Feb. 6, 1951 P. JANIS 2,540,080

REFLEX KLYSTRON ELECTRON DISCHARGE DEVICE

Filed June 22, 1948

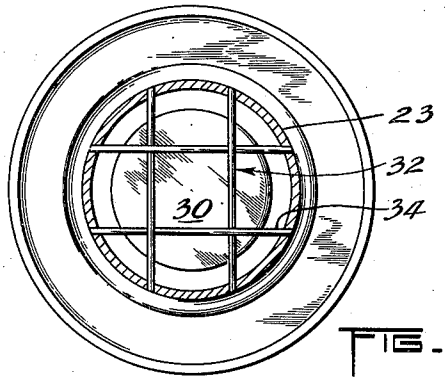

FIG. 3

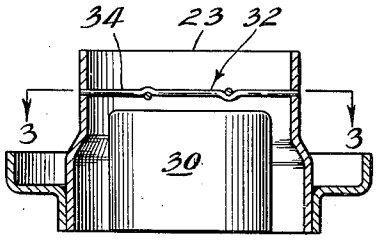

FIG. 2

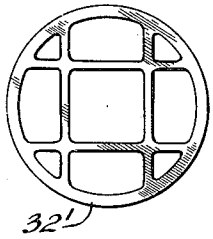

FIG. 5

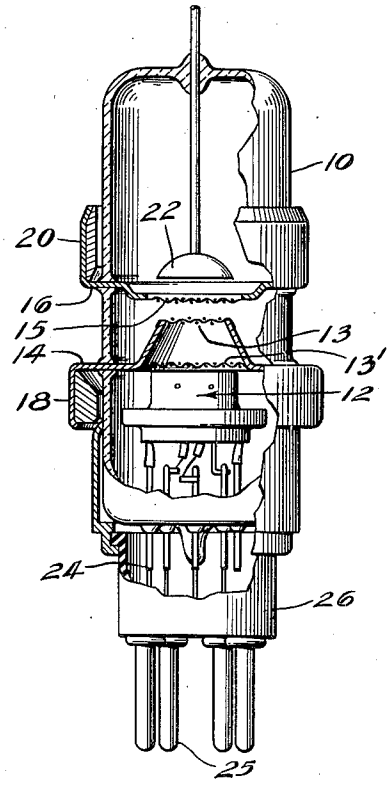

FIG. 1

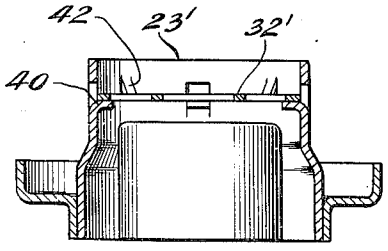

FIG. 4

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Patented Feb. 6, 1951

2,540,080

UNITED STATES PATENT OFFICE

2,540,080

REFLEX KLYSTRON ELECTRON DISCHARGE DEVICE

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Application June 22, 1948, Serial No. 34,494

5 Claims. (Cl. 250—27.5)

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The present invention relates to electron-discharge devices and more particularly to electron-discharge devices wherein a stream of electrons from a cathode is passed through a gap in a hollow resonator, either built into the tube or electrically associated therewith, and the stream is reflected back through the gap by a suitable potential on a reflecting electrode. Such devices are commonly known as reflex Klystron tubes.

An object of the present invention is the provision of a reflex Klystron tube which may be cut off by applying a grid voltage to a grid electrode which is considerably less than has heretofore been the case.

Another object of the present invention is the provision of a reflex Klystron as aforesaid in which a more abrupt control grid characteristic is obtained.

Still another object of the present invention is the provision of a reflex Klystron particularly adapted to pulse modulation.

A further object of the present invention is the provision of a velocity modulation tube adapted for pulse modulation and which does not require additional externally available control electrodes.

Still a further object of the present invention is the provision of a reflex Klystron adapted for pulse modulation in which the application of the modulating potential does not materially effect the focusing of the electron beam within the tube.

Still a further object of the present invention is the provision of a reflex Klystron tube in which power output and other tube characteristics are not effected by the characteristics of the pulse modulating potential.

The foregoing objects, and others which may appear from the following detailed description, are attained by providing a reflex Klystron tube having, within an evacuated envelope, a cathode for projecting a stream of electrons along the length of the envelope, a reflector electrode near the other end of the envelope for reflecting electrons back towards the cathode, and between the cathode and reflector electrode a plurality of grid electrodes adapted to be associated with a number of external resonant cavities. Surrounding the cathode structure and projecting beyond the emissive surface thereof is a focusing ring for controlling the electric field in the vicinity of the cathode whereby a beam of electrons is formed. Electrically connected to said ring and supported thereby is an open grid structure. The addition of this grid structure results in a tube which can be cut-off over the whole frequency

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range over which it is capable of operation by the application of a maximum negative potential to focusing ring of the order of 50 or 60 volts, whereas heretofore known tubes require potentials of over 350 volts for complete cut-off. Since this grid electrode is electrically connected to the focusing ring, no additional terminals are required to be brought out from the base of the tube. Thus the tube of the present invention may be directly substituted for previously known tubes in signal generators, or like structures, without requiring modification of any of the physical characteristics of the device into which it is connected. However, the substituton of the tube of the present invention will result in a lowering of the electrical requirements for pulse modulating the tube, thus simplifying the pulse modulator structure, and due to the lessened power requirements, will result in a simpler and cheaper power supply.

The present invention will be more fully understood by reference to the following detailed description which is accompanied by a drawing in which:

Fig. 1 illustrates in partial longitudinal section a tube embodying principles of the present invention, while

Fig. 2 is an enlarged view in transverse cross-section of the cathode structure of the tube of Fig. 1, and

Fig. 3 is an end view of the cathode structure shown in Fig. 2 along a section taken at the lines 3—3 of Fig. 2, while

Fig. 4 is a modification of the form of cathode and grid structure shown in Fig. 2, and

Fig. 5 is a plan view of the grid alone, as used in the modification of Fig. 4.

In Fig. 1 of the drawing, reference numeral 10 indicates the evacuated glass envelope of an electron-discharge device having at one end, an electron beam forming structure 12. This structure incorporates a heated electron emissive cathode 30 and a focusing ring 23 for producing a beam of electrons. The beam of electrons is accelerated by grid 13' and from there is projected through grid 13 in apertured electrode 14 and through grid 15 in apertured electrode 16. Electrodes 14 and 16 may be in the form of conductive metal discs passing through the wall of the glass envelope 10 of the tube. Grid 13' is electrically connected to electrode 14. Preferably the electrodes terminate in cylindrical rims 18 and 20, adapted to make good contact with the walls of an exterior resonating chamber. The resonating chamber is not shown since it may be of various forms and of varying dimen-

sions, depending upon the desired frequency of operation of the system. The stream of electrons from cathode 30, after passing through grids 13 and 15, is reflected back through the resonator gap between grids 13 and 15 by a suitable negative potential applied to reflector electrode 22. The energizing potentials on the electrodes of the tube are so related to the dimensions of the tube and associated resonating chamber as to cause the reflected electrons to pass back through the gap between electrodes 13 and 15 in bunches, thus exciting the associated resonant cavity into oscillation. Lead wires 24 connected to the focusing ring 23, to the cathode 30, and to the associated heater structure, pass through the base of glass envelope 10 and are connected to connection pins 25 forming part of a conventional tube plug-in base 26. Heretofore constructed tubes have been supplied with a plug-in base 26 having four terminal pins 25 and it is considered desirable that the present tube, while having different electrical characteristics from previously known tubes, be arranged to be plugged-into the same socket arrangement. Thus any additional control function desired must be provided by a rearrangement of the internal structure of the tube without additional connections to the exterior. In Figs. 2 and 3 is shown the modification in structure which makes this improved result obtainable. Here the focusing ring 23 is shown in vertical cross-section, while the cathode 30, within the ring 23, is shown in elevation. The top surface of the cathode 30 is provided with an electron emissive coating and a suitable electrical heating arrangement, not shown in detail, is provided within the cathode 30.

A short distance above the electron emissive surface of cathode 30 is provided a grid structure 32. In the modification shown in Figs. 2 and 3, grid 32 is in the form of four chordal wires 34 arranged in pairs crossing each other. In a tube which was actually constructed and tested, the grid wires 34 were ten thousandths of an inch in diameter, spaced about an eighth of an inch apart and positioned within three to ten thousandths of an inch from the cathode. The grid wires 34 are preferably so formed at their intersection points that the linear portions of the wires are in approximately the same plane. The ends of the grid wires, where they pass through the cylindrical gun structure 23, are preferably welded in place. It will be noted that this forms a very open grid structure having a large central aperture providing a substantially unobstructed central area over the cathode surrounded by a number of smaller clear spaces.

A modified form of gun focusing ring and grid structure is shown in Fig. 4. This form is somewhat easier to construct than the previously described modification. Here the focusing ring 23' is provided with a ledge on which the grid 32' is mounted. The ledge is formed by striking in lips 40 from the material of which the ring 23' is formed. The grid 32' is then dropped into place and additional pierced fingers 42 are pressed inwardly, thus locking the grid 32' in place. In this form of construction the grid is preferably electro-formed as a single thin flat sheet of metal having apertures of the desired size and arrangement therein. In electro-forming, a suitable conductor, or conductively coated insulating matrix, is placed in an electroplating bath and metal is deposited into the matrix until the desired thickness is formed. The deposited metal sheet is then stripped from the matrix and trimmed to size, if necessary. Thus a thin, perfectly flat grid structure, with accurately proportioned apertures, nicely rounded at the edges, and with filleted corners is provided. The grid is shown in plan view in Fig. 5.

While I have particularly shown and described several modifications of the present invention, it is to be clearly understood that my invention is not limited to these particular embodiments, but that modifications may be made within the scope of the invention.

What is claimed is:

1. An electron-discharge tube having an evacuated envelope, a source of electrons at one end of said envelope, focusing means adjacent said source for forming said electrons into a beam, a plurality of apertured electrodes adapted to be coupled to a cavity resonator and mounted in the path of said beam and an open grid structure provided with a substantially unobstructed central area surrounded by a number of smaller apertures and electrically connected to said first named means and closely adjacent said source.

2. An electron-discharge tube having an evacuated envelope, a cathode near one end of said envelope and having a flat electron emissive surface, an open ended conductive sleeve surrounding said cathode for forming said electrons into a beam, a plurality of grids adapted to be coupled to a cavity resonator and mounted in the path of said beam, a reflector electrode near the other end of said envelope and an open grid structure across said sleeve immediately adjacent said cathode surface, said grid structure being electrically connected to said sleeve, said grid structure being in the form of a thin flat pierced metal disc.

3. An electron-discharge tube having an evacuated envelope, a cathode near one end of said envelope and having a flat electron emissive surface, an open ended conductive sleeve surrounding said cathode for forming said electrons into a beam, a plurality of grids adapted to be coupled to a cavity resonator and mounted in the path of said beam, a reflector electrode near the other end of said envelope and an open grid structure across said sleeve immediately adjacent said cathode surface, said grid structure being electrically connected to said sleeve, said grid structure being in the form of a thin flat disc having a large central aperture and smaller apertures surrounding said central aperture.

4. An electron-discharge tube having an evacuated envelope, a cathode near one end of said envelope and having a flat electron emissive surface, an open ended conductive sleeve surrounding said cathode for forming said electrons into a beam, a plurality of grids adapted to be coupled to a cavity resonator and mounted in the path of said beam, a reflector electrode near the other end of said envelope and an open grid across said sleeve immediately adjacent said cathode surface, said grid being electrically connected to said sleeve, said grid being in the form of a thin flat disc having a large central aperture and smaller apertures surrounding said central aperture, said grid being secured to said sleeve by means of tongues struck inwardly from the material of said sleeve at each side of said disc.

5. An electron-discharge tube having an evacuated envelope, a cathode near one end of said envelope and having a flat electron emissive surface, an open ended conductive sleeve surrounding said cathode for forming said electrons into

a beam, a plurality of grids adapted to be coupled to a cavity resonator and mounted in the path of said beam, a reflector electrode near the other end of said envelope and an open grid across said sleeve immediately adjacent said cathode surface, said grid being electrically connected to said sleeve, said grid being in the form of a number of chordal wires crossing above said cathode surface and defining a large central aperture and a number of smaller surrounding apertures.

PETER JANIS.

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