April 28, 1942. A. L. SAMUEL 2,280,980

ELECTRON DISCHARGE DEVICE

Filed Jan. 21, 1941

FIG. 1

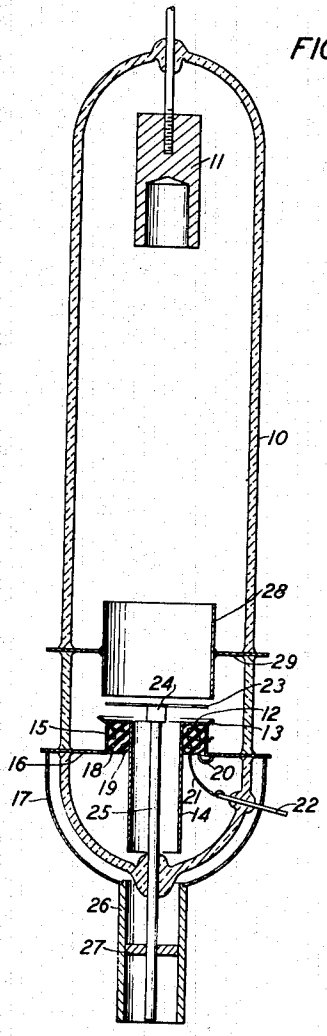
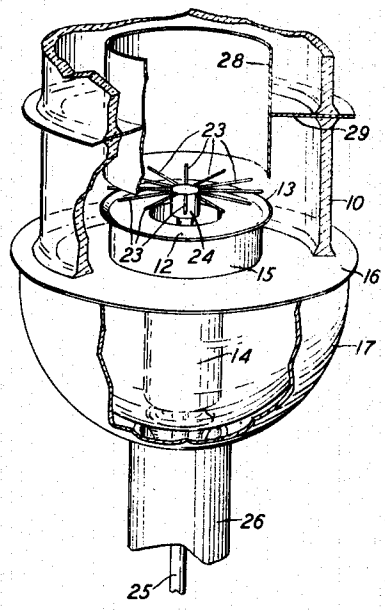


FIG. 2



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ELECTRON DISCHARGE DEVICE

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6 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices of the electron beam type and especially suitable for use at ultra high frequencies.

One object of this invention is to decrease the losses in and thereby increase the efficiency of electron discharge devices.

Another object of this invention is to obtain high shielding of the input element, such as the control electrode or grid, in electron discharge devices especially suitable for ultra high frequency operation.

A further object of this invention is to facilitate the association of an electron discharge device with a coaxial line input system therefor.

In one illustrative embodiment of this invention, an electron discharge device comprises a cathode, a control electrode or grid and an anode mounted in succession in an enclosing vessel, the cathode being formed to produce an electron beam directed upon the anode and subject to control by the control electrode or grid.

In accordance with one feature of this invention, the cathode comprises an annular emissive surface adjacent and coaxial with which a grid is mounted, the cathode and grid being provided with coaxial leading-in conductors. For example, the leading-in conductor for the control electrode or grid may be a linear rod or wire coaxial with the emissive surface of the cathode, and the leading-in system for the cathode may include a cylindrical portion coaxial with and encompassing the leading-in conductor for the control electrode or grid.

In accordance with another feature of this invention, the leading-in system to the cathode includes also a dished metallic member coaxial with and encompassing both the cylindrical portion aforementioned and the leading-in conductor for the control electrode, the dished member being adapted to have connected thereto, in coaxial relation with the cathode and control electrode, the outer conductor of a coaxial line.

The invention and the foregoing and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing, in which:

Fig. 1 is an elevational view in section of an electron beam discharge device illustrative of one embodiment of this invention; and

Fig. 2 is an enlarged detail view in perspective of the input end of the discharge device shown in Fig. 1, portions of the structure being broken away to show details of construction more clearly.

Referring now to the drawing, the electron discharge device there illustrated comprises an elongated, highly evacuated, vitreous enclosing vessel 10 at one end of which there is mounted a cup-shaped anode 11, preferably of a material having poor secondary electron emission characteristics. Mounted at the other end of the vessel 10 is a unitary cathode structure which comprises an annular metallic portion 12 having a lip or flange 13 and coated on the surface facing the anode with a material having good thermionic emission characteristics, a cylindrical metallic portion 14, which may be integral and coaxial with the annular portion 12 as shown and a metallic supporting member including a cylinder 15 coaxial with the cylindrical portion 14 and including also an annular member 16 hermetically sealed to and extending through the side wall of the enclosing vessel 10. Secured to the annular member 16 is a dished metallic shield 17 which may be substantially hemispherical as shown and conforms to the portion of the enclosing vessel thereadjacent. The cathode structure comprises also a heater element including a heating coil 18 encased in insulating material 19, one end 20 of the coil 18 being connected to the annular member 16 and the other end 21 thereof being connected to a leading-in conductor 22 sealed in the wall of the enclosing vessel 10 and extending through an aperture in the shield 17.

Mounted opposite the emissive portion 12 of the cathode is a control electrode or grid which, as shown clearly in Fig. 2, comprises a plurality of wires 23 parallel to the portion 12 of the cathode and extending radially from a hub 24 at the inner end of a leading-in conductor 25 coaxial with the cathode structure and sealed in one end of the enclosing vessel 10.

The conductor 25 constitutes the inner element of a coaxial transmission line, the outer element of the line being a cylindrical conductor 26 secured or connected to the metallic shield 17. This coaxial line may be tuned to the frequency at which the electron discharge device is intended to be operated, by a metallic slider 27 contacting with both the conductors 25 and 26.

The electrons emanating from the cathode define a hollow cylindrical beam and are concentrated and accelerated toward the anode 11 by a cylindrical electrode 28 which is supported in coaxial relation with the cathode structure by a metallic annulus 29 sealed in the wall of the

enclosing vessel 10, and which is maintained at a positive potential with respect to the cathode. The intensity or magnitude of the electron current may be controlled by a suitable potential or signal impressed between the conductors 25 and 26 of the coaxial input line which may, of course, be coupled to a coaxial transmission line.

It will be noted that the cathode and control electrode structure is electrically symmetrical with respect to the common axis thereof and that the cathode and control electrode constitute, in effect, electrically integral parts or continuations of the coaxial input system. Consequently, a very low loss input is achieved. Also, it will be appreciated that the leading-in conductor 25 for the control electrode is highly shielded by the conductive members 14, 16, 17 and 26 at cathode potential, throughout substantially its entire length, whereby interaction between input and output is minimized.

Although a specific embodiment of the invention has been shown and described, it will be understood, of course, that it is only illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising a hollow cathode structure including an annular substantially plane electron emissive surface, a control electrode coaxial with said surface and substantially parallel thereto, said surface and said control electrode being electrically symmetrical with respect to the common axis thereof, an electron receiving element, means enclosing said cathode structure, electron receiving element and control electrode, a linear leading-in conductor connected to said control electrode, coaxial with and extending through said structure, and means for shielding said leading-in conductor comprising a hollow metallic member electrically integral with said emissive surface and coaxial with and encompassing said conductor.

2. An electron discharge device comprising a hollow cathode structure including an annular substantially plane electron emissive surface, a control electrode coaxial with said surface and substantially parallel thereto, an electron receiving element, means enclosing said cathode structure, electron receiving element, and control electrode, a linear leading-in conductor connected to said control electrode, coaxial with and extending through said structure, and means for shielding said leading-in conductor comprising a hollow metallic member electrically integral with said emissive surface and coaxial with said conductor and a cylindrical metallic member within said hollow member, coaxial therewith and encompassing said conductor.

3. An electron discharge device comprising a cathode structure having an annular substantially plane electron emissive surface, a control electrode coaxial with said emissive surface and comprising a plurality of radially extending wires overlying and parallel to said surface, an electron receiving electrode, and coaxial leading-in systems connected to said cathode and said control electrode, the cathode leading-in system encompassing the control electrode leading-in system, and said cathode structure including a cylindrical metallic shield electrically integral with said emissive surface and encompassing said control electrode leading-in system.

4. An electron discharge device comprising a cathode structure having an annular substantially plane electron emissive surface, a control electrode coaxial with said emissive surface and comprising a plurality of radially extending wires overlying and parallel to said surface, an electron receiving electrode, and coaxial leading-in systems connected to said cathode and said control electrode.

5. An electron discharge device comprising an enclosing vessel, an annular cathode structure at one end of said vessel including an annular electron emissive element and an annular metallic member extending transversely of said vessel and projecting through the side wall thereof, an anode, a control electrode opposite said electron emissive element, a leading-in conductor connected to said control electrode, extending through and coaxial with said cathode structure and sealed in said one end of said vessel, and leading-in means connected to said cathode structure including a hollow member encompassing said one end of said vessel, electrically connected to said annular member and coaxial with said leading-in conductor.

6. An electron discharge device in accordance with claim 5 wherein said cathode structure includes a cylindrical metallic member, electrically integral with said annular member, coaxial with said leading-in conductor and substantially coextensive with the portion thereof within said enclosing vessel.

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