

Sept. 16, 1941.

G. F. BRETT
ELECTRON BEAM TUBE
Filed July 8, 1939

2,256,311

Fig. 1.

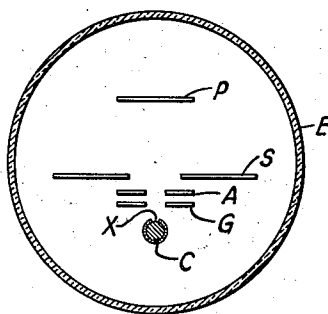


Fig. 2

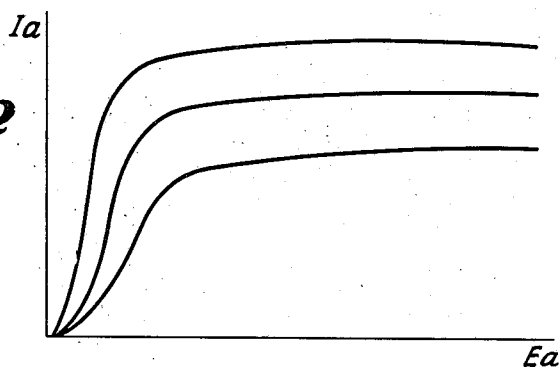
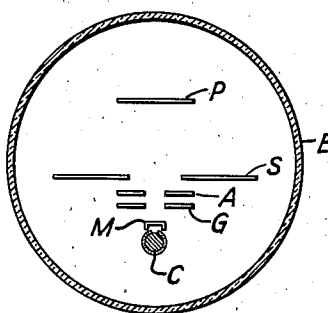


Fig. 3



INVENTOR.
GEORGE FAIRBURN BRETT
BY *Charles McClair*
ATTORNEY.

UNITED STATES PATENT OFFICE

2,256,311

ELECTRON BEAM TUBE

George Fairburn Brett, Chelmsford, England, assignor to Radio Corporation of America, a corporation of Delaware

Application July 8, 1939, Serial No. 283,394
In Great Britain July 29, 1938

3 Claims. (Cl. 250—141)

This invention relates to electron discharge devices and more particularly to electron beam tubes, i. e. to tubes of the kind wherein the discharge partakes more of the nature of a defined jet or beam, usually a ribbon-like beam, rather than a mere stream.

In conventional types of electron discharge tubes of the beam type appreciable variations occur between different tubes and usually it is found difficult to obtain internal impedances exceeding a half a megohm. At times the anode current-anode voltage characteristic is not as flat as desired.

The principal object of the present invention is to provide an improved electron discharge device of the beam tube type having to a close degree of accuracy, a predetermined high internal impedance and a long substantially flat substantially horizontal portion to its collector-electrode current-voltage characteristic.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing in which Figure 1 is a schematic diagram showing a transverse section of an electron discharge device made according to my invention, Figure 2 shows the characteristic curves of a tube made according to my invention, and Figure 3 is a diagrammatic representation of a tube shown in Figure 1.

There are numerous known constructions of electron beam valves. One typical construction is represented schematically in Figure 1 and comprises a rectilinear cathode C, a control grid G in the form of a slotted plate adjacent said cathode, an accelerator anode A in the form of a similar slotted plate adjacent the control grid, a screen-suppressor electrode S in the form of a further slotted plate (larger than the other plates and with a wider slot) adjacent the accelerator anode, and a final anode or collector electrode P in the form of a plate which is at a substantial distance from the screen-suppressor. The direction of length of the slots is the same as the direction of length of the rectilinear cathode, the slots being aligned with one another and with the cathode and the collector electrode so that in use a ribbon like jet of electrons is projected through the slots towards the collector electrode. All of the electrodes are enclosed within evacuated envelope E.

Referring to Figure 2 one of the features of an electron beam valve, such as the known electron

beam valve just described, is that its collector electrode current I_a (ordinates)—collector electrode voltage E_a (abscissae) curve exhibits a long substantially flat horizontal portion corresponding to a high impedance. In Figure 2 three such curves are shown for three different values of grid voltage (with relation to cathode voltage) the top curve being for zero grid voltage and the lower curves for increasing values of negative grid voltage. For many purposes, for example, when the tube is to be used as a constant current device, it is desirable that this part of the characteristic shall be as flat as possible and correspond to as high an impedance as possible. In practice, however, as pointed out above, with a known construction of electron beam tube, such as that above described, it is found that appreciable variations occur as between tube and tube of the same intended design and performance and in general it is found difficult to obtain internal impedances exceeding about a $\frac{1}{2}$ megohm.

The present invention is based upon the discovery that the defects above referred to of known electron beam tubes arise by reason of the fact that the small, almost line-like, area on the cathode which extends over the length thereof and is nearest to the collector electrode is always subjected to considerable influence by the electrostatic field of the collector electrode in spite of the screening action of the other electrodes between the cathode and the said collector, whereas the total emission from the cathode includes a major portion which comes from parts of the cathode laterally of this small area and which are substantially not subjected to the field of force of the collector electrode.

According to the present invention an electron beam tube is characterized in that electron emission from the small area of the cathode which is nearest the collector electrode and is subjected to the field of force thereof is substantially eliminated or substantially prevented from contributing to the operating discharge in the valve.

Broadly speaking there are two ways of carrying the invention into effect. One is actually to prevent emission from the area of the cathode in question and the other is—and this amounts in effect to the same thing—to mask off the small area in question so that although electrons will actually leave the said area they cannot contribute to the operating electron discharge.

In applying the present invention to the usual form of electron beam tube such, for example, as the tube first described in this specification and having an indirectly heated cathode, the

electron emissive coating provided on the said cathode is scraped away along a narrow line (at X in Figure 1) running along the center of the emissive portion of the cathode structure, said line being centrally behind or in registry with the slots in the slotted electrodes and directly facing the collector.

Instead of mechanically removing the center part of the active surface of the cathode, such removal may be effected by utilizing ionic bombardment during the pumping out stage of the process of manufacturing the valve. Thus, argon, or other suitable inert rare gas, may be admitted to the envelope after activation of the cathode and suitable potentials applied to the various electrodes so that a narrow visible beam corresponding to a track of ionized atoms is formed. These ionized atoms strike the center portion of the cathode which will finally be rendered inactive if the bombardment is continued long enough.

As hereinbefore stated the invention may also be carried into effect by masking off a portion of a cathode, for example a line-like narrow mask M may be provided adjacent the cathode or actually touching it as shown in Figure 3 between the said cathode and the collector so as to prevent contribution by the central portion of the cathode to the operating electron discharge.

An incidental but not unimportant improvement obtained by the invention is that a relatively greater portion of the emission is within effective grid control than is the case with the usual known electron beam valves, and hence the ratio of mutual conductance to anode current is increased as compared to such known valves.

While I have indicated the preferred embodi-

ments of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims.

What I claim as new is:

1. An electron discharge device having a cathode and anode, and a plurality of apertured electrodes positioned between the cathode and anode, said apertures being aligned and parallel to the cathode, and means for preventing emission from that portion of the cathode registering with said apertures.

2. An electron discharge device having a cathode and anode, and a plurality of apertured electrodes positioned between the cathode coated with emitting material and anode, said apertures being aligned and parallel to the cathode, said cathode being free of any emitting material along the surface registering with the apertures in said apertured electrodes.

3. An electron discharge device having a cathode and anode, and a plurality of apertured electrodes positioned between the cathode and anode, said apertures being aligned and parallel to the cathode, and means for preventing emission from that portion of the cathode registering with said slots, and including a shield registering with the apertures in said electrodes and shielding that portion of the cathode registering with said apertures.

GEORGE FAIRBURN BRETT.