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ELECTRON BEAM TUBE

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Fig. 1.

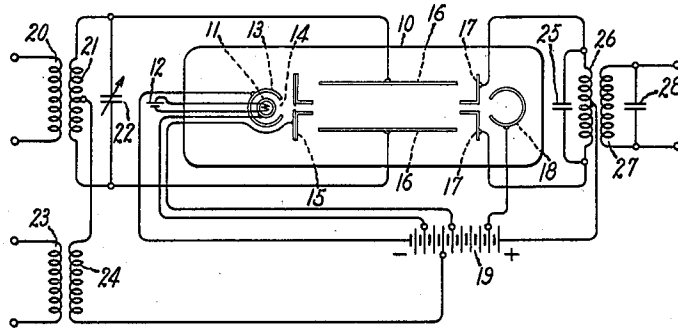
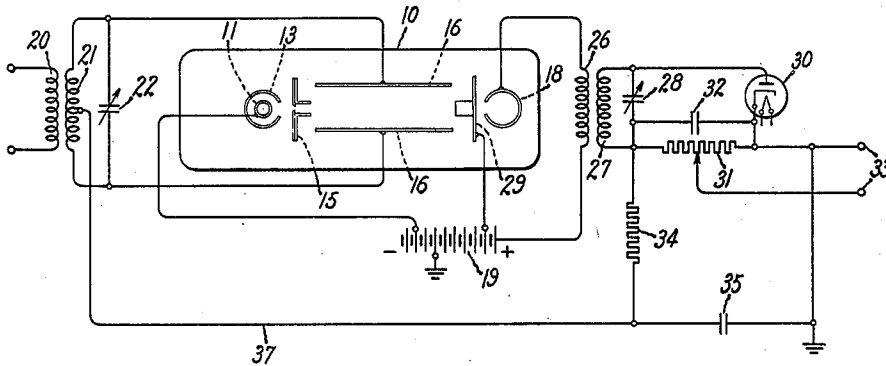


Fig. 2.



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ELECTRON BEAM TUBE

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9 Claims. (Cl. 250—27)

The present invention relates to circuits utilizing electron beam tubes and more particularly to circuits wherein a plurality of control voltages applied to such a tube influence simultaneously the current flowing therethrough.

5 In my Letters Patent No. 2,074,829, issued March 23, 1937, and assigned to the same assignee as the present application, I have described and claimed an electron beam tube wherein electronic control is accomplished by deflecting the beam transversely to its path through the agency of a pair of deflecting members. These deflecting members are incidentally made to serve as beam focusing means by applying a predetermined fixed common bias to the members.

10 It is an important aspect of my present invention that a secondary control of the beam, or more properly of the output of the tube, may be accomplished by varying the common bias applied to the deflecting members. Thus by varying the beam deflection in accordance with a first controlling influence and varying the beam focus in accordance with a second controlling influence, the tube output may be caused to vary as a joint function of both of these influences. Furthermore, both modes of control are accomplished by the use of a common electrode structure for the deflecting members.

15 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, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing, in which Fig. 1 is a diagrammatic view of an electron beam tube connected in a circuit according to my invention and Fig. 2 shows in diagram a different type of circuit in which my electron beam tube is connected in accordance with my invention.

20 In Fig. 1 the glass envelope 10 contains a cathode 11 which is indirectly heated by a source of potential 12. A focusing member 13 partially surrounds the cathode 11, and has a narrow opening 14 through which a beam of electrons emerges. The beam of electrons passes through a narrow opening in the accelerating electrode 15, as is explained in my Letters Patent No. 2,074,829. The cathode, focusing member and accelerating electrode constitute an electron gun.

25 After leaving the accelerating electrode 15 the electron beam passes between the members 16, which form a common means for deflecting the

electron beam transversely to its path and for focusing the beam. It is then collected by either one of a pair of anodes 17 or passes through the opening between the anodes 17 into a collecting anode 18, depending upon the amount of deflection or diffusion of the beam caused by the members 16. The anodes 17 as shown are two electrically separate members each of angle shape. They have a space remaining between them of conveniently small size through which electrons may pass to the collecting anode 18.

30 The focusing electrode 13 is, as shown, usually connected to the most negative terminal of a source of electromotive force 19. The cathode 11 is connected to the source of potential at a point slightly more positive than electrode 13, and the accelerating electrode 15 is connected to a point yet more positive than the cathode. A source of radio frequency signals, which is represented by the primary 20 of a transformer, supplies voltage through a tuned circuit, comprising the secondary 21 of the transformer and a condenser 22, across the combined electron-deflecting and electron focusing members 16. The signal voltages applied across the members 16 influence the electron beam to produce corresponding deflections as the beam passes therebetween.

35 A source of high frequency energy, which may be represented by primary 23 of a transformer, is coupled to secondary 24 of the transformer of which one end is connected to the central point of the secondary 21. The other end of the transformer secondary 24 is connected to an intermediate point on the source of potential 19. The connection of the common bias lead to an intermediate point on the potential source 19 biases both of the members 16 alike and produces a focusing action upon the electron beam passing between members 16. In other words, the common bias voltage varies the mutual conductance of the tube to the voltage supplied from secondary 21. The bias voltage necessary for proper focusing may be either positive or negative with respect to the cathode, depending on the distance between the members 16, the voltage applied to the various electrodes, and the structure of the tube.

40 Superimposed upon the bias voltage developed by the battery 19, the high frequency voltage induced in the transformer secondary 24 is also applied equally to the members 16. By this voltage the beam focus is caused to change cyclically so that the beam density or cross-sectional area near the anodes 17 varies in accordance with the high frequency voltage supplied from the primary 45

23. When the beam is most dense a large number of electrons can pass between the anodes 17 and be collected by the anode 18. When the beam is least dense a much smaller portion can pass between the anodes 17, even though the beam remains undeflected and centered on the slit through the anodes 17. A large number of electrons are then collected by the anodes 17, and a small number of the anode 18.

10 Each anode 17 is connected to one end of a tuned circuit including a condenser 25 and a transformer primary 26. The central point of transformer primary 26 is, as shown, usually connected to the most positive point on the source 19. The anode 18 is usually connected to a point on the source 19 slightly less positive than the point to which the anodes 17 are connected. The transformer primary 26 is coupled to a secondary 27 which is tuned by a condenser 28. This tuned circuit may supply energy to any desired consumption or output circuit.

The electron beam tube and its associated circuit as shown in this figure may conveniently be used as a converter stage in the operation of a conventional superheterodyne radio receiver. If the signal received from an antenna be impressed upon primary 20 and a locally generated wave of fixed frequency be impressed upon the primary 23, an intermediate frequency voltage is developed across the condenser 28. The action of the members 16 upon the electron beam is such that the voltage received from the antenna deflects the electron beam and thus varies the ratio in which anodes 17 receive electrons. The voltage received from the local oscillator varies the density of the electron beam and thus varies the rate at which transfer of the electron beam from one of the anodes 17 to the other may be accomplished by the deflecting voltage. In this way the mutual conductance of the tube to the signal voltage is controlled by the local oscillator. The voltage in the output circuit 25, 26 is therefore a voltage of intermediate frequency comprising a joint function of both the signal from the antenna and the locally generated wave. The output circuit may conveniently be tuned to the intermediate frequency which it is desired to transmit to the remainder of the superheterodyne receiver.

50 In Fig. 2 the same general type of electron beam tube is connected in a somewhat different type of circuit. In this figure parts previously described in connection with Fig. 1 have been given similar reference characters. Several connections to the electron gun have been omitted for the sake of simplicity. An audio modulated high frequency voltage source represented by the transformer primary 20 is, as before, coupled to transformer secondary 21 and supplies voltage across condenser 22 which forms a tuned circuit with the transformer secondary. This voltage is applied across members 16 so that the electron beam is deflected thereby. The anodes 17 shown by Fig. 1 are replaced in this tube by a single anode 29 which has an opening in its center through which the electron beam may pass when in neutral position. The circuit is slightly modified by connection of anode 18 through transformer primary 26, which is untuned, to the most positive point of potential source 19. The anode 29 is connected to a somewhat less positive point on the source 19. Deflection of the electron beam produces a voltage variation upon anode 18 and therefore across transformer primary 26. The form of tube shown by this figure and the

corresponding connections have been found more desirable for mechanical reasons than the form of tube shown by Fig. 1.

Voltage induced in the transformer secondary 27 is impressed across variable condenser 23 which forms a tuned circuit therewith and across the diode 30 and the resistor 31. The diode 30 and its accompanying circuit operates to demodulate the wave supplied from the electron beam tube so that the modulation or audio frequency voltage derived from the carrier wave is developed across the resistor 31, which is shunted by a radio frequency bypassing condenser 32. A suitable portion of this audio frequency voltage may be supplied to any suitable consumption device connected to terminals 33. A time delay circuit, or network, is connected in shunt with the resistor 31 and comprises a resistor 34 connected in series with a condenser 35. The cathode of the diode 30 is maintained at a fixed potential with respect to the cathode 11 of the electron beam tube, and the audio frequency voltage developed across the resistor 31, after being filtered to produce automatic volume control voltage by the time delay network, is supplied through the resistor 34 of the time delay network to the center of the transformer secondary 21.

In operation the automatic volume control voltage supplied from resistor 34 biases both of the members 16 alike to vary the focusing of the electron beam. If a strong signal is received from the antenna and rectified by the diode 30, the voltage developed across the resistor 31 varies the bias applied to the members 16 so as to reduce the focusing action of the members. When the focusing action is reduced, the gain of the electron beam tube is reduced and the signal rectified by the diode 30 is correspondingly smaller. Automatic volume control is thereby accomplished in a simple and improved manner.

It will be appreciated that the voltage applied to the various electrodes in the electron beam tube are not critical and any one or more may be varied within wide limits. The proper voltage upon the members 16 should be determined by experiment for the desired focusing action. Other circuits and other modifications of the circuit shown which apply two distinct influences to the members 16 will occur readily to those skilled in the art. For instance, the converter system of Fig. 1 may be combined with the A. V. C. system of Fig. 2 simply by inserting the secondary of a local oscillator transformer in lead 37 of the latter figure. As another possibility, off-channel noise suppression may be obtained by biasing members 16 to defocus the beam when no carrier is being received. Thus the tube itself may be used in any application where it is desired to use some variable control voltage to vary the mutual conductance of the tube to a signal voltage.

While I have shown particular embodiments of my invention, it will, of course, be understood that I do not wish to be limited thereto, since different modifications may be made both in the circuit arrangement and instrumentalities employed, and I aim by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

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

1. In an electron beam tube, means for generating a beam of electrons, means for receiving said electrons and responding to variations in said beam, a common means for deflecting said

electron beam transversely to its path and for varying the focus thereof, means between said common means and said generating means for maintaining a constant field at said generating means whereby the magnitude of said beam remains constant, means connected to said common means for changing the deflection of said beam in response to a first varying controlling influence, and additional means connected to said common means for changing the focus of said beam in response to a second varying controlling influence, whereby the response of said electron receiving means is a joint function of both of said controlling influences.

2. An electron beam tube comprising an electron gun, electron receiving means, a combined electron-deflecting and electron focusing electrode structure interposed between said gun and said means, means between said structure and said electron gun for maintaining a constant field at said electron gun whereby the magnitude of said beam remains constant, a circuit connected to supply a first varying control voltage across said electrode structure for deflecting said beam transversely to its normal path, and additional means connected to said electrode structure for varying the focused condition of said beam in accordance with the variations of a second varying control voltage, and an output circuit connected to said electron receiving means whereby the tube output may be caused to vary as a joint function of said voltages.

3. An electron beam tube comprising an electron gun having an electron emitting surface for producing a beam of electrons, an anode for receiving said electrons, a pair of combined electron-deflecting and electron-focusing electrodes positioned on opposite sides of said beam between said gun and said anode, a means interposed between said pair of electrodes and said surface and co-operating therewith to provide a controllable beam focusing system, said interposed means acting to maintain a constant field at said electron gun whereby the magnitude of said beam is maintained constant, a source of direct current for impressing a desired potential on the anode a negative terminal of which is connected to said gun, means including a first varying voltage source for impressing different potentials on said pair of electrodes to deflect the electron beam, and controlled means for impressing a focusing voltage on said pair of electrodes and for varying such focusing voltage to vary the condition of focus of the electron beam, and means connected between said direct current source and said anode for developing an output potential which is a joint function of said deflecting voltage and said focusing voltage.

4. In combination in an electron beam tube, means for generating a beam of electrons, means for receiving said electrons and impressing corresponding potential variations on an output circuit, combined electron-deflecting and electron-focusing electrodes between said generating means and said receiving means, means interposed between said electrodes and said generating means and co-operating therewith for preventing potential changes of said electrodes from producing a changing field at said generating means, whereby the magnitude of said beam is maintained constant, means for impressing a varying voltage between said electrodes for deflecting said beam of electrons, and means for impressing a varying focusing voltage upon said electrodes

and for varying such voltage to change the condition of focus of said beam.

5. In a superheterodyne receiving system having a signal receiving means, a local source of oscillations and an intermediate frequency channel, a converter tube comprising an electron gun for producing a beam of electrons, an electron receiving member connected to said intermediate frequency channel, a pair of combined electron-deflecting and electron-focusing electrodes between said electron receiving member and said gun, means between said pair of electrodes and said electron gun for maintaining a constant field at said electron gun whereby the magnitude of said beam is maintained constant, a circuit connected between said pair of electrodes and energized by said signal receiving means, and a circuit connected to said electrodes for impressing a variable focusing voltage on said electrodes, said focusing voltage being supplied by said local source of oscillations, whereby the voltage impressed on said intermediate frequency channel by said electron receiving member is a joint function of the voltages of said signal receiving means and said local source of oscillations.

6. In combination with an electron beam tube comprising an electron gun for projecting a beam of electrons, electron receiving means, a pair of combined electron-deflecting and electron-focusing electrodes between said means and said gun, a circuit for impressing a modulated wave across said pair of electrodes, a circuit connected to said electron receiving means for demodulating said waves, and a network connected to said demodulating circuit to apply a common focusing voltage to said electrodes which is a function of the magnitude of said demodulated waves.

7. In combination with an electron beam tube having an electron gun, means including a plurality of anodes for receiving an electron beam from said gun, a pair of combined electron-deflecting and electron-focusing electrodes interposed between said gun and said means, means between said pair of electrodes and said electron gun for maintaining a constant field at said electron gun whereby the magnitude of said beam is maintained constant, a circuit for impressing an alternating voltage between said pair of combined electrodes for varying the deflection of said beam, and a circuit for impressing an alternating voltage as a variable focusing voltage between said pair of electrodes and said gun for varying the focusing action of said electrodes, whereby said first means develops a voltage which is a joint function of said alternating voltages.

8. In an electron beam tube, means for generating a beam of electrons, means for receiving said electrons and responding to variations in said beam, a common means for deflecting said electron beam transversely to its path and for varying the focus thereof, said common means comprising a pair of juxtaposed electrodes having substantial extension along the path of said beam and adjacent thereto, means interposed between said common means and said generating means and co-operating therewith to provide a controllable beam focusing system, said interposed means acting to maintain a constant field at said generating means whereby the magnitude of said beam is maintained constant, means connected to said common means for changing the deflection of said beam in response to a first varying controlling influence, and additional means connected to said common means for changing the focus of said beam in response to a second vary-

ing controlling influence, whereby the response of said electron receiving means is a joint function of both of said controlling influences.

5 9. In an electron beam tube, means for generating a beam of electrons, means for receiving said beam and impressing corresponding potential variations on an output circuit, a pair of plate shaped electrodes lying parallel with and adjacent to said beam of electrons, means interposed between said electrodes and said generating means
10 and co-operating therewith to provide a control-

lable beam focusing system, said interposed means acting to maintain a constant field at said generating means whereby the magnitude of said beam is maintained constant, means for impressing a varying voltage between said electrodes for deflecting said beam of electrons transversely to its path, and means for impressing a variable focusing voltage upon said electrodes and for varying such focusing voltage to change the condition of focus of said beam. 5

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