July 9, 1940. R. C. HERGENROTHER 2,206,954

ELECTRON DISCHARGE DEVICE

Filed Aug. 13, 1938

FIG.1.

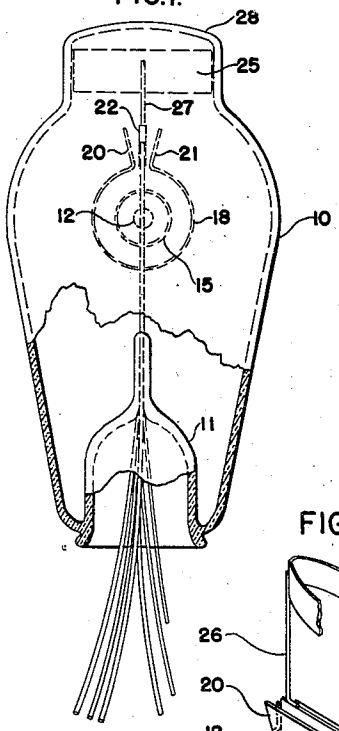


FIG.3.

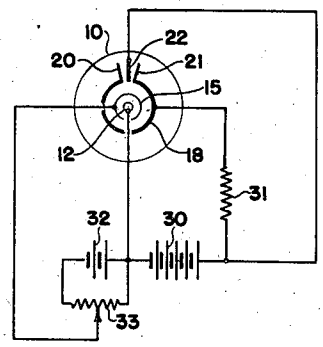
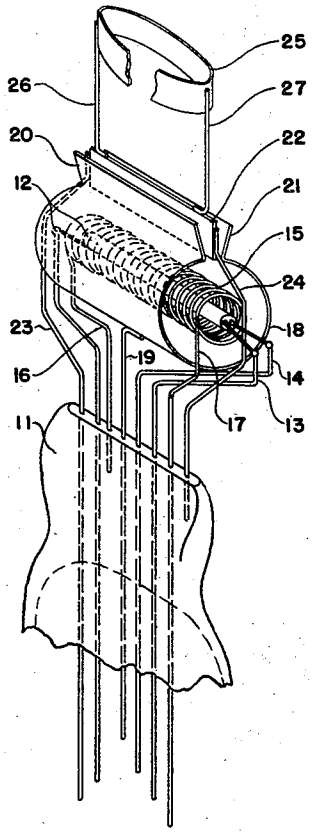


FIG.2.



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ELECTRON DISCHARGE DEVICE

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8 Claims. (Cl. 250—27.5)

This invention relates generally to electron discharge devices having a fluorescent screen and particularly to such devices in which the intensity of illumination of the screen is a function of the control potentials applied to the device. While the invention is of general utility, it is particularly useful as a tuning indicator in modulated-carrier signal-receiving apparatus.

Electron discharge devices having luminous fluorescent screens have commonly been used as tuning indicators in wave-signal receivers. Such devices have generally comprised auxiliary electrodes including an auxiliary cathode, mounted within an envelope common to a vacuum-tube amplifier. The auxiliary cathode of such devices is operated at its emission saturation point in order to limit the flow of electrons to the fluorescent screen. Such prior art devices have a disadvantage in that they may have a relatively short life due to the fact that the cathode is operated at the saturation point and have a further disadvantage in that the number of electrons emitted to the screen or anode is not a function of the control potential, thereby causing the change in intensity of illumination of the screen to be limited to a relatively small value over the range of operating potentials applied to the device. Furthermore, prior art devices have commonly relied on a "shadow angle" to indicate tuning, rendering the determination of a critical indication somewhat difficult.

It is an object of the present invention, therefore, to provide an improved electron discharge device of the type described, in which the above-mentioned disadvantages are eliminated.

It is also an object of the invention to provide an improved electron discharge device of the type described which is particularly suitable for use as a visual tuning indicator in a wave-signal receiver and in which resonance is indicated by a glow on a luminous screen, the brilliancy of the glow being a function of the degree of accuracy of tuning.

It is a further object of the invention to provide an improved electron discharge device of the type described adaptable for use as a visual tuning indicator in a wave-signal receiver, in which resonance is indicated by the degree of separation of two parallel ribbons on a luminous screen.

In accordance with the invention, there is provided an electron discharge device including a cathode, an anode, and a fluorescent screen, together with electrode means disposed between the cathode and screen and forming means for directing and focusing portions of the electron stream emitted by the cathode into two flat beams for forming luminous ribbons on the fluorescent screen, the electrode means comprising a single pair of deflecting electrodes and the relative position of said beams being a function of the potentials applied to the pair of deflecting electrodes. Preferably the electron directing means comprises protruding portions of the anode together with a deflector electrode disposed therebetween. Also, in accordance with the preferred embodiment of the invention, there is provided a control electrode between the cathode and the anode, and the cathode, the control electrode, and the anode may be utilized in the conventional manner as a vacuum-tube repeater. The preferred arrangement is such that the protrusions on the anode together with the deflector electrode effectively form a means for directing the electron beams and the preferred method of operation is that of maintaining constant the potential on the deflector electrode and causing the potential of the anode to vary as a function of a control voltage applied to the control electrode.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 is a side elevation of an electron discharge device in accordance with the invention, the envelope being broken away; Fig. 2 is a perspective view of the assembly of the electrodes of the tube; while Fig. 3 is a circuit diagram illustrating the preferred method of operation of the tube.

Referring now more particularly to Figs. 1 and 2 of the drawing, there is shown an envelope 10 having a pressed re-entrant stem 11 in which are supported a plurality of lead-in wires supporting the electrodes of the tube. The electrodes comprise a cylindrical indirectly heated cathode 12, heated by a filament through lead-in wires 13 and 14, a cylindrical grid or control electrode 15 surrounding cathode 12 and mounted on supports 16 and 17, and a substantially cylindrical main anode 18 surrounding control electrode 15 and mounted on support 19. The main anode 18 is provided with radially extending protrusions 20 and 21 midway between which there is disposed a deflector electrode 22 mounted on supports 23 and 24. In order to prevent accumulation of electrons in the vicinity of the fluorescent screen of the discharge device, there is provided a collecting anode 25 mounted on, and electrically

connected to, deflector electrode 22, by means of supports 26 and 27. When the electrode assembly just described is assembled in envelope 10 having a fluorescent screen 28 on the inner wall thereof, the passageways between deflector electrode 22 and the protrusions 20 and 21 on anode 18 are in line with cathode 12 and the screen 28, and collecting anode 25 is disposed adjacent screen 28 as shown.

In considering the characteristics of the tube just described, it will be seen that, with proper operating potentials applied to the several electrodes, protrusions 20, 21, together with deflector electrode 22, effectively provide means for directing portions of the electron stream emitted by cathode 12 into two parallel beams forming parallel luminous ribbons on screen 28. The intensity of the electron stream emitted by cathode 12 and, therefore, the brilliancy of the parallel ribbons on screen 28 is a function of the control potential applied to control electrode 15. Also, the spacing of the parallel ribbons on tube 26 is a function of the difference in potential between deflector electrode 22 and anode 18.

Reference is made to Fig. 3 for an illustration of a preferred method of operation of the discharge device of the invention. Only the tube elements necessary in the description are shown. The circuit comprises a source of potential 30, to the positive terminal of which deflector electrode 22 is directly connected and to which anode 18 is connected through a load resistor 31. In order to provide a negative-bias potential for control electrode 15, there is provided a source of potential 32 across which is connected resistance potential divider 33, control electrode 15 being connected to the adjustable tap of potential divider 33.

In considering the operation of the circuit of Fig. 3, it will be seen that the potential of deflector electrode 22 is maintained constant, while the potential of anode 18 decreases as the negative voltage applied to control electrode 15 is decreased, due to the increased current flow through load resistor 31. Therefore, as the control voltage applied to electrode 15 is increased, the brilliance of the luminous ribbons on screen 28 increases and simultaneously a difference in potential between protrusions 20, 21 and deflector electrode 22 results, effectively deflecting the streams toward each other to decrease the distance between the parallel luminous ribbons.

The use of the discharge device of the invention as a tuning indicator in a wave-signal receiver is mentioned as being a particularly practical adaptation of the discharge device of the invention. The automatic amplification control-bias potential of the receiver may be utilized to vary the potential of grid 15 so that the distance between the parallel luminous ribbons on screen 28 and their brilliancy varies with the tuning of the receiver, the distance being a minimum when the receiver is tuned to resonance with a received signal and the ribbons then having their greatest brilliancy.

While there has been shown a structure utilizing a small aperture between element 22 and protrusions 20 and 21 for directing the electron streams onto the screen 28, it will be understood that other means for producing this result may be utilized. For instance, cylindrical electron lenses, or lenses of any other type, may be utilized for focusing the electrons into parallel ribbons on the screen.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An electron discharge device including a cathode, an anode, a fluorescent screen, and electrode means disposed between said cathode and said screen and forming means for directing portions of the electron stream emitted by said cathode into two flat beams for forming luminous ribbons on said screen, said electrode means comprising a single pair of deflecting electrodes common to both of said beams and the relative position of said beams being a function of the potential applied to said pair of deflecting electrodes.

2. An electron discharge device including a cathode, an emission control electrode, an anode, a fluorescent screen, and a single deflector electrode, said anode and said deflector electrode effectively comprising means for directing portions of the electrons emitted by said cathode into two flat beams for forming two parallel luminous ribbons on said screen, said anode and said single deflector electrode comprising deflecting electrodes common to both of said beams and the relative position of said beams being a function of the potential applied between said anode and said deflector electrode and the brilliance of said beams being a function of the potential applied to said control electrode.

3. An electron discharge device including a cathode, a main anode, a fluorescent screen, a collector anode adjacent said screen for preventing the accumulation of charges thereon, and a deflector electrode, said main anode and said deflector electrode effectively comprising two means for directing portions of the electrons emitted by said cathode into two flat beams for forming two parallel luminous ribbons on said screen, the relative position of which is a function of the potential applied between said main anode and said deflector electrode.

4. An electron discharge device including a cylindrical cathode, an emission control electrode surrounding said cathode, a cylindrical anode substantially surrounding said control electrode and comprising a pair of elongated opposed plate-like members extending radially from said cathode, a deflector plate interposed between said members, and a fluorescent screen, said anode and said deflector electrode effectively comprising two means for directing portions of the electron stream emitted by said cathode into two flat beams for forming parallel luminous ribbons on said screen, the relative position of which is a function of the potential applied between said anode and said deflector electrode.

5. An electron discharge device including an elongated cathode, an emission control electrode for said cathode, an anode having plate-like members extending longitudinally to said cathode, a deflector plate electrode disposed between said members, a fluorescent screen, said anode and said deflector electrode effectively comprising two means for directing portions of the electron stream emitted by said cathode into two flat beams for forming two parallel luminous ribbons on said screens, the relative position of which is a function of the potential applied between said anode and said deflector electrode.

6. An electron discharge device including a

cylindrical cathode, an emission control electrode surrounding said cathode, a cylindrical anode having a longitudinal flanged slot and substantially surrounding said control electrode, the flanges extending radially from said cathode, a deflector plate electrode disposed between said flanges, and a fluorescent screen, said anode and said deflector electrode effectively comprising two means for directing portions of the electron stream emitted by said cathode into two flat beams for forming two parallel luminous ribbons on said screen, the relative position of which is a function of the potential applied between said flanges and said deflector electrode.

7. An electron discharge device including a cylindrical cathode, an emission control electrode surrounding said cathode, a main cylindrical anode having a flanged slot and substantially surrounding said control electrode, said flanges extending radially from said cathode, a deflector plate electrode between said flanges, a fluorescent screen, a collector anode adjacent said screen, said main anode and said deflector electrode effectively comprising two means for directing portions of the electrons from said cathode into two flat beams for forming two luminous parallel ribbons on said screen, the relative position of which is a function of the potential applied between said main anode and said deflector electrode, and means electrically connecting said deflector electrode and said collector anode.

8. An electron discharge device including a cathode, an emission control electrode adapted to be subjected to a variable control potential, a fluorescent screen, an anode, and a deflector electrode, said anode and said deflector electrode effectively comprising two means for directing portions of the electron stream emitted by said cathode into two flat beams for forming parallel luminous ribbons on said screen, the relative position of which is a function of the potential applied between said anode and said deflector electrode, said anode being adapted to have its potential varied in accordance with variations in potential of said control electrode, and said deflector electrode being adapted to be maintained at a constant potential.

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