Oct. 21, 1958 J. F. STEPHENS 2,857,544

ELECTRON DISCHARGE DEVICE ANODE STRUCTURE

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FIG.1

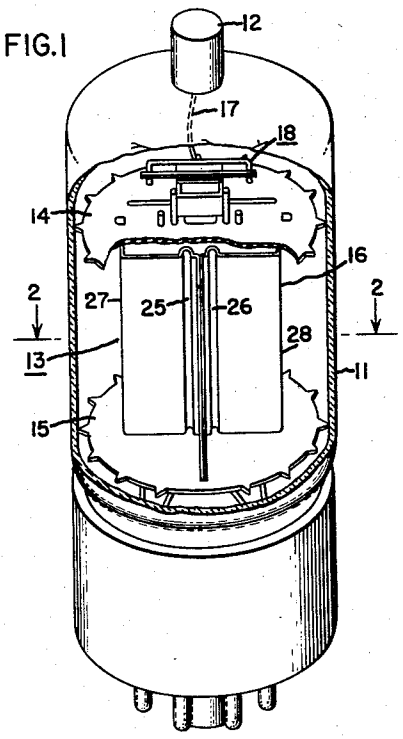


FIG.2

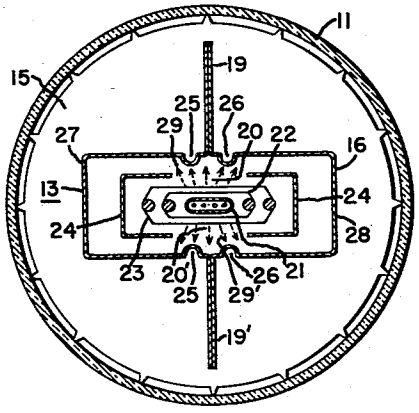
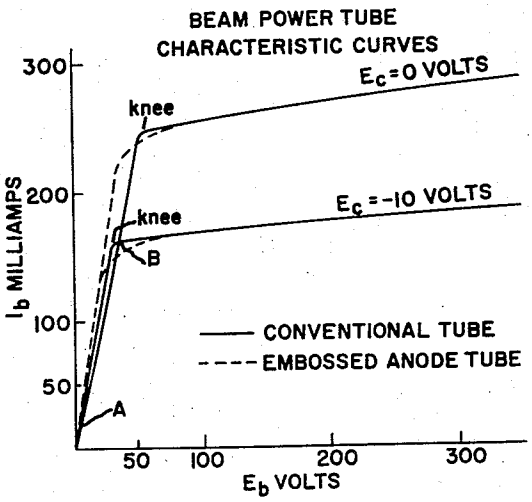


FIG.3



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ELECTRON DISCHARGE DEVICE ANODE STRUCTURE

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3 Claims. (Cl. 313—299)

My invention relates to electron discharge devices and more particularly to beam power tubes and structures for minimizing spurious oscillations within said tubes.

Those electron discharge devices including a cathode, an anode, a control grid, a screen grid and having shaped electrodes for the purpose of concentrating and confining the electrons so that the electrons emerge as defined beams are known as beam power tubes. In addition the grids of said tubes have parallel spacings to further concentrate the electrons in beams. The electron density effects the space charge region existing between the screen grid and the anode to produce a negative voltage gradient near the anode which acts as a virtual cathode and eliminates the necessity of a suppressor grid in reducing secondary emission effects. Beam power tubes have the advantages of high power output, high power sensitivity, high efficiency and are consequently extensively used. However, a problem associated with the use of beam power tubes is that of spurious oscillations. For example, when using beam power tubes in the horizontal deflection circuitry of television receivers, spurious oscillations emanating from the beam power tubes are radiated, picked up by the signal circuit of the receiver, amplified as picture information and appear as cyclic interference on one side of the picture tube raster as a vertical band or bands, either curved or straight, continuous or broken, depending upon the strength of the oscillations.

Accordingly, it is an object of the present invention to provide improved electron discharge devices of the beam power type in which spurious oscillations are prevented or greatly reduced.

Another object of the invention is to provide an improved anode structure for beam power tubes.

Yet another object is to devise a novel method for suppressing spurious oscillations in a cathode ray tube deflection system.

Further objects and advantages will become apparent from the following description and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of the specification.

In carrying out the objects of the invention, I provide a novel anode structure for a beam power tube for the purposes of suppressing spurious oscillations in said tube.

For a detailed explanation of the invention, reference is made to the accompanying drawings in which:

Figure 1 is an isometric view, partly in cross section, of a beam power tube showing an anode made according to my invention.

Figure 2 is a cross sectional view taken along the line 2—2 of Figure 1.

Figure 3 is a graph of tube current versus voltage characteristic curves showing the comparison and advantages of beam power tubes incorporating my invention.

In Figure 1, there is shown a beam power tube envelope **11**, having a cap connection **12**, and an electrode assembly **13** within said envelope **11** including an anode

16 rectangular in cross section mounted between two mica plates **14** and **15**. Anode **16** surrounds the other elements of electrode assembly **13** and is connected to the outside power source (not shown) through the lead **17** and cap **12**. Barium getter assembly **18** is shown mounted above the mica plate **14**. The various pin-wire connections to the tube may be of conventional design and are not, per se, a part of this invention and therefore are not shown and will not be further described.

Figure 2 is a cross sectional top view taken along line 2—2 of Figure 1 and better shows my invention. In Figure 2, electrode assembly **13** consists of cathode **21**, control grid **22**, screen grid **23**, and beam confining plates **24** disposed so as to confine oppositely directed electron beams **29** and **29'** therebetween.

In accordance with my invention, the anode **16** is formed with similarly shaped embossments **25** and **26** centrally positioned on opposite sides of the rectangular anode **16** and projecting inwardly toward the space-charge regions **20** and **20'** where the anode intercepts the electron beams **29** and **29'**. Embossments **25** and **26** extend along the length of the anode **16**, and have a double humped or double U-shaped contour. Anode **16** may be formed of two cup-shaped similar pieces **27** and **28** which are joined at their open ends to form a complete closure. Pieces **27** and **28** may include fins **19** and **19'** which extend in opposed directions and perpendicularly to the sides of the rectangular anode; said fins **19** and **19'** are affixed to each other and serve as a means of heat dissipation.

It is believed that the spurious oscillations in the beam power tube which cause the picture interference are the result of current discontinuities within the tube and further that the current discontinuities are caused by a shift of the virtual cathode during the portion of the operating cycle during which the plate potential is low. This belief appears sound since the effect is most pronounced when the beam-power tube is employed as a deflection tube and is driven at low values of plate voltage; the current discontinuities of the offending tube appear to be traceable to the portion of the plate characteristic curve (I_b vs. E_b) known as the "knee," see Figure 3. The frequency of the oscillations is dependent upon the dimensions and potentials of the tube.

In the graph of Figure 3, curves of the tube current versus voltage characteristics are plotted to show the comparison and advantages obtained when employing beam power tubes incorporating the anode of my invention as in contrast with conventional beam power tubes. In the graph the axis of abscissas represent E_b, anode voltage in volts, and the axis of ordinates represent I_b, plate current in milliamperes; the curves are plotted for constant values of E_c, the grid bias voltage.

Conventional beam power tubes are characterized by having abrupt sharp knees and negative transconductance characteristics, that is, for a constant low value of plate voltage higher values of plate current result when using higher negative values of grid bias. The negative transconductance characteristic region is evident between point A and point B of the conventional tube characteristic curves, Figure 3. Therefore, if the tube is to be driven into or below the knee the immediate task is to round the sharp knee and to eliminate the negative transconductance characteristics in a manner which will not be deleterious to the aforementioned tube characteristics and quality characteristics which make the tube highly desirable commercially.

I have found that the shape of the knee and the slope of the curve is a function of the electron focusing between the screen or number two grid and the plate. An anode located at too great a distance from the screen adversely affects the power output, sensitivity, and efficiency of the

tube while an anode located too near the screen causes undesired secondary emission.

The anode **16** of my invention is formed with embossments or projections **25** and **26** for the purposes of varying the focusing of the electron beams **29** and **29'** without changing the secondary emission suppressing function of space-charge regions **20** and **20'** located between the anode **16** and the screen grid **23**. Contiguous points on embossments **25** and **26** are at variably spaced distance from the screen grid **23** and change the field configuration in the space charge regions **20** and **20'** at the operating levels of the current density, thus preventing the space charge regions **20** and **20'** from becoming an abnormally low potential area which would tend to distort the primary electron beams **29** and **29'**.

It has been shown that by employing the embossed anode **16** of the invention that, although the knee is rounded, the tube perveance, that is, the slope of the tube characteristic curves below the knee, is actually increased and indicates that the negative transconductance operating region is eliminated. Figure 3 clearly shows the marked improvement obtained using a beam power tube incorporating my invention.

As has been previously stated, when a beam power tube of the type heretofore known is used in the horizontal deflection system of a television receiver, the tube will cause transient or spurious oscillations which will result in vertical lines on the picture tube of a television receiver. In a beam power tube incorporating my invention by virtue of the embossments **25** and **26** which project inwardly toward the space charge region **20**, spurious oscillations are eliminated or so greatly reduced that no interfering lines are apparent on a television receiver. Beam power tubes incorporating my invention may also be advantageously used to reduce high-frequency interference in the output of a radio receiver.

While specific examples have been given in describing details of this invention, it will be understood that they have been given merely by way of illustration and that the invention is not limited thereto. Further, while I have suggested employing the beam power incorporating my invention in a deflection circuit of a television receiver or in the output stages of a radio receiver it will be understood that the use of said tube is not limited thereto and that other uses will be apparent to those skilled in the art.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A beam power tube comprising an anode, a cathode, a screen grid, beam-confining electrodes disposed between said screen grid and said anode, said anode having curved surface portions extending toward the space bounded by said anode, said screen grid, and said beam forming electrodes, and said curved surface portions having a double U-shaped contour.

2. A beam power tube comprising an anode, a cathode, a screen grid, beam-confining electrodes, said anode comprising two cup-shaped members joined to define junctions at the open ends thereof and having inwardly projecting embossments adjacent said junctions and extending toward the space bounded by said anode, said screen grid and said beam forming electrodes, and said embossments having a double U-shaped contour.

3. In a beam power tube comprising electron beam producing means, a control grid, a screen grid, beam confining electrodes, and an anode, said beam confining electrodes being elongated and defining longitudinally elongated oppositely directed beams, said anode comprising an elongated box-like member surrounding the other of said electrode elements and including oppositely disposed portions each intercepting only one of said beams, and each of said oppositely disposed portions of said anode including a pair of parallel, longitudinally, inwardly extending curved surface portions disposed in the intermediate area of each of said beam intercepting portions of said anode, each pair of said curved surface portions having a double U-shaped contour and effecting substantially variable interception of the electrons of said beam, whereby undesired oscillations in said tube are suppressed.

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