March 5, 1946. O. H. FULTON, JR 2,396,170

ELECTRON DISCHARGE DEVICE

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Fig. 1.

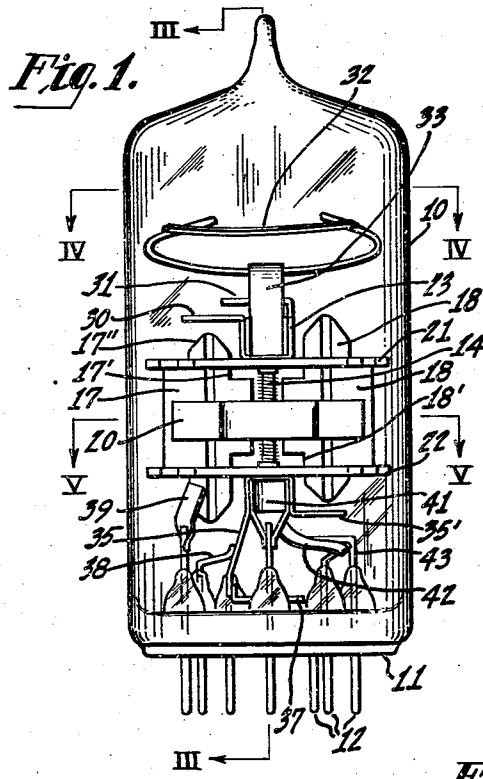


Fig. 2.

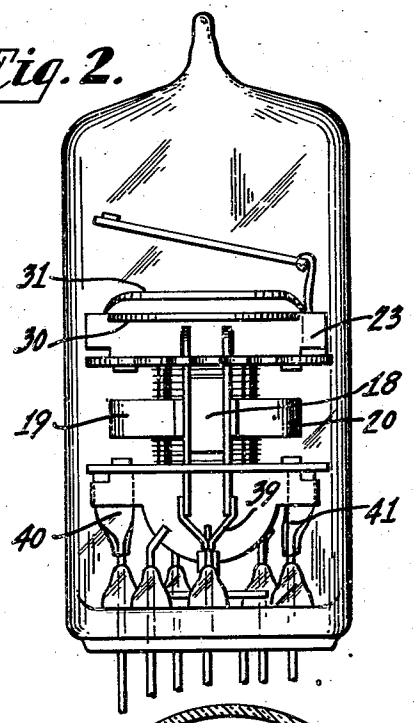


Fig. 4.

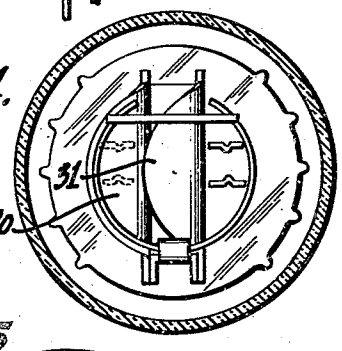


Fig. 3.

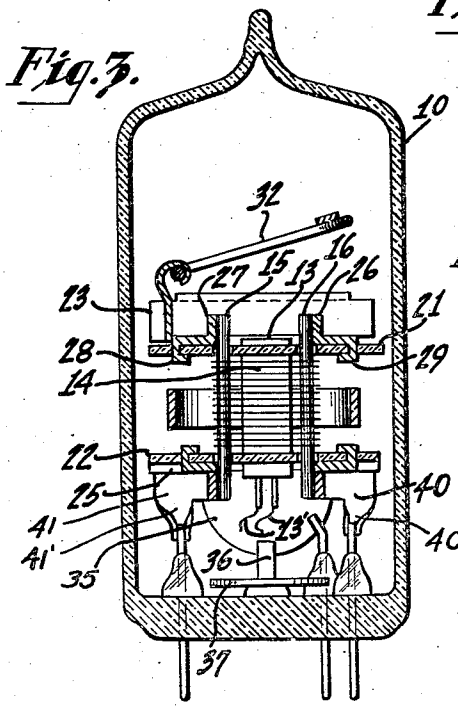
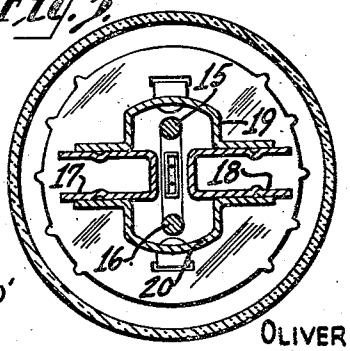


Fig. 5.



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Fig. 6.

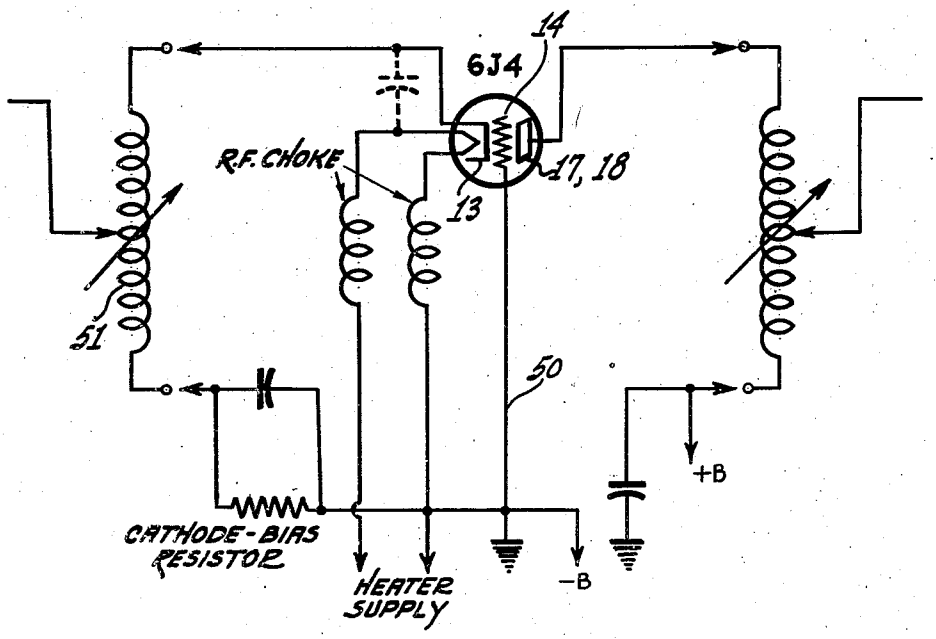


Fig. 7.

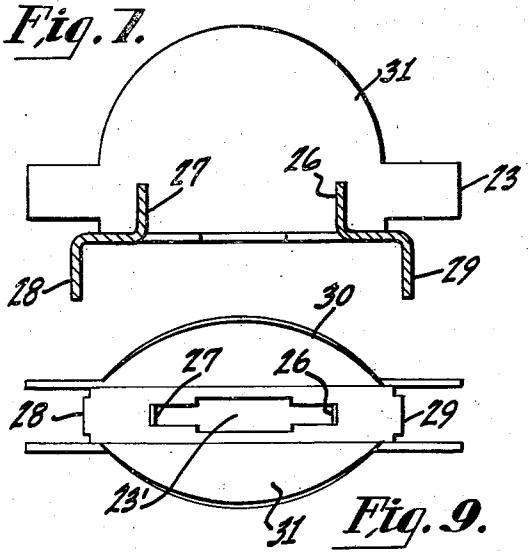


Fig. 9.

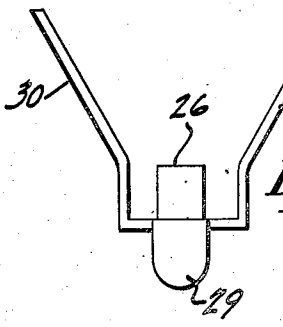


Fig. 8.

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UNITED STATES PATENT OFFICE

2,396,170

ELECTRON DISCHARGE DEVICE

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Application January 18, 1945, Serial No. 573,343

9 Claims. (Cl. 250—27.5)

My invention relates to electron discharge devices and particularly to such devices useful at very high frequencies.

When an electron discharge device is to be used as an amplifier or as a mixer at ultra high frequencies, a low noise level is a primary consideration. Best results require the use of a high vacuum triode. However, in triodes used as radio frequency amplifiers, feedback becomes a problem. To eliminate the need for neutralization due to undesired regeneration, when the device is used as a radio frequency amplifier, it is operated as a grounded grid triode and the input and output must be well shielded from each other to bring about low feedback capacity, that is plate-to-cathode and heater.

Since lead inductance and interelectrode capacity are limiting factors in high frequency operation, these must be kept at a minimum. At high frequency, transit time loading is a problem which must be overcome by close spacing of elements introducing a manufacturing problem in assembly. High transconductance and a moderately high amplification factor are also desirable features. Lightweight construction with all electrode leads coming through one end of the envelope simplifies and reduces the size of the associated circuits, particularly where lumped parameters are used.

It is, therefore, an object of my invention to provide an improved electron discharge device useful as an amplifier or mixer at ultra high frequencies of the order of 500 megacycles.

Another object of my invention is to provide such a device having a low noise level, that is a high signal-to-noise ratio.

A particular object of my invention is to provide an electron discharge device of the triode type, suitable for use as a grounded grid amplifier or mixer and particularly adaptable for use with circuits having lumped parameters.

A further object of my invention is to provide such a device having a high transconductance and moderately high amplification factors.

Another object of my invention is to provide a device of this kind having low inductance high radio frequency conductance.

A further object of my invention is to provide such a device in which small interelectrode capacity with resultant low input and output capacities and low feedback capacity are provided.

A still further object of my invention is to provide such a device in which the transit time loading factors are small.

These and other objects will appear hereinafter.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawings in which Figure 1 is a side elevation of an electron discharge device made according to my invention, Figure 2 is a view of Figure 1 turned 90°, Figure 3 is a section taken along the line 3—3 of Figure 1, Figure 4 is a section taken along the line 4—4 of Figure 1, Figure 5 is a section taken along the line 5—5 of Figure 1, Figure 6 shows a typical grounded grid circuit utilizing a tube made according to my invention, and Figures 7 to 9, inclusive, are enlarged views of a detail of the construction used in an electron discharge device made according to my invention.

Referring to the drawings, an electron discharge device made according to my invention includes an evacuated envelope 10 having a flat press 11 and the usual plurality of leads 12 sealed therethrough and arranged in a circle, the press 11 serving as the base for the tube.

The mount assembly comprises a flat cathode 13 surrounded by a flat grid 14 having side rods 15 and 16 lying in a common plane. Mounted opposite the flat sides of the cathode coated with the usual emitting coating are a pair of anode members 17 and 18 having a U-shaped transverse section, the closed ends of the U being flat and oppositely disposed to the emitting surfaces of the cathode. These anode elements are cut back as at 17′ and 18′ to reduce the cathode-anode capacity while at the same time providing the necessary surface registering with the emitting surfaces of the cathode to receive all the electrons therefrom. These anode elements are strapped together by means of strapping elements 19 and 20. This mount assembly is received between and supported by a pair of spaced insulating spacer members 21 and 22, preferably of mica. They are provided with the proper apertures for receiving the ends of the cathode, grid side rods and the anode or plate ears, such as 18″ and 17″.

According to my invention the device is primarily to operate with a grounded grid circuit and the grid structure is such that the anode and its lead are substantially completely shielded at all points from the cathode and the cathode heater leads.

In accordance with my invention I provide

shielding elements at the top and bottom of the grid and secured to the grid. The top shielding element 23, which may be seen in greater detail in Figures 7, 8 and 9, prior to assembly, is provided with an aperture 23' through which the cathode extends without contact. At the ends of the aperture are provided tabs 26 and 27 which are secured to the upper ends of the side rods 15 and 16 preferably by welding. The shield is also provided with a pair of tabs 28 and 29 which extend through appropriate apertures in the mica spacer 21 and are folded over to securely lock the mica shield and grid together. The shield is provided with a pair of arcuate shaped flaps or aprons 30 and 31 which, as shown in Figures 1 to 3 inclusive, are formed to provide the necessary shielding. Flap 31 is folded over the trough to completely shield the upper end of the cathode from the ears of the anode and the flap 30 is bent over the upper ears of the plate member 17. Thus no part of the cathode directly sees the anode outside the grid-cathode space and complete shielding results.

Mounted at the lower end of the mount assembly is a second shield member 25 substantially like that at the top of the mount assembly. This bottom shield member, however, is provided with a strap 36 at the lower end of which is mounted a transverse shielding disc 37 which extends close to the top of the press 11 and is received between the various leads arranged in a circle.

The bottom shield 25 is electrically connected to the lower ends of the grid side rods 15 and 16. However, in this case the tabs corresponding to 26 and 27 are removed from the shield. In their place U-shaped elements 41 and 40 are used, the end view of which is shown in Figure 1, the side view in Figure 2 and in section in Figure 3. These U-shaped elements have a pair of oppositely disposed dependent legs such as 40' and 41' which may be wrapped around and welded to the lead wires. The downwardly extending legs are connected to a pair of oppositely disposed leads in the press, the leads lying in the same plane so that the press is bisected by the shield and leads. In assembly the elements 40 and 41 are first welded to the grid side rods and then to the sides of the shield.

The lower ears of the anode element 17 are connected through U-shaped strap 39 to one of the leads, and the strap and lead are completely shielded by one of the arcuate-shaped aprons or skirts 35 on the lower shield and by the strap member 36. A further strap 38 connects the shield to one of the leads 12.

The cathode is provided with a strap 42 connected to another lead 12 oppositely disposed to the anode lead, and the two heater leads 13' are connected to two other leads 12. These connectors and leads are shielded from the strap 39 and its associated lead by the apron or skirt 35, and the lower ears on the anode element 18 are shielded from the cathode and cathode heater leads by the skirt 25' which is formed to extend transversely of the mount and parallel to the base and extends between the lower ears of anode element 18 and the cathode strap and heater leads.

Thus it is apparent that the anode and cathode are completely shielded from each other at all points, including the connectors and leads, and that this arrangement permits an external shield to be connected to the oppositely disposed contact leads and pins connected to the bottom shield so that externally the input and ouput circuits may also be shielded from each other, thus preventing regeneration.

A getter ring 32 may be secured to this top shield by means of the strap 33. All of the connectors between the contact pins and leads and the various electrodes are wide straps which have low loss and low conductance. Because of the high turns-per-inch of the grid wires, in the example shown 240 turns per inch of 1.2 mil wire was used, and the close spacing between plate and grid of the order of 15 mils, high transconductance and low transit time loading results. A transconductance of between 11,000 and 12,000 micromhos with an amplification factor of 55 has been obtained with devices made according to my invention, the whole arrangement being placed in an envelope less than two inches in length and three quarters of an inch in diameter.

While I have indicated the preferred embodiments of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims.

What I claim as new is:

1. An electron discharge device having an envelope including cathode, grid and anode electrodes, said cathode electrode and said anode electrode having leads, said grid electrode having a shield provided with a skirt adjacent the anode electrode lead and positioned between the anode lead and the cathode lead, said envelope having a press, a plurality of leads extending through said press, said grid shield being connected to leads oppositely disposed across said press whereby the space between the press and said electrodes is divided into two shielded compartments.

2. An electron discharge device having an envelope provided with a press at one end thereof, a plurality of leads extending through said press, a mount within said envelope comprising a cathode, grid and anode supported on said leads, said grid being provided with shields for shielding said anode from said cathode, said cathode and said anode being connected to leads oppositely disposed across said press, said grid shield being connected to leads at opposite sides of said press, said last leads lying in a plane passing between said cathode lead and said anode lead.

3. An electron discharge device having an envelope provided with a press at one end thereof, a plurality of leads arranged in a circle extending through said press, a mount within said envelope comprising a cathode, grid and anode supported on said leads, said grid having a shield for shielding said anode from said cathode, said cathode and said anode being connected to leads disposed on opposite sides of said circle, said grid shield being provided with connectors connected to leads on opposite sides of said circle, said last leads lying in a plane passing between said cathode lead and said anode lead.

4. An electron discharge device including an envelope having a press provided with a plurality of leads extending therethrough, a mount supported within said envelope and including a cathode, a grid surrounding said cathode, and an anode outside of said grid, a connector connected between the anode and a lead in said press, and a

connector connected between said cathode and a lead in said press oppositely disposed to said lead connected to said anode, said grid being provided with a shield connected thereto and positioned between the press and said grid, said shield being provided with a skirt adjacent said anode lead for shielding said anode lead from said cathode lead, said shield being connected to other leads in said press, said other leads lying in a plane passing between the anode lead and the cathode lead.

5. An electron discharge device including an envelope having a press provided with a plurality of leads extending therethrough, a mount supported within said envelope and comprising a pair of insulating spacer members, a cathode and a grid surrounding said cathode positioned between said spacing members, and an anode outside of said grid and positioned between said spacing members, said cathode, grid and anode extending through said spacer members, a low inductance lead connected between the anode and a lead in said press, and a low inductance lead connected between said cathode and a lead in said press oppositely disposed to said lead connected to said anode, said grid being provided with a shield connected thereto and positioned between the press and one of said insulating spacer members, said shield being provided with a skirt adjacent said anode lead for shielding said anode lead from said cathode lead, said shield being provided with a pair of oppositely disposed low inductance connectors connected to other leads lying in a plane passing between the anode lead and the cathode lead.

6. An electron discharge device including an envelope having a press, a plurality of leads extending through said press and arranged around said press, a mount supported by said leads and including a flat cathode, a flat grid surrounding said cathode and provided with a pair of side rods lying in a plane parallel to the flat side of said grid, and anode elements positioned adjacent the flat sides of said cathode and grid, a shield connected to the side rods of said grid adjacent said press, an anode lead extending from one of said anode elements and connected to a lead in said press, a cathode lead extending from said cathode and connected to a lead in said press oppositely disposed to the anode lead, said shield having an apron adjacent said anode lead, a shield lying parallel to the press and within the space defined by the leads in said press and connected to said apron, a second apron on said shield extending parallel to the press and positioned between the anode and said cathode lead.

7. An electron discharge device including an envelope having a press, a plurality of leads extending through said press and arranged in a circle, a mount supported by said leads and including a cathode, a grid surrounding said cathode and provided with a pair of side rods lying in a plane, and an anode adjacent the grid, a shield connected to the end of the side rods of said grid adjacent said press, said anode being connected to a lead in said press, said cathode being connected to a lead in said press oppositely disposed to the anode lead, said shield having an apron adjacent said anode lead, a shield lying parallel to the press and within the circle defined by the leads in said press and connected to said apron, a second apron on said shield extending parallel to the press and positioned between the anode and said cathode lead, and connections between the shield and oppositely disposed leads lying in the plane of said side rods.

8. An electron discharge device including an envelope having a press, a plurality of leads extending through said press and arranged around said press, a mount supported by said leads and including a flat cathode, a flat grid surrounding said cathode and provided with a pair of side rods lying in a plane parallel to the flat sides of said cathode, and anode elements positioned adjacent the flat sides of said cathode and grid, a shield connected to the grid side rods at each end of said grid, an anode element being connected to a lead in said press, said cathode being connected to a lead in said press oppositely disposed to the anode lead, the shield adjacent the press being provided with an apron adjacent said anode lead, a shield lying parallel to the press and within the space defined by the leads in said press and connected to said shield, a second apron on said last mentioned shield extending parallel to the press and positioned between an anode and said cathode lead, the shield at the end of said grid remote from said press having an apron folded over the ends of the grid side rods and the end of said cathode remote from said press.

9. An electron discharge device including an envelope having a press, a plurality of leads extending through said press and arranged in a circle, a mount supported by said leads and including a pair of spaced insulating spacers, a flattened cathode mounted between said spacers, a flattened grid surrounding said cathode and provided with a pair of side rods lying in a plane parallel to the flat sides of said cathode, and anode elements positioned adjacent the flat sides of said cathode and grid and having ears extending through said mica spacers, a shield connected to the side rods at each end of said grid on the outside of the space between said spacers, said anode elements being connected to a lead in said press, said cathode being connected to a lead in said press oppositely disposed to the anode lead, the grid shield adjacent the press having an apron adjacent said anode lead, a shield lying parallel to and adjacent the press and within the circle defined by the leads in said press and connected to said apron, a second apron on said last mentioned grid shield extending parallel to the press and positioned between an anode ear and said cathode lead, the shield at the end of said grid remote from said press having a skirt extending over an anode ear, and a second skirt folded over the ends of the grid side rods and the end of said cathode remote from said press.

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