May 18, 1926. 1,585,445

J. C. WARNER

ELECTRON DISCHARGE APPARATUS AND METHOD OF OPERATING THE SAME

Filed Feb. 29, 1924

Fig. 1.

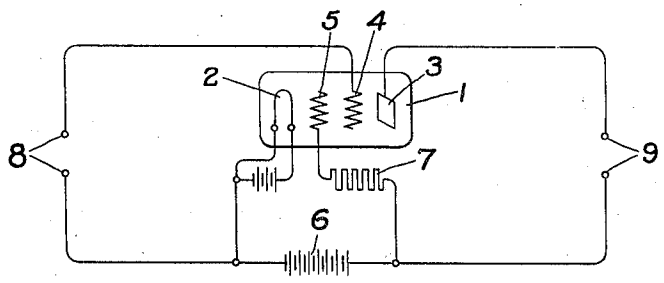
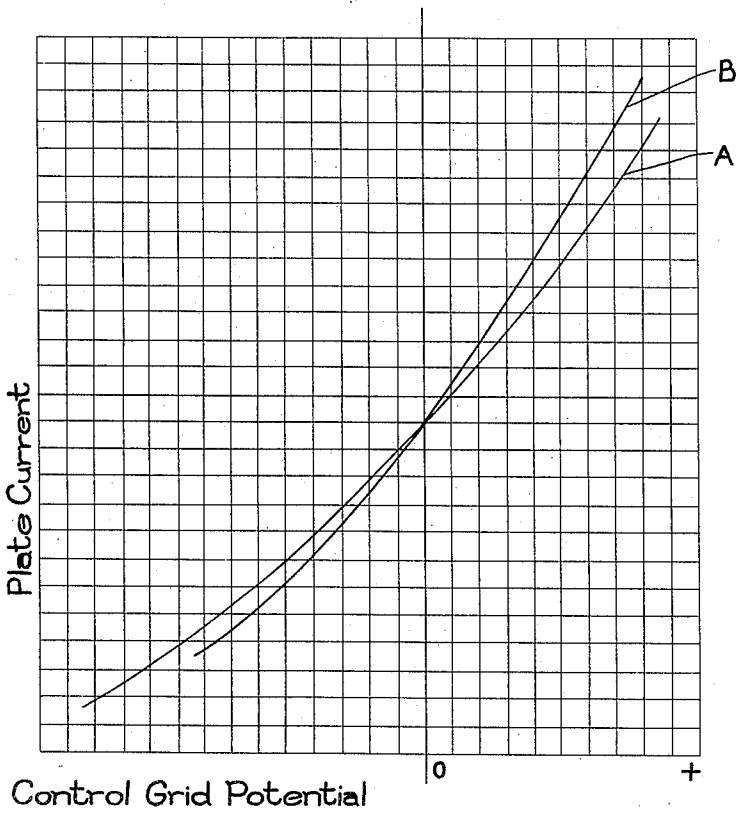


Fig. 2.



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UNITED STATES PATENT OFFICE.

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ELECTRON-DISCHARGE APPARATUS AND METHOD OF OPERATING THE SAME.

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My present invention relates to electron discharge apparatus, and more particularly to devices of the thermionic type having at least four electrodes.

One of the objects of my invention is to provide an improved method for operating a device of the type mentioned, and a new circuit organization whereby this method may be carried out.

In connection with electron discharge devices of the thermionic type having a grid for controlling the flow of current between cathode and anode, it has been proposed to employ a second grid between the cathode and the control grid, and to impress upon this second grid a constant positive potential somewhat lower than that of the anode. A grid used in this way is commonly known as a space charge grid. The purpose of this grid is to lower the impedance between the cathode and anode, and for this purpose the grid has ordinarily been maintained at a constant positive potential. It has been observed, however, that the current flowing to this space charge grid varies in the opposite way from the manner in which the current to the anode varies when acted upon by the control grid. That is, as the current to the anode increases the current to the space charge grid decreases, and vice versa.

A more specific object of my invention is to provide means for taking advantage of this secondary variation of the current to the space charge grid to assist the control grid in its action in varying the current flowing to the anode.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, my invention itself, however both as to its organization and method of operation will best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 shows a circuit arrangement whereby my invention may be carried into effect, and Fig. 2 shows some characteristic curves indicating the improvement in the operating characteristics of the device, which may be obtained by making use of my invention.

I have indicated in Fig. 1 of the drawing an electron discharge device 1 having the usual electron emitting cathode 2, and anode 3, a control grid 4 and a space charge grid 5. In practice devices suitable for carrying out my invention may most conveniently be made in concentric form, the cathode being centrally located, the space charge grid 5 closely surrounding the cathode and the control grid 4 and anode 3 surrounding the cathode and space charge grid.

The usual source of potential 6 is connected in the output circuit of device 1 and the positive terminal of this source is connected through a resistance 7 to the space charge grid 5. Currents to be amplified may be supplied to the input terminals 8 of the system and the amplified currents may be supplied from the output terminals 9 to any desired apparatus.

The operation of the circuit described is as follows:—

As the potential of the control grid 4 is varied, the current to the space charge grid through the resistance 7 will vary, and hence the potential drop across resistance 7 will vary. If the control grid is made more positive with respect to its initial value the plate current will increase and the current to the space charge grid decrease. As a result the potential drop across resistance 7 will decrease and the potential of the space charge grid increase, thus aiding the control grid in its action since the space charge grid also controls to a certain extent the plate current. In the same way when the potential of the control grid is made negative with respect to its initial value the plate current will decrease, the current to the space charge grid will increase and the potential drop across resistance 7 will increase. As a result the potential of the space charge grid 5 will decrease and cause a greater decrease in the plate current than would result from the action of the control grid alone.

The effect of this method of operation is indicated in the characteristic curves of Fig. 2. Curve A of Fig. 2 represents the relation between plate current and the potential of the control grid with the space charge grid operating at a fixed potential which may be substantially a mean between the potential of the cathode and that of the anode. Curve B represents the plate current grid potential characteristic when the system is operated in the manner described. In this particular instance the value of resistance 7 is so chosen that with no potential upon the control grid the voltage of the space charge grid is the same as when the characteristic

A was taken. It will be apparent from an inspection of curves A and B that the slope of curve B is considerably steeper than that of curve A. Since the degree of amplification obtained is dependent upon the slope of the characteristic curve, it is evident that curve B represents a distinct improvement in the degree of amplification which may be obtained over that represented by curve A.

While I have shown and described a preferred embodiment of my invention, it will be evident that my invention is by no means limited to the particular embodiment shown. The impedance indicated in circuit with the space charge grid need not necessarily be an ohmic resistance as other forms of impedance devices may be used which will give a suitable voltage drop.

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

1. The combination with an electron discharge device having an electron emitting cathode, an anode and two grids interposed between cathode and anode, of an input circuit connected to the grid nearest the anode, an output circuit containing a source of potential which is connected to the anode through a load, and a connection from a point of constant potential on said source through an impedance to the grid nearest the cathode whereby that grid is maintained at a positive potential less than that of the anode.

2. The combination with an electron discharge device having an electron emitting cathode, an anode, and two grids interposed between cathode and anode, of an input circuit connected to the grid nearest the anode, an output circuit which includes a source of potential having its positive terminal connected to the anode through a load, and a connection from the positive terminal of said source through an impedance to the grid nearest the cathode.

3. The combination with an electron discharge device having an electron emitting cathode, an anode, and two grids interposed between cathode and anode, of an input circuit connected to the grid nearest the anode, an output circuit which includes a source of potential having its positive terminal connected to the anode through a load, and a connection from the positive terminal of said source through an ohmic resistance to the grid nearest the cathode.

4. The combination with an electron discharge device having an electron emitting cathode, an anode and two grids interposed between cathode and anode, of an input circuit connected to the grid nearest the anode, an output circuit containing a source of potential which is connected to the anode, means for impressing a positive potential upon the grid nearest the cathode, and means for producing variations in the potential of the grid nearest the cathode corresponding in direction to variations in the potential of the other grid whereby both grids cooperate to control the current to the anode.

5. The combination with an electron discharge device having an electron emitting cathode, an anode and two grids interposed between anode and cathode, of an input circuit connected to the grid nearest the anode, an output circuit containing a source of potential the positive terminal of which is connected to the anode, means for impressing currents to be amplified on the input circuit, and means for causing the potential of the grid nearest the cathode to vary in a corresponding manner with the potential variations of the other grid.

6. The method of operating an electron discharge device having an electron emitting cathode, an anode and two grids interposed between cathode and anode which consists in producing a flow of current between cathode and anode, impressing a variable potential upon the grid nearest the anode, and causing the potential of the grid nearest the cathode to vary in the same direction as that of the other grid thereby controlling the current to the anode by the conjoint action of the two grids.

7. The method of operating an electron discharge device having an electron emitting cathode, an anode and two grids interposed between cathode and anode, which consists in producing a flow of current between the cathode and anode and between the cathode and the grid nearest the cathode, impressing a variable potential upon the grid nearest the anode, and thereby causing the current to the other two electrodes to vary, and utilizing the variation in current to the grid nearest the cathode to vary the potential of that grid in a manner corresponding to the variation in potential of the other grid.

In witness whereof, I have hereunto set my hand this 28th day of February 1924.

JOHN C. WARNER.