

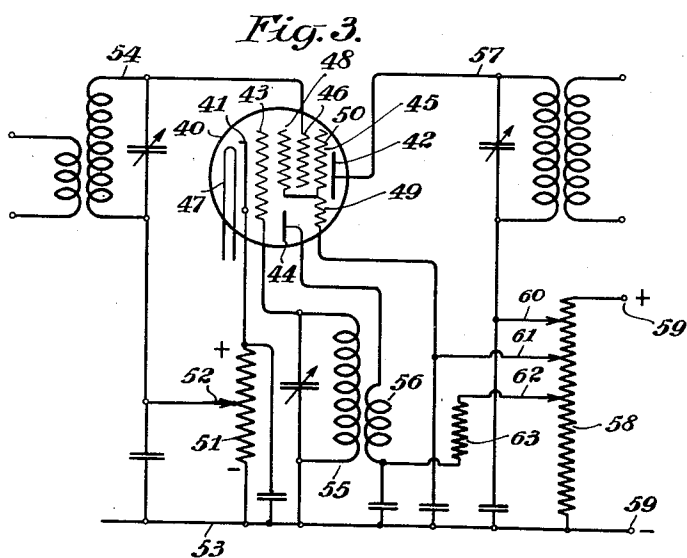
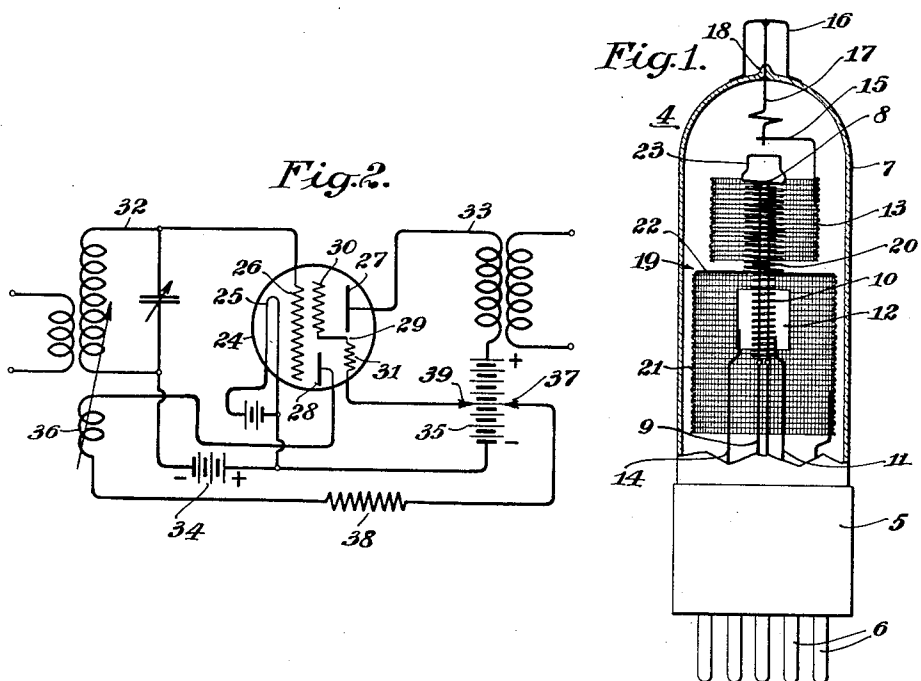
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ELECTRON DISCHARGE DEVICE

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ELECTRON DISCHARGE DEVICE

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The present invention relates to electron discharge devices of the type having a cathode or electron emitting element, an anode, and a control electrode interposed between said elements.

The object of the present invention is to provide an improved electron discharge device of the above character, which is adapted to perform a plurality of functions in an electrical circuit, and more particularly to have a variable mutual conductance or transductance independent of an auxiliary function of the device in an electrical circuit.

A further and more specific object of the present invention is to provide an improved electron discharge device, of the type having an anode and a control electrode, with means for varying the transductance between said elements and means, independent of said elements and the variable transductance, for providing an independent feedback or oscillator circuit, the frequency of which may remain substantially constant in response to variations in the transductance of said device.

A still further object of the present invention is to provide an improved electron discharge device of the type having a cathode or electron emitting element, an anode, and other electrode elements whereby, in connection with suitable electrical circuits, it is adapted to perform two independent functions and to have a variable mutual conductance or transductance independent of its other functions in the circuit.

An electronic discharge device embodying the invention is particularly adapted for use in circuits hereinafter described, and as shown and claimed in my copending application, Serial No. 654,421, filed January 31, 1933, entitled "Signaling systems", and my joint application with Arthur V. Loughren, Serial No. 678,406, filed June 30, 1933, entitled "Radio signaling systems", both applications being assigned to the same assignee as this application.

The invention will be better understood from the following description when considered in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 is a cross-sectional view, and substantially full size, of an electron discharge device embodying the invention;

Fig. 2 is a diagrammatic view of the device of Fig. 1 illustrating its use in an electrical circuit; and

Fig. 3 is a similar diagrammatic view of a modification of the device of Figs. 1 and 2, together

with an electrical circuit with which it is adapted to operate.

Referring to Fig. 1, 4 is an electron discharge device having a base member 5 provided with suitable terminal prongs 6 and supporting an enclosing envelope 7 within which is located a central, elongated cathode 8 having leads 9 which connect with certain of the base terminals 6.

The cathode is surrounded by a suitable grid structure 10 which, in the present example, is cylindrical in form and extends throughout the length of the cathode in spaced relation thereto. Further, in the present example, the grid is in the form of a helix comprising a conducting wire, and is provided with a connection lead 11 with one of the base prongs.

Associated with the cathode and grid electrodes are two anode or plate electrodes 12 and 13 arranged in spaced relation to each other along the length of the grid at substantially opposite ends thereof. The anodes are also arranged in spaced relation to the grid electrode 10 and, in the present example, are cylindrical in form and substantially concentric with the cathode and grid electrodes and in axially spaced relation to each other along the grid and cathode elements. The anodes are, therefore, non-concentric in their relation to each other, but are coaxial with the cathode, the control grid and each other.

The anode 12 is of smaller area than the anode 13, and is more adjacent to the terminal ends of the cathode and control grid as indicated. The anode 12 is, furthermore, a solid-walled, non-perforated, open-ended tubular member relatively closely spaced with respect to the grid electrode 10 as distinguished from the anode 13 which is of an open-ended tubular construction provided by wire mesh, although either anode may be solid or perforated as required. The terminal leads for the anodes 12 and 13 are indicated at 14 and 15, respectively.

It will be noted that the terminal lead 15 for the anode 13 is connected with a separate spaced terminal member 16 at the opposite end of the device from the remaining terminal elements or prongs 6. The connection between the lead 15 and the cap terminal 16 is completed by a flexible lead 17 extending through the envelope 7 into the cap 16, as indicated, through a sealed joint 18.

The cathode, the control grid, and the smaller or auxiliary anode 12 are all electrostatically shielded within a common enclosure provided by a screen grid structure 19 comprising an inner grid section 20 and an outer shield or screen section 21 arranged in non-concentric, substan-

tially co-axial relation to each other and united by a plate or centrally perforated cap 22 for one end of the screen section. Conforming to the cylindrical construction of the other elements of the device, the screen grid structure is also cylindrical and the grid section 20 is of smaller diameter than the screen section 21, the cap 22 serving to join the two sections. It will be noted that the cathode and control grid extend through the perforation in the cap and that the cap lies in a plane at a right angle to the axis of the cathode and control grid.

The grid section 20 of the screen grid structure is closed at its free end by a cap 23, while the free end of the screen section 21 is open to permit the connection leads to pass through it to the terminal prongs 6. It will be noted that the screen section is of sufficient length to extend fully over the electrode elements within it and to completely electrostatically shield them from external fields.

The arrangement is such that the grid section 20 of the screen grid structure is associated with the anode 13 and, in the present example, is interposed between it and a portion of the control grid 10. The screen section 21 is more particularly associated with the smaller or auxiliary anode 12 and the remaining portion of the control grid 10 which it serves to shield. With this arrangement it will be seen that the screen is completed by the cap or plate 22 and that the two anodes are electrostatically shielded from each other by the screen structure.

The construction above described is adapted for compact mounting within an enclosing envelope because of the fact that the main anode surrounds an inner portion of the screen grid structure while the outer portion of the same screen grid structure surrounds the other anode, and all elements are arranged substantially co-axial with the cathode and control grid which extend throughout the length of the active elements of the device.

Furthermore, the main anode 13 and its terminal 16 are by this construction substantially entirely isolated electrostatically from the remainder of the elements of the electron discharge device. This construction, therefore, has the advantage that the load placed upon a circuit in connection with the anode 13 has no appreciable effect upon the circuit associated with the remaining elements of the device.

A circuit for which the device 4 is adapted, is indicated in Fig. 2, to which attention is now directed and wherein the electron discharge device of Fig. 1 is illustrated diagrammatically at 24 and wherein there are provided a cathode 25, a control grid 26, an anode 27, an auxiliary anode 28 and a screen grid structure 29 comprising a grid section 30 and a screen section 31, all arranged as shown in Fig. 1.

A control grid 26 is connected with a tuned signal input circuit 32 and is provided with a signal output circuit 33 connected with the anode 27. Suitable bias and anode potentials for circuits 32 and 33 are supplied, respectively, from sources indicated at 34 and 35. The auxiliary anode 28 is provided with a feed-back connection indicated at 36 with the input circuit 32 and is connected with a variable tap connection 37 on the source of potential 35, whereby it is operated at a positive potential preferably lower than the potential of the anode 27. A current limiting resistor 38 is connected in circuit with the auxiliary anode 28 and between it and the source 35 and will hereinafter be referred to.

The screen grid structure 29 is also operated

at a positive potential through a suitable connection with the source 35 as indicated by the variable tap 39, representing any suitable means for varying the potential delivered to the screen grid structure.

With a tube construction as shown and described, it has been found that the potential applied to the screen grid structure may be varied to vary the mutual conductance between the control grid 26 and the main anode 27, whereby the signal output to the output circuit 33 may be controlled. It has been found that the mutual conductance between the control grid 26 and the auxiliary anode 28 is substantially independent of the signal output control provided by the screen grid structure 29 above described. Therefore, a feed-back connection provided in connection with the anode 28 may be designed to remain substantially constant while the signal output from the device 24 is varied. This is a desirable feature in connection with tuned radio frequency circuits to which the advantages of regeneration may be applied without additional controls.

In the above described manner, the mutual conductance between the control grid and the main anode may be varied by varying the potential of the screen grid without appreciably varying the mutual conductance between the control grid and the auxiliary anode. At the same time, the screen grid structure functions as a screen grid between both anodes and the main anode and the remaining elements of the device.

For wide variations in the control of the signal output, it is preferable that a constant current source be utilized as a source of potential for the auxiliary anode. Such a constant current source may be provided, as shown in the present example, by a source of substantially constant voltage 35 together with the series high resistance 38, the resistance being of the order of the plate resistance of the plate 28 or preferably higher. This arrangement prevents material changes in the current flowing to the auxiliary anode 28 for the reason that the potential drop in the resistor 38 is high compared with the internal drop through the anode 28. The mutual conductance between the control grid 26 and the auxiliary anode 28 will be substantially constant with variation in the potential of the control grid 26. It is sufficient, however, that the resistor 38 be of such a value that in the case of variations in the bias potential for the control grid 26, a large change in the mutual conductance between the control grid 26 and the anode 27 will result. The use of the resistor 38 will of course, necessitate the use of a relatively higher potential at the source 35.

However, if the amplification factor between the control grid and the auxiliary anode is low compared with that between the control grid and the screen grid, then a much lower potential will suffice to hold substantially constant current to the auxiliary anode and a substantially constant mutual conductance between the control grid and the auxiliary anode.

Among the advantages which may be attributed to an electron discharge device of the character described, an important advantage is that a circuit associated with the auxiliary anode is substantially independent of the volume control operation of the device, which may be controlled by controlling the screen grid. The screen grid is, therefore, both a control grid for volume and a screen grid or shield between the anodes and between one of the anodes, which is the main

anode in the present example, and the control grid. The two circuits associated or connected with the anodes are, therefore, substantially independent of each other. Therefore, the use of an electron discharge device as described, permits the gain in an amplifier stage to be controlled at will without substantially affecting the regeneration, and hence the volume may be controlled without appreciably affecting the selectivity of a receiver in which such an amplifier stage is used.

Briefly stated, with an electron discharge device or amplifier tube of the character described the transductance of one plate can be controlled by variation of the screen grid voltage, leaving the transductance of the other plate practically unchanged. In a regeneration circuit, the plate whose conductance is varied may be utilized as the amplifier plate, while the other plate may be used for regeneration. In a circuit of this character, it will be seen that it is possible to control the gain of an amplifier therein while maintaining the selectivity constant.

The electron discharge device thus performs two separate functions in an electrical circuit, providing an independent, variable, mutual conductance in connection with the output circuit, and the auxiliary function in the circuit shown, independent of the variable mutual conductance, to provide regeneration.

Referring now to Fig. 3, a modification of the device of Figs. 1 and 2 is shown at 40. In addition to the heated cathode, indicated at 41, anode 42, control grid 43, auxiliary anode 44 and screen grid structure 45, the device is provided with an additional control grid 46. In general, the electrode arrangement is substantially the same as that in the preceding device, except that a heater 47 is provided for the cathode 41 and the screen grid structure is modified to provide for the second control grid.

The screen grid structure 45 includes a screen section 48 and a shield section 49 corresponding to that shown in the preceding figures, and in addition is provided with a second screen section 50 which is interposed between the second control grid 46 and the main anode 42. The additional functions of the structure will hereinafter be pointed out. The screen grid structure, however, is utilized to control the output circuit for the main anode by varying its potential in the same manner as described in connection with the device shown in Figs. 1 and 2, all independently of the auxiliary anode and its associated circuits.

In the present example a self bias resistor 51 is provided in the cathode return circuit, from which the control grid 46 receives a bias potential through a variable tap 52 and the first control grid 43 receives a bias potential by connection with a return lead indicated at 53. The control grid 46 is connected with a tuned signal input circuit 54, while the control grid 43 is connected with a second, independent, tuned circuit 55 which receives a feed-back potential from the auxiliary anode 44 through a feed-back coil 56 associated with said circuit. The main anode 42 is connected with a suitable signal output circuit 57 as indicated.

Operating anode potentials and the positive controlling potentials for the screen grid structure are provided by a suitable source such as a potential divider resistor 58 having supply terminals 59 and on which suitable variable taps indicated at 60, 61 and 62, respectively, are provided for

the main anode, control grid structure, and auxiliary anode. A current limiting resistor 63 is connected in circuit with the auxiliary anode for the purpose of providing with the potential supply means, a constant current source for the auxiliary anode, as described in connection with the preceding embodiment.

The circuit provides a combined detector and oscillator in one device and wherein the screen grid structure is a unit functioning simultaneously to shield the two anodes from each other, and the main anode and the second or outer control grid 46, each from the remaining elements of the device, whereby the output signal through the circuit 57 may be controlled independently by movement of the contact 61, or other suitable control operation, to vary the potential applied to the screen grid structure. The cathode 41, control grid 43, and auxiliary anode 44 provide, with the circuits 55 and feed-back connection 56, an oscillator which is electronically coupled with the output circuit 57. The signal control grid 46 is shielded from the remainder of the electrodes, and it has been found that variation of the biasing potential may be utilized to control the output signal through circuit 57 independently of the operation of the oscillator portion.

Through the combined function of the electrostatic shield and control electrode, the screen grid structure permits the signals received in the circuit 54 and the oscillator signals generated in the circuit 55 to be mixed in the device 40 and transferred as a beat frequency to the output circuit 57, while the oscillator and input circuits are maintained substantially independent of each other. For the purpose of control, it is preferable that the sections 48 and 50 of the screen grid structure be provided in the form of grids similar to the grid section 20 of the device described in connection with Fig. 1, while the section 49 may be of the screen type similar to that shown at 21 in said figure.

The advantages of a single unitary screen grid structure interposed between one or more control grids and a main anode, whereby the mutual conductance between said main anode and one or more of the control grids may be varied independently of the mutual conductance between one control grid and an auxiliary anode, may be provided in connection with circuits other than those shown in the present example, although the circuits shown represent the present preferred electrical circuits adapted to be associated with a device embodying the invention.

I claim as my invention:

1. An electron discharge device including cathode means, screen grid means, a control grid, two anodes, said screen grid means being interposed between said anodes and arranged electrostatically to shield said anodes from each other, and a second control grid electrostatically shielded from the first control grid and said anodes by said screen grid means.

2. In a screen grid electron discharge device, a unitary screen grid structure comprising a grid section and a screen section, a control grid electrode and a cathode extending through said sections within the screen grid structure, an anode within the screen section associated with said cathode and control grid, and a second anode associated with the cathode and control grid and located exteriorly of the grid section of the screen grid structure.

3. An electron discharge device comprising a

cathode, a control grid surrounding said cathode, an anode associated with a portion of the cathode and control grid, a second anode associated with a second portion of the cathode and control grid, said anodes surrounding and being co-axial with respect to the cathode and control grid and being non-concentric with respect to each other, and a screen grid structure interposed between said anodes and electrostatically isolating one of said anodes from the remaining electrodes of said device.

4. An electron discharge device comprising a cathode, a control grid surrounding said cathode, an anode associated with a portion of the cathode and control grid, a second anode associated with a second portion of the cathode and control grid, said anodes surrounding and being co-axial with respect to the cathode and control grid and being non-concentric with respect to each other, a screen grid structure comprising a grid section interposed between the control grid and one of said anodes, and a screen section substantially enclosing the cathode, control grid and the other of said anodes.

5. An electron discharge device comprising a cathode, a control grid surrounding said cathode, an anode associated with a portion of the cathode and control grid, a second anode associated with a second portion of the cathode and control grid, said anodes surrounding and being co-axial with respect to the anode and control grid and being non-concentric with respect to each other, a screen grid structure comprising a grid section interposed between the control grid and one of said anodes, a screen section substantially including the cathode, control grid and the other of said anodes, a second control grid associated with said first named anode, and a second screen section for said screen grid structure interposed between said second control grid and said first named anode.

6. An electron discharge device comprising electron emitting means, a screen grid, a control grid, and two anodes electrostatically shielded from each other by said screen grid, said screen grid being in two sections, one being located exteriorly of and substantially enclosing one anode and the other being substantially within the other anode.

7. An electron discharge device comprising electron emitting means, a pair of control grids, a pair of anodes, and a screen grid structure providing an electrostatic shield between said anodes and between said control grids, said screen grid and control grids being located in the electronic stream of said device between said first named means and one of said anodes.

8. An electron discharge device comprising electron emitting means, a pair of control grids arranged in series relation to each other in the electronic path of said device, a pair of anodes arranged in parallel relation to each other in the electronic path of said device, and a screen grid structure providing an electrostatic shield between said anodes and between said control grids.

9. An electron discharge device comprising electron emitting means, a pair of control grids, a pair of anodes, a screen grid structure providing an electrostatic shield between said anodes and between said control grids, and said screen grid structure further providing a control electrode to vary the signal output from said device.

10. A screen grid electron discharge device comprising a screen grid structure, a regeneration plate electrode and a main plate electrode electrostatically shielded from each other by said screen grid structure, said screen grid structure comprising a portion controllable to vary the transductance of said device through said main plate electrode, and said screen grid structure further comprising a portion constituting means for maintaining the transductance of the device through the regeneration plate electrode substantially independent of variations in the transductance through said main plate electrode.

11. An electron discharge device having a control grid, a main anode and a regeneration anode, and means for rendering the transductance between the regeneration anode and the control grid substantially constant in response to variations in the transductance between the control grid and the main anode, said means including a unitary screen grid structure a portion of which is interposed between said anodes and an other portion of which is interposed only between the main anode and the control grid.

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