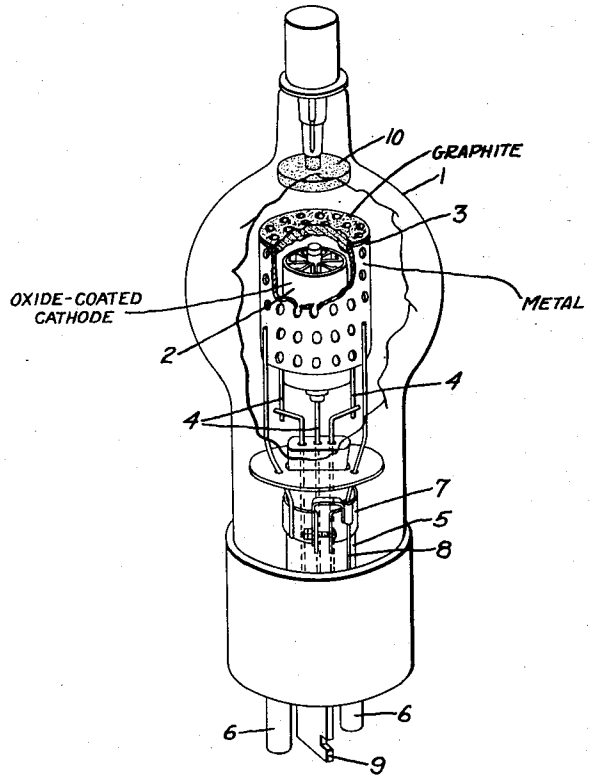
Dec. 18, 1934. A. GLASER ET AL 1,985,087

ARC DISCHARGE APPARATUS

Filed Nov. 4, 1932



Inventors:
August Glaser,
Werner Koch,
by Charles E. Mueller
Their Attorney.

Patented Dec. 18, 1934 1,985,087

UNITED STATES PATENT OFFICE

1,985,087

ARC DISCHARGE APPARATUS

August Glaser, Berlin-Frohnau, and Werner Koch, Berlin-Hermsdorf, Germany, assignors to General Electric Company, a corporation of New York

Application November 4, 1932, Serial No. 641,264
In Germany November 9, 1931

2 Claims. (Cl. 250—27.5)

The present invention relates to arc discharge apparatus and more particularly to devices of this sort which employ an electrostatic control member and an oxide-coated cathode.

In arc discharge devices which employ grids, there is a normal tendency for the control factor to vary. These variations have been found to reside for the most part in the grid itself and appear to have their inception at the surface of the control member. In a device containing gas or vapor, and an oxide-coated cathode, directly or indirectly heated, the oxide tends to sputter or evaporate from the cathode. If the grid is made of a metal, such as nickel, which readily combines with the oxide, the active material from the cathode is deposited on the grid and emits electrons.

An object of our invention is to improve the operating characteristics of grid controlled arc discharge devices and in particular, to improve the control member of these devices which contain oxide-coated cathodes. Briefly stated, and in accordance with our invention, we propose to substitute solid graphite for the ordinary nickel grids. The invention will be better understood when reference is made to the drawing which shows an elevational view, in perspective and partly broken away, of a tube embodying our invention. The figure shows a conventional form of tube, apart from the improved grid, which is described by A. W. Hull in articles entitled "Hot Cathode Thyratrons" appearing in the General Electric Review, Vol. 32, 1929, at pages 213 to 223 inclusive, and 390 to 399 inclusive. In the drawing, numeral 1 designates an envelope containing a cathode 2 of the well-known indirectly heated type, surrounded by a perforate grid 3. The grid is open at the bottom and closed at the top except for the discharge openings. The cathode is supported by leading-in conductors 4 sealed in the lower stem 5 and extended through the envelope to the terminals 6. A pair of these conductors serves to carry the load current and the other conductor is connected to the heater within the cathode. The cathode consists of a metal cylinder, preferably nickel, with vanes extending radially inwardly to support the cylinder from the inner core which contains the heater. The exterior of the cylinder, and the spaces between the vanes on the interior of the cylinder are coated in any suitable and well-known manner with electron-emitting material, preferably barium and its oxide. The grid 3 derives its support from a metal clamp 7 which embraces the stem 5. A conductor 8 is connected between the clamp and the middle terminal member 9. The anode 10, which may be fabricated of carbonized metal or solid graphite, takes the form of a circular plate presented flatwise to the grid and is supported from the other end of the envelope. The envelope contains an inert gas, such as helium or argon at a pressure, for example, 500 microns, sufficient to support an arc-like discharge at the operating voltages.

As stated in the articles referred to, devices of this sort are preferably energized by alternating current. The starting of the arc may be controlled by alternating or direct current voltages applied to the grid and since the arc is stopped by the periodic removal of the anode voltage, i. e. at the end of each positive half-cycle, the grid determines the average value of the rectifier current output. In practice, it is desirable that the control exercised by the grid, i. e. the determination in each half-cycle of the anode voltage at which the arc shall start, be uniform throughout the recurring cycles. As stated hereinbefore, considerable variation in this control has been experienced, particularly in those tubes which employ oxide-coated cathodes. The tendency of the control factor to vary under these conditions has been traced to the grid, and it is found that the grid emitted electrons and was taking over temporarily, the function of a cathode. Generally speaking, the higher the operating temperature of the tube and grid, the greater is this emission effect. When the grid member is made of nickel, and an alkaline earth oxide such as barium oxide, is employed as the active coating on the cathode, such oxide particles as leave the cathode become deposited on the grid due to the large affinity that nickel has for the oxide. Other grid metals having less affinity for the oxide material than nickel also form an oxide deposit to a smaller degree. This deposit or layer is most pronounced at the portion of the grid which lies directly in the electron path.

In order to eliminate these variations of control, we propose to use graphite for the control member, the graphite being in the solid form as distinguished from simply a carbon coat or paint. A grid made of this material may be fabricated in any well-known and suitable manner and provided with apertures for the discharge current, similar to the ordinary metal grids. Due to the fact that graphite has little or no affinity for barium oxide, the charged oxide particles do not lodge to any great extent thereon and such few particles as do stick, offer no harmful effects from the electron emission standpoint. The use of

graphite for this purpose presents an advantage over the ordinary metal grids in that it radiates heat to a greater extent on account of the increased "black body" effect and hence, operates at a lower temperature for a given bulb temperature. By lowering the temperature of the grid, the tendency to emit electrons is still further decreased. Graphite in solid form is particularly advantageous over carbon-coated grids in that it not only offers greater "black body" effect as a whole, but also does not scale or peel as would be the case simply of a coating.

Inasmuch as the collection of the oxide particles takes place to a greater extent at that portion of the grid which is exposed directly to the electron stream, i. e. the portion interposed immediately between the cathode and anode, it may be desirable to have only this portion made of graphite and the remaining portion, i. e. the part which surrounds the cathode, constituted of metal in the usual manner. In this case, the advantages of graphite insofar as offering freedom from control disturbances is concerned, are not obtained in the fullest degree but from a practical standpoint, the compromise structure may be all that is necessary for a given tube performance.

While we have described our invention with particular reference to an indirectly heated cathode, it is apparent that the invention is not limited thereto but contemplates the use of all types of oxide-coated members, filaments, etc., indeed, to any form of cathode from which electronically active material is evaporated during operation.

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

1. An electron discharge device comprising an envelope containing an oxide-coated cathode and an anode in opposed relation, a gas in said envelope at a pressure sufficient to support an arc-like discharge at the operating voltages, a metal grid surrounding said cathode and having a portion disposed between the cathode and anode, said grid portion being constituted of graphite.

2. An electron discharge device comprising an envelope containing a cathode and an anode, a gas in said envelope at a pressure sufficient to support an arc-like discharge at the operating voltages, a cylindrical grid of metal surrounding the cathode and having a transverse portion constituted of graphite.

AUGUST GLASER.
WERNER KOCH.