Jan. 17, 1933. H. J. ROUND 1,894,599

FOUR-ELECTRODE VALVE

Filed April 22, 1927 2 Sheets-Sheet 1

Fig. 1

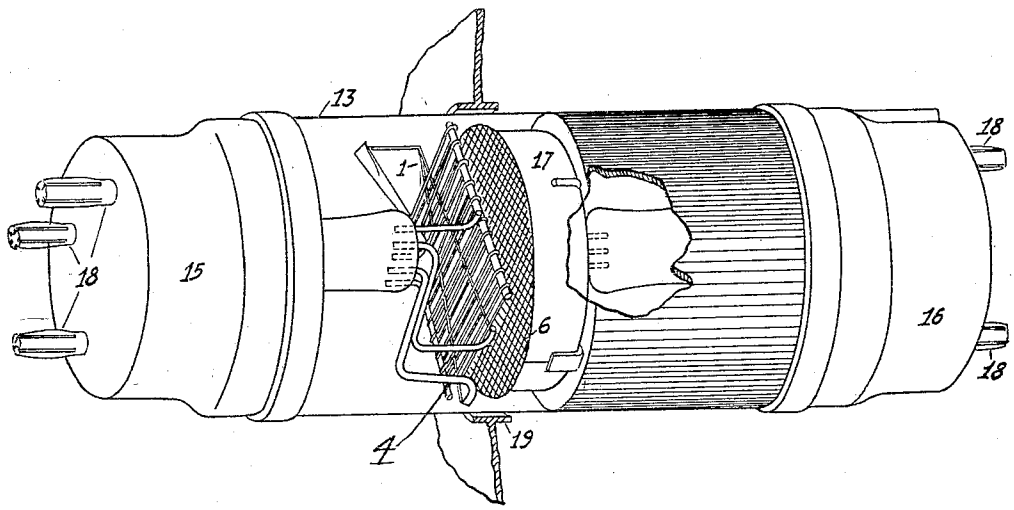


Fig. 1a

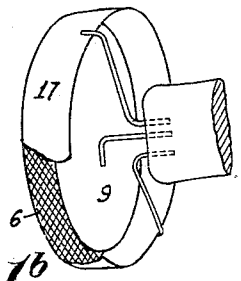


Fig. 5

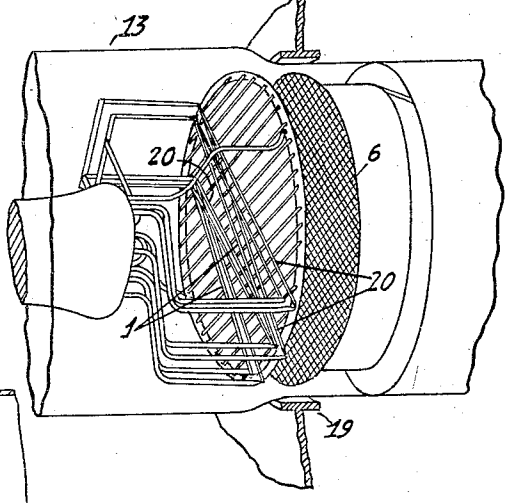
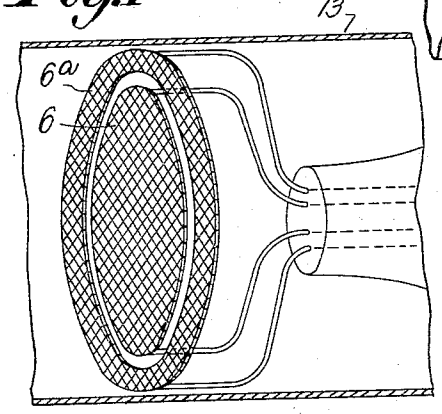


Fig. 1b



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Fig. 4

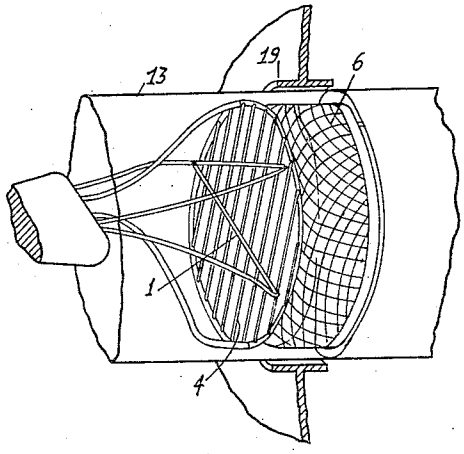


Fig. 2

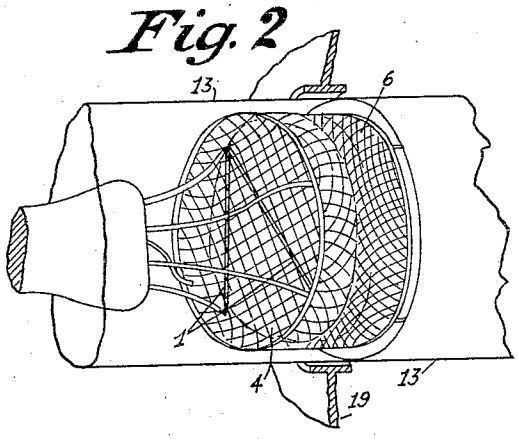
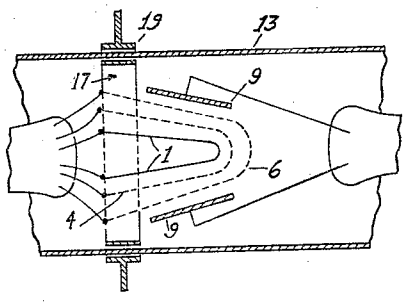


Fig. 3



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UNITED STATES PATENT OFFICE

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FOUR-ELECTRODE VALVE

Application filed April 22, 1927, Serial No. 185,822, and in Great Britain May 5, 1926.

This invention relates to four-electrode valves and has for its principal object the elimination to as great a degree as possible of undesired effects, more especially self-oscillation, due to inter-electrode capacity.

According to one feature of this invention a four-electrode valve is so constructed and arranged that one of the grids is virtually an electrostatic shield or screen between two other of the electrodes, whereby the capacity effects betwen the two said electrodes and between the input and output circuits therewith associated are minimized or eliminated. The grid next adjacent the plate (hereinafter called the outer or screen grid) is arranged completely to shield the other grid (hereinafter called the inner or control grid) from the plate. Such complete shielding is effected by continuing the outer grid substantially to the envelope of the valve, and preferably there is provided an external screen so that when in use the input and output circuits of the said valve are shielded from one another externally also. It will be seen that in a valve constructed in accordance with this invention the proximity of the "shield" or screen grid to the walls of the valve permits the external screen to be in effect electrostatically coupled to the shield or screen grid and thereby function in effect as a continuation or extension of the shield grid. If desired means may be provided for increasing the effective coupling between shield grid and external screen, for example, by dishing the shield grid and by forming or otherwise providing a ring or rim of substantial width along the edge of the shield grid and upon that part of the external screen near the walls of the valve or by dishing the shield grid or forming a rim along the outer edge of the shield grid or the inner edge of the external screen.

A further object of the invention is to provide improved means for neutralizing the effects of space charge in and thereby improving the characteristic of a thermionic valve.

As is well known the introduction of a positively charged grid between the filament and the control grid of a thermionic valve tends to improve the characteristic of the valve by the process known generally as neutralization of the space charge. It has been found, however, that the space charge grid tends to absorb to itself considerable quantities of current. This absorption effect partially cancels the benefit which the space charge grid is designed to provide.

This disadvantage is overcome by this invention, in which the space charge grid of a thermionic valve is constructed of a very fine and preferably single wire, which is shaped similarly to the filament, and is placed preferably parallel to and directly between the filament and the control grid. A convenient size for the space charge grid wire is approximately that of the filament.

It has been found that such a fine wire space charge grid tends to absorb very little current, and that consequently the general characteristic of the valve is considerably improved.

These and other advantages will become apparent from the specification when read in connection with the attached drawings in which:

Fig. 1 is a view in perspective with parts in section of a valve constructed in accordance with my invention,

Fig. 1*a* is a detailed view of the construction and location of the anode and shield grid, of the tube shown in Fig. 1,

Figure 1*b* is a modification of the valve shown in Figure 1;

Fig. 2 is a perspective with parts in section, of a modification of the valve shown in Fig. 1,

Fig. 3 is a section of a modified form of the valve,

Figs. 4 and 5 are perspective views with parts broken away of further modifications of the valve shown in Fig. 1.

Referring to Figures 1 and 1*a*, a double ended thermionic valve is shown with a cylindrical envelope 13 which encloses four cooperating electrodes and which has at the ends two insulating caps or bases 15, 16 with contact pins 18. 1 is an electron emitting cathode, such as a filament of V form as shown, surrounded by a flat oval section con-

trol grid 4 constituted by a flattened helical wire as shown.

The grid and filament are mounted transversely of the envelope so that the planes of the filament and of the flat sides of the grid are at right angles to the axis of the tubular glass envelope.

6 is a "shield" or screen grid which is preferably a sheet or disk of metal gauze placed with its plane perpendicular to the axis of the envelope, and fixed to a hoop or ring of sheet metal, such as a metal cylindrical rim 17 which may be located on one side of the gauze and extends between the edge of the anode and the walls of the envelope through the plane of the anode 9.

The anode 9 extends transversely of the envelope parallel to the plane of the cathode, is of disk form and is located on the side of the shield grid remote from the filament, the filament and inner or control grid being carried from one stem and the shield grid and anode from the other.

The location of the filament within the grid facilitates accurate manufacture and moreover has been found to result in improved mutual conductance in the valve.

In use the valve may to advantage be inserted in a hole, slightly larger than the tubular envelope, in a grounded metal sheet or outside screen 19 extending transversely of the envelope in substantially the plane of the screen grid 6 and electrostatically coupled to the screen grid 6 because of the proximity of the outer edge of the screen grid 6 to the outside screen 19, which as a result acts in effect as a continuation of the shield grid, that part of the valve on one side of the space between the input and output electrodes being on one side of the outer screen, while the other lies on the other side. The outer screen 19 may be provided with a ring or flange adjacent the envelope as shown, to increase its effective coupling with the shield grid.

In the form of construction shown in Figure 2, the valve is double-ended and is provided with a glass envelope 13 of substantially cylindrical shape. At each end of the valve is provided a glass stem, one of which carries the filament 1 (and support therefor) and the inner or control grid 4, while the other stem carries the outer or screen grid 6 and the plate 9 which being underneath 6 is not visible. The filament is of V shape, its loop being steadied by a supporting wire fused into the adjacent valve stem. The inner or control grid is of flat-bottomed dish-shape, and, in section, surrounds the filament on three sides.

The outer or screen grid is of similar shape and similarly surrounds the plate which is of disk form. The filament is arranged to be parallel to that side of the dish-shaped grid which is at right angles to the axis of the tube.

In another construction in Fig. 3 the anode is arranged alone at one end of the valve and the filament, inner and outer grids are mounted at the other end, the outer grid being formed as a gauze or grid iron dish of such size as to cover the inner grid.

In the modification shown in Figure 3, the filament is hairpin-shaped, and is enclosed by a thimble-shaped inner grid which may have flattened sides, as in the figure. The outer grid is also thimble-shaped and is extended radially at its base to the wall of the valve, the anode being formed as two plates, one on either side of the flat part of the outer grid. If desired the thimble-shaped electrodes may have open ends, provided the outer grid is of sufficient length effectively to shield the inner grid from the anode.

Figure 4 illustrates a further modification in which the grid 4 is formed as a plurality of parallel wires stretched as chords to a rim of metal.

The arrangement shown in Figure 5 of the accompanying drawings is generally similar to that shown in Figure 1, except that an additional space charge grid 20 is provided between the filament and the control grid, which latter is formed of a plurality of parallel wires stretched as chords to a rim of metal. It will be seen that the space charge grid is formed of a fine single wire parallel and of similar shape and size to the filament.

In all constructions of shielded grid valves in accordance with this invention, care should be exercised that the output or anode leads be not brought close to the input grid leads since capacity there between will tend to cancel the advantages obtainable by the invention.

If desired the leads from the electrodes may each be brought out through a different part of the valve envelope. For example, the filament and anode may be stemmed to, and the leads led out from, opposite ends of the valve, the main grid and shield grid being carried from and externally connected through auxiliary stems situated opposite one another in the walls of the envelope. Such a construction is particularly advantageous for short waves.

If desired the outer or screen grid need not itself be extended to the walls of the envelope, but may be in effect extended thereto by means of a separate shield member in close proximity to the outer grid and extended substantially to the walls of the envelope. In such an arrangement, see Figure 1*b* which is a modification of the construction shown in Figure 1, the outer or screen grid 6 does not itself extend to the walls of the valve and its outer periphery is in close proximity to, but not actually touching, a shield member 6*a* formed as an annulus stemmed to one

end of the valve, and extending substantially to the walls of the envelope as shown. The shield member may be earthed or connected to any point at fixed potential as regards high frequency, e. g. the cathode.

This form of construction, i. e. one in which the outer or screen grid is effectively extended by means of a separate shield member, is obviously similarly applicable to any modification in accordance with the invention.

Further, in all such constructions the "gettering" operation in manufacture should be so carried out that the film of deposit does not extend from the anode beyond the shield grid, since such deposit will tend to spread the electrostatic field and prevent the shielding from being complete. The desired limitations of the film deposit may be obtained by placing the "gettering" material behind the anode so that the edge of the shield grid in effect casts a "shadow", or in any other way.

In operation the shield or screen grid of a valve made according to this invention is connected to ground, preferably through a high tension battery, while the outside screen 19, if one be employed, is directly grounded.

In a valve employing 120 volts anode potential, 80 volts has been found a suitable positive potential for the shield or screen grid.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, what I claim is:—

1. A thermionic valve having an envelope, a cathode, an anode, a control grid, an additional electrode extending transversely across the envelope of the valve to near the outer walls of the envelope between the anode and the control grid, and a rim integral with the outer periphery of the additional grid-like electrode.

2. A thermionic valve having an envelope, an electron-emitting cathode, an anode, a control grid, an additional screening grid-like electrode extending substantially to the walls of the envelope between the anode and the control grid, an annulus of conductive material surrounding the outside of the envelope of said valve in the plane of said additional electrode, and a flange about the inner periphery of said annulus, whereby said annulus is, in effect, an extension of the additional grid-like electrode.

3. A thermionic valve having an envelope, a cathode disposed in a plane, an anode of which a substantial portion is disposed in a plane parallel to that of the cathode, a control electrode adjacent the cathode, a screen member between the anode and the control electrode and disposed in a plane parallel to those of the cathode and anode, and an external screen member disposed in the same plane as the interior screen member.

4. In a thermionic valve, the combination with a tubular envelope enclosing an electron emitting cathode, a control grid adjacent said cathode, an anode extending transversely of said envelope, and a screen grid extending transversely of said envelope between said control grid and said anode with its edge near the walls of said envelope, of a metal sheet extending transversely of said envelope in the plane of said screen grid and sufficiently near the edge of said screen grid to be electrostatically coupled to and thereby form in effect an external extension of said screen grid.

5. A thermionic valve comprising a tubular envelope enclosing an electron emitting cathode, a control grid, a disc shaped anode mounted in a plane perpendicular to the axis of said envelope, a perforated screen grid mounted between said control grid and said anode parallel to said anode with its periphery near the wall of said envelope, and an annular metal rim on said screen grid surrounding said anode, and extending lengthwise of said envelope beyond the plane of said anode.

6. A thermionic valve comprising a tubular envelope enclosing an electron emitting cathode, a control grid, a disc shaped anode mounted in a plane perpendicular to the axis of said envelope, a perforated screen grid adjacent and parallel to said anode with its periphery near the wall of said envelope, and an annular external screen extending transversely of said envelope in the plane of said screen grid and surrounding said envelope sufficiently close to the edge of said screen grid to form in effect an external extension of said screen grid.

7. The combination with a metal sheet having an aperture, of a thermionic valve comprising a tubular envelope only slightly smaller than the aperture in said sheet and positioned in said aperture and enclosing an electron emitting cathode, a control electrode, an anode, and a screen grid extending transversely of said envelope with its edge near the walls of said envelope and in registry with said sheet.

8. A thermionic valve comprising a tubular envelope enclosing an electron emitting cathode, a transverse anode, a transverse control grid adjacent said cathode, and a screen grid mounted to extend transversely of said envelope between said control grid and said anode and having an annular metal rim projecting along the wall of said envelope between the edge of said anode and said wall.

9. A thermionic valve comprising a tubular envelope enclosing an electron emitting cathode, a control electrode adjacent said cathode, a cup shaped screen electrode hav-

ing a perforated bottom portion extending transversely of said envelope adjacent said control electrode and a rim portion extending away from said control electrode, and a disc anode mounted inside said cup shaped screen electrode adjacent the perforated bottom thereof and with its plane perpendicular to the axis of said envelope.

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