April 21, 1942. A. M. GLOVER 2,280,228

ELECTRON BEAM DISCHARGE DEVICE

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Fig. 1.

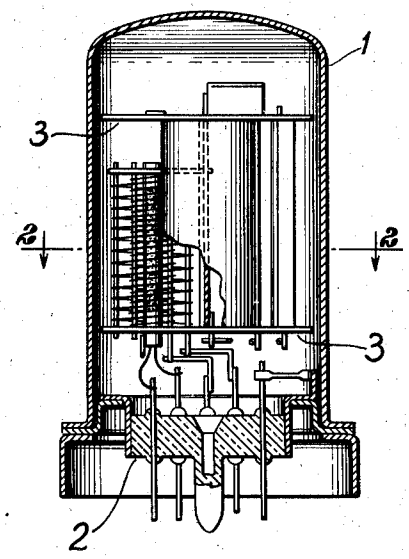


Fig. 2.

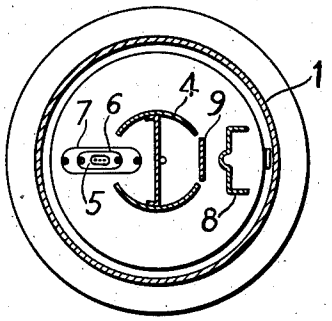
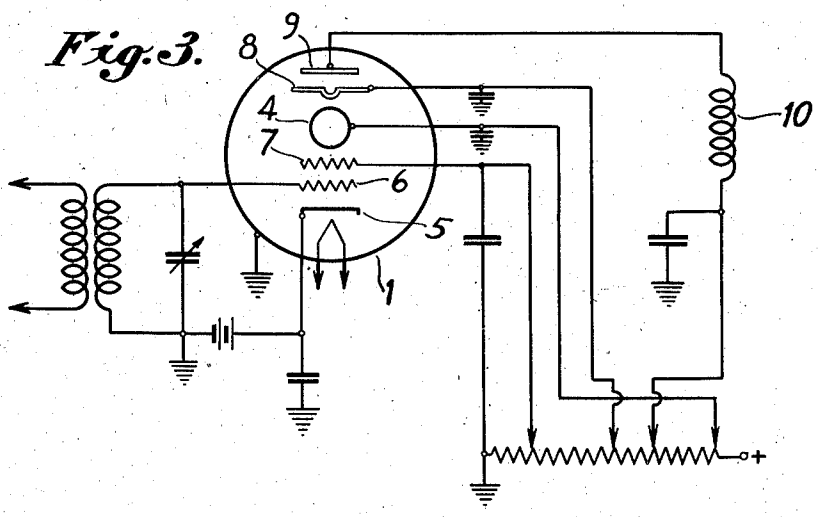


Fig. 3.



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ELECTRON BEAM DISCHARGE DEVICE

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3 Claims. (Cl. 250—27.5)

My invention relates to electron discharge devices, particularly to devices of the electron beam forming type.

Attempts have been made to obtain high gain and high transconductance by mounting a cathode with beam forming electrodes on one side of an annular space defined by two concentric cylinders and by so relating the potentials of the cylinders with the speed of electrons as to focus the electrons on a collector in said space diametrically opposite the cathode. Experience has shown that although the beams can be focused upon the collector, the tube is critical in operation and subject to extraneous electrical and magnetic disturbances.

The object of my invention is an electron discharge device of the beam forming type with high gain and high transconductance in which the operation is unaffected by extraneous electrical disturbances.

The characteristic features of my invention are defined in the appended claims and one embodiment thereof is described in the following specification and shown in the accompanying drawing in which Figure 1 is a longitudinal sectional view of an electron discharge device embodying my invention; Figure 2 is a transverse sectional view of the tube shown in Figure 1 on line 2—2, and Figure 3 is one diagrammatic showing of circuit connections of the tube of Figures 1 and 2.

The envelope 1 of the electron discharge device as shown in Figure 1 is of metal, such as iron, and of the type usually used in the manufacture of conventional metal radio receiving tubes. The electrodes within the envelope are completely enclosed in metal except for a small glass header 2 of the button type sealed in one end of the envelope and carrying the lead-in conductors for the electrodes. Insulating spacer discs 3 of the conventional mica type support the electrodes at their ends. Centrally in the envelope is metal cylinder 4, and flattened indirectly heated cathode 5, mounted between the spacers, is parallel to the axis of the envelope and cylinder. Surrounding the cathode is control grid 6 of the wire-wound or ladder type on two side rods. The control grid side rods are placed in a plane through the center of the tube so as to direct beams of electrons in opposite directions tangentially of the cylinder 4. Around the control grid is accelerating electrode 7. The accelerating electrode 7 may be a grid on side rods and structurally similar to the control grid. Diametrically opposite the cathode are mounted the output electrodes 8 and 9 of the tube. With the cathode at emission temperature, the potential of the accelerating electrodes 7 and cylinder 4, may be adjusted to direct two electron beams in opposite directions from the flat sides of the cathode in circular paths and focused upon the output electrodes. The output electrodes may comprise a first and a second anode side-by-side so that the beams may be deflected from one to the other by modulating the potential of the inner cylinder 4. Alternatively, one anode may be coated with electron emitting material, such as metal oxides which will emit secondary electrons when bombarded by the primary electrons of the beams. The first anode 8, for example, may be coated with barium oxide on its surface opposite the second anode 9. When the first anode is struck by primary electrons a larger number of secondary electrons are emitted and pass to the second anode 9. The tube thus constructed has an increased amplification factor and transconductance, and one circuit for this tube, more fully hereinafter described, is shown in Figure 3.

The electron beams originating at the cathode appear to be deflected into cylindrical paths by the concentric metal cylinders 4 and envelope 1, and if the potential of the cylinder is high with respect to the envelope, the beams follow the concentric equipotential lines of force to the output electrodes. The diameter of the circular paths of the beams may be materially changed by slight changes in the field between the two concentric cylinders, and because of the high susceptibility of the beams to the cylinder potentials, beam tubes made by the usual construction are undesirably affected by external electromagnetic and electrostatic disturbances.

The beam tube constructed according to my invention is substantially free in operation of electrostatic as well as electromagnetic disturbances. The metal envelope of my tube is employed as one of the focusing electrodes for the beams, and it has been found that if the diameter of the metal envelope is sufficiently large, it may be grounded and operated at zero direct current and high frequency potential. It has been found, further, that the cathode 6 should be placed nearer the inner cylinder 4 than the envelope, or inside a circle half way between the envelope and the cylinder. Although the metal envelope may be solidly connected to ground, the beams from the cathode can be easily focused in the output electrodes. Thus operated, my tube is particularly free of disturbances either of the

electromagnetic or electrostatic types exteriorly of the envelope. The elimination of one focusing electrode materially simplifies the manufacture of the tube. With the beams closer to the inner cylinder 4 than to the envelope wall, cylinder potential control over the beams is relatively greater than the control of the outer cylinder or envelope over the beams.

When the face of the first anode 8 is coated with electron emissive material, the tube may be connected as shown in Figure 3, an input circuit is connected between the control grid 6 and the cathode 5. The output circuit, including any suitable coupling device such as winding 10, is connected to the anode. The outer cylinder or envelope 1 is grounded and the inner cylinder 4 is connected to a high positive potential. The transconductance of the amplifier thus connected is the product of the control grid transconductance and the primary to secondary emission ratio of the collector 8. When the two anodes are placed side-by-side in the path of the beams and the beams shifted from one electrode to the other by modulating the potential on the inner cylinder 4, the output circuit would of course be connected between the two anodes. A second input circuit could then be connected to the cylinder 4, and the tube operated as a converter or mixer tube.

Good results have been obtained in mounting the electrodes of my novel tube in a metal envelope .930 inch in diameter, the inner cylinder having a diameter of .375 inch, with the cathode spaced about one-third the distance from the inner cylinder toward the envelope, or about .565 inch between the cathode axis and envelope axis, and with the voltage on the inner cylinder being 200 volts, the accelerating electrode voltage being 200 volts, the first anode 8 voltage being 200 volts, the second anode voltage being 250 volts, and the control grid being —1.5 volts. With these dimensions and potentials the electron beam may be focused upon the center of the first anode 8 with the metal envelope grounded, giving an output current in the second anode circuit that did not change in the presence of strong electrostatic or electromagnetic fields about the tube.

I claim:

1. An electron discharge device comprising a cylindrical metal envelope adapted to be electrically grounded, a header closing one end of said envelope, lead-in conductors sealed in said header, a metal cylinder, smaller than said envelope, in and extending longitudinally of said envelope, a cathode in the annular space between the envelope and cylinder, a control grid around said cathode, and an output electrode in said annular space on the side of the cylinder opposite said cathode.

2. An electron discharge device comprising a cylindrical metal envelope, an elongated cathode, an elongated anode, said cathode and anode being spaced, parallel and disposed longitudinally of said envelope, a control grid surrounding said cathode, a cylindrical metal focusing electrode parallel to the axis of said envelope between said cathode and anode, and lead-in conductors sealed in said envelope and connected to said cathode, anode and focusing electrode, the electrodes within said metal envelope being so constructed and arranged that electron current may flow between the anode and cathode with said envelope at ground potential.

3. An electron discharge device comprising a cylindrical envelope of ferro-magnetic metal, lead-in conductors hermetically sealed in one end of said envelope, a metal cylinder smaller in diameter than said envelope in and extending longitudinally of said envelope, said cylinder being disposed substantially centrally of said envelope, a cathode extending longitudinally of the envelope parallel to said cylinder and positioned closer to said cylinder than to said envelope, a control grid around said cathode, and an accelerating electrode adjacent said control grid, and an anode in said annular space diametrically opposite said cathode.

ALAN M. GLOVER.