

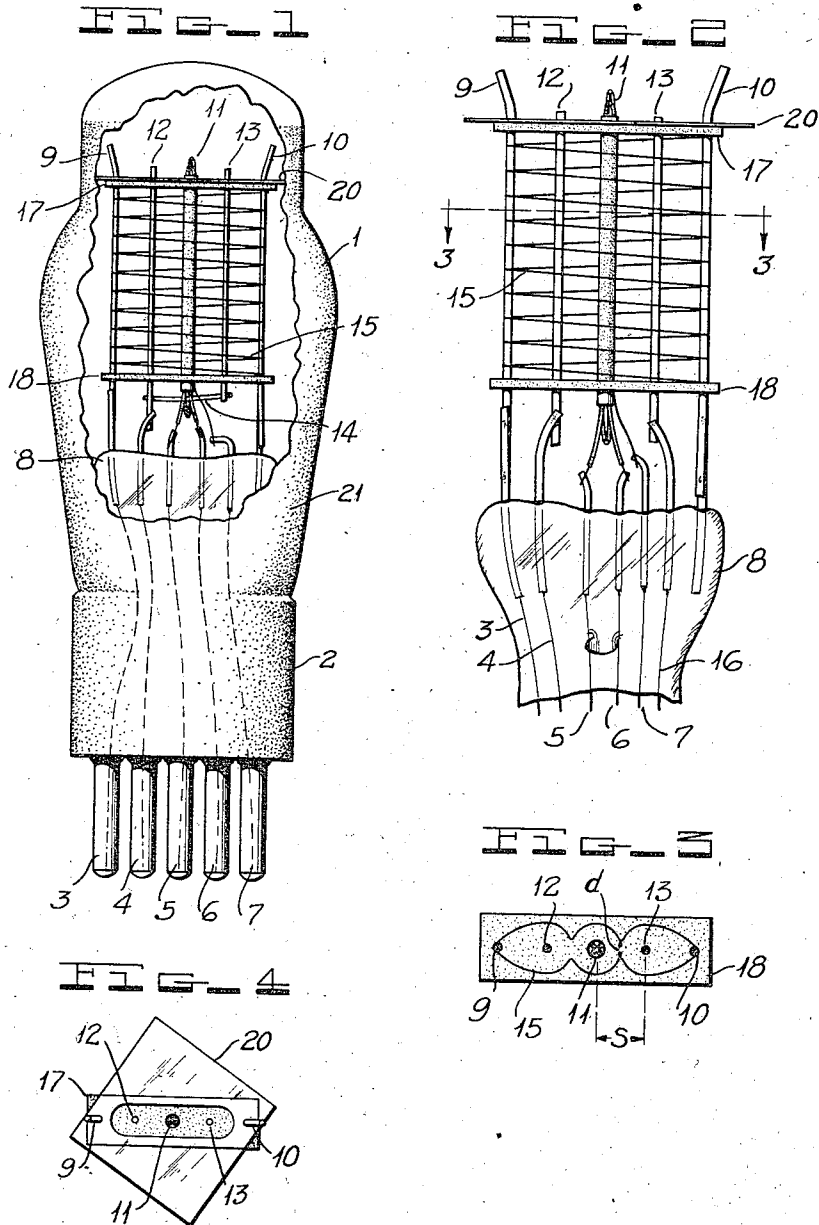
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ELECTRON DISCHARGE DEVICE

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ELECTRON DISCHARGE DEVICE

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My invention pertains to electron discharge devices and relates in particular to that type of such devices known as thermionic tubes.

Thermionic tubes as universally constructed employ a control grid located between the cathode and the anode. Such construction necessitates providing an anode of considerable surface area in order that the temperature of the anode may be maintained sufficiently low to ensure that the control grid enclosed thereby will not attain a temperature high enough to emit electrons and thereby lower the input impedance of the tube.

It is an object of my invention to reduce the area of the anode and thus simplify and render more economical the construction and at the same time retain the desirable electrical characteristics of such tubes and attain new advantageous electrical characteristics.

Another object comprises increasing the energy radiation of the anode that an effective energy dissipation may be attained.

Another object comprises producing a thermionic tube in which due to the novel form and positioning of the control grid with respect to the anode and cathode, a multiplication of the amplification factor may be attained.

An additional object comprises producing a thermionic tube in which a variable amplification factor may be attained.

A further object comprises producing a thermionic tube having a large grid area whereby the temperature of the grid may be maintained sufficiently low to eliminate primary electron emission.

A still further object comprises producing a thermionic tube in which the direct capacitance between the anode and control grid is a minimum whereby the tube may be effectively used as a short wave oscillator.

I accomplish all of the above noted desirable features and others which will be hereinafter pointed out and described by means of a novel construction in which the control grid is disposed externally with respect to the cathode and the anode and is formed with re-entrant or constricted portions between the cathode and anode whereby both the anode and the cathode are partially encircled by the grid.

In the drawing accompanying and forming a part of this specification and in which like reference numbers designate corresponding parts throughout:

Fig. 1 is a side view of my improved tube with a portion of the envelope broken away to show the electrodes therein;

Fig. 2 is a side view of my improved tube with the enclosing envelope broken away to show an alternative connection of the anodes.

Fig. 3 is a sectional plan view taken on the line 3—3 of Fig. 2; and

Fig. 4 is a top view of the structure shown in Fig. 1 with the envelope omitted.

Referring now particularly to Figs. 1, 3, and 4, the envelope 1, which is preferably of glass or other vitreous material, is provided with a stem and press 8 and the usual base 2 containing contact prongs 3, 4, 5, 6, and 7. The envelope 1 and base 2 are preferably provided with a metal coating 21 sprayed thereon as described in my Patent No. 1,958,953, issued May 15, 1934, for a purpose which will hereinafter be discussed.

The press 8 supports a cathode 11, the heater terminals of which are connected as shown to contact prongs 5 and 6. The cathode may be, as shown, of the indirect heated type or it may be of the filamentary type either coated or uncoated. Adjacent the cathode and likewise supported from the press are rod-like anodes 12 and 13. These are electrically interconnected by conductor 14 and are connected as shown to contact prong 4. A pair of standards 9 and 10, one of which, 9, is connected to contact prong 3, are supported by the press and serve to support the control grid 15 which is shown for the sake of simplicity in the form of a conductor wound in helical form on the standards 9 and 10. The electrodes are maintained in their relative positions with respect to each other by means of spacers 17 and 18. Preferably these spacers are constructed of any well-known ceramic adapted to withstand high temperature.

There is provided an additional spacer 20 which may be of mica for the purpose of positioning the upper portion of the electrode assembly in the envelope 1. This spacer 20 is as shown in Fig. 4 provided with a central aperture to remove the material of the spacer from contact with the cathode 11 and the anodes 12 and 13 in order to prevent deterioration of the mica spacer by the high temperature carried by these electrodes.

The control grid 15 is as shown in Fig. 3 positioned externally with respect to the anode rods 12 and 13 and the cathode 11. The control grid may be constructed on a mandrel and is formed with re-entrant or constricted portions as shown in Fig. 3 so that the grid when in position partially encircles each of the anode rods 12 and 13 and the cathode 11.

In tubes which I have constructed in accordance with my invention, I have found that the

distance "d", Fig. 3, is quite important in determining the amplification constant of the tube and its other electrical characteristics. With the structure shown in the figures, a great many of the electrons in their journey from the cathode 11 to the anode rods 12 and 13 must pass through the control grid 15 twice. That is, they pass through the grid from the cathode outward and from outside of the grid inward to the anode rods 12 and 13. This weaving of the electrons through the grid causes a multiplication of the amplification factor and renders possible the attainment of a high transconductance triode.

For example, when the distance "d" has a value of approximately 0.045 inch, I obtain an amplification factor of 3, and when this constricted portion is reduced only slightly, as for instance to 0.020 inch, I obtain an amplification factor of 9. In tubes which I have constructed with the distance "d" having a value of 0.025 inch, I have been able to duplicate the commercial triode Type 227 in an electrical manner even though the anode instead of having a large surface consists of only a wire twenty-five thousandths of an inch in diameter. This will serve to illustrate the degree of simplification and economy attained.

Preferably the anodes are constructed of refractory material such as tungsten, molybdenum or nickel, depending upon the number of watts of energy it is desired to dissipate. It is therefore essential that the spacers 17 and 18 be able to withstand this high temperature without causing the evolution of gases as in the case of mica and for this reason the mica spacer 20 is provided with the aperture as shown in Fig. 4. Because of the fact that the grid is external with respect to the anode it can be maintained at a sufficiently low temperature to avoid primary electron emission and at the same time the anodes may be operated at a very high temperature in order to achieve the desired dissipation of energy. The anode rods may be maintained at a white heat or just under a temperature at which the vapor pressure of the metal of the rod will not cause thinning out of the rod for several thousand hours. The energy therefore which is radiated from the anodes is in the form of light and from physical laws it follows that the energy per quantum increases with the increasing frequency of light. Consequently, the dissipation of energy from the refractory anode rods takes place efficiently within a frequency spectrum corresponding to white light, whereas in the case where a large area anode is utilized, the radiation takes place in the red end of the spectrum in the form of long wave length heat rays. Obviously, the structure is simple and economical due to the small size of the anodes and as these anodes with the externally disposed grid can be operated at very high temperatures the equivalent dissipation of energy to that of the older type construction can be attained.

The ratio

$$\frac{d}{s}$$

Fig. 3, is important in the functioning of the tube. I find by experiment that it is not useful to have this ratio of greater value than 33%. The maximum utility is in the region when this variation is equal to less than 10%. When this factor is equal to some value of the order of 10% then in the region of cut-off a low amplification factor is attained and at zero voltage on the grid a high

amplification factor is attained. By proper design of the factor

$$\frac{d}{s}$$

it is possible to design a tube with a variable amplification factor to achieve valuable commercial results.

It is of advantage in my novel construction to provide an exterior metallic coating 21 on the envelope and base 2, as the electrons emerging from the cathode through the control grid and weaving back again through the grid cause a certain number of electrons to exist outside of the grid for a small period of time. If an uncoated envelope were used, grid action of wall charges would produce undesirable effects, but with the use of the coating 21 as shown this grid action of wall charges is minimized and the fluctuation component due thereto is reduced to a minimum. Ordinarily this metallic coating 21 is grounded to the cathode in order to prevent the above noted ill effects and also stray field charges from affecting the fluctuation component of the anode current.

In Fig. 2, I have shown a modification of my invention in which the rod-like anodes 12 and 13 are brought out to separate contact prongs as 4 and 16 that the tube may be used as a double anode tube. The other elements shown in Fig. 2 are exactly the same as those described with reference to Figs. 1, 3, and 4 and it is thought that no further explanation of this embodiment is necessary.

From the foregoing it will be readily apparent that I have produced a novel thermionic tube in which, while the present desirable electrical characteristics are retained and new desirable features are attained, the construction is simplified and rendered more economical to produce.

It should be noted also that the energy radiation of the anode is increased to provide fully effective energy dissipation and that a multiplication of the amplification factor may be easily achieved, or that a variable amplification factor may be attained.

It should be further noted that the relatively large grid area and the external position of the grid permits maintaining the grid at a temperature sufficiently low to ensure substantially no primary electron emission. It should also be pointed out that the structure permits of a minimum direct capacitance between the anode and control grid, thereby produces a tube which may be effectively used in the very short wave spectrum as an oscillator.

Having thus completely described and disclosed my invention, what I claim and desire to secure by United States Letters Patent is as follows:

1. An electron discharge device comprising, a substantially evacuated envelope containing a cathode, an anode, said anode being in the form of a plurality of rods electrically interconnected, and a control grid externally disposed with relation to both said cathode and said anode, and formed with re-entrant portions located between said cathode and anode.

2. An electron discharge device comprising, a substantially evacuated envelope containing a cylindrical cathode, an anode, said anode being in the form of a plurality of rods electrically interconnected and a control grid helically and externally disposed with relation to both said anode and cathode and having constricted portions between said cathode and anode whereby said cath-

ode and anode are each partially encircled by said grid.

5 3. An electron discharge device comprising, a substantially evacuated envelope containing a cathode, a plurality of anodes and a control grid externally disposed relative to said cathode and each of said anodes and having re-entrant portions located between said cathode and each of said anodes.

10 4. An electron discharge device comprising, a substantially evacuated envelope containing a cathode, a pair of anodes positioned substantially co-planar with said cathode, and a control grid externally disposed relative to said cathode and
15 each of said anodes and having constricted por-

tions located between said cathode and each of said anodes whereby said cathode and each of said anodes are partially encircled by said grid.

5 5. An electron discharge device comprising a substantially evacuated envelope containing a cathode and an anode in the form of a rod of small diameter, a control grid externally disposed relative to both said cathode and anode and formed with re-entrant portions located between
10 said cathode and anode and a metallic coating on the exterior surface of said envelope for co-action with the electrodes located within said envelope.

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