting current through said auxiliary electrode.

In witness whereof, I have hereunto set
30 my hand this 17th day of September, 1915.

CHARLES V. FERGUSON.