

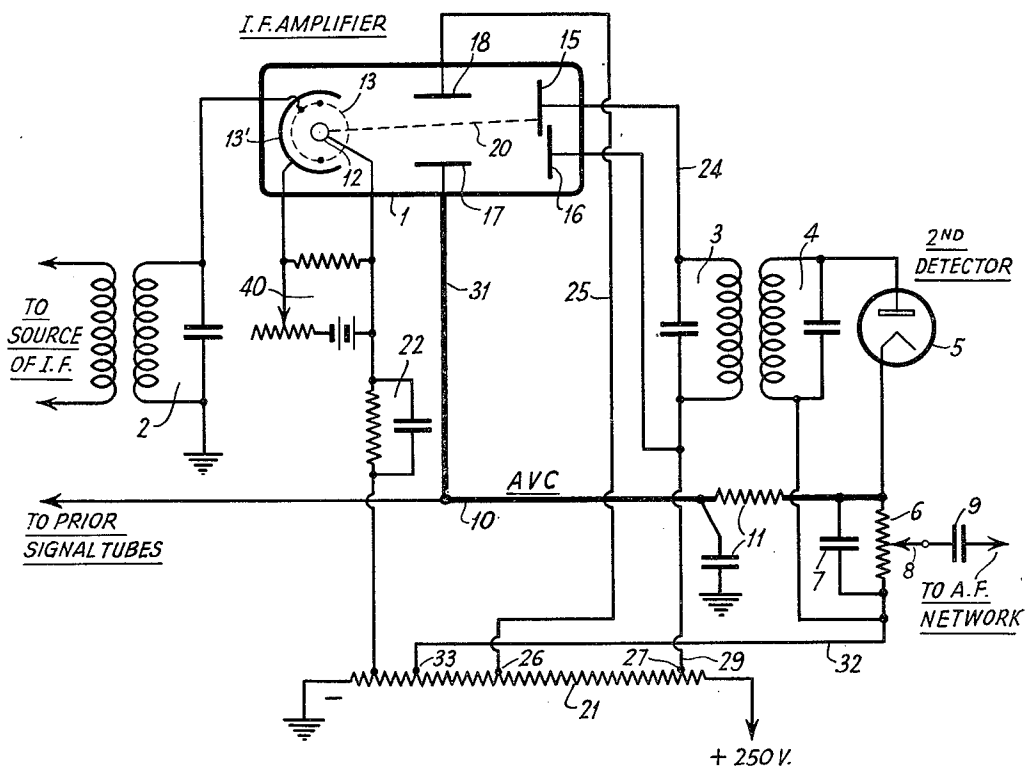
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AUTOMATIC GAIN CONTROL CIRCUIT

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AUTOMATIC GAIN CONTROL CIRCUIT

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7 Claims. (Cl. 250—20)

My present invention relates generally to gain control circuits for signal transmission systems, and more particularly to automatic volume control arrangements for radio receivers of the type employing signal transmission tubes of the electron beam type having negative mutual conductance characteristics.

In my copending application Serial No. 746,495, filed October 2, 1934, I have disclosed automatic volume control arrangements for broadcast receiver constructions, wherein the signal transmission tubes are controlled in gain by having them decrease in mutual conductance when an electrode of the controlling signal rectifier varies in potential in a positive sense. By virtue of such connections the automatic volume control connection may be made to an electrode of the control rectifier which varies in potential in a positive direction as the received signal amplitude increases. Specifically such operation is secured in the arrangement of the aforesaid application by utilizing in the controlled transmission stage a tube provided with a cathode, a signal grid, an output electrode, an auxiliary positive electrode, and a special gain control electrode which is disposed between the output electrode and the auxiliary electrode, the output and auxiliary electrodes being positive with respect to the gain control electrode, and the control electrode being geometrically related to the auxiliary and output electrodes so that the mutual conductance between the output electrode and signal grid is reduced, and the transmission efficiency of the stage is automatically decreased, as the received signal amplitude increases. The specific types of tubes shown in the aforesaid application are of the normal construction wherein the various electrodes are disposed in concentric manner about the cathode.

It may be stated that it is one of the main objects of my present invention to secure the same type of automatic volume control action as was secured with the arrangement of my copending application, and yet employ for the controlled signal transmission tube an electron discharge tube of the beam type, the controlled network being essentially characterized by the fact that the signals are impressed upon a control grid through which passes an electron beam, focusing electrodes being employed to cause the beam to fall on an output electrode connected to the signal output circuit feeding into a signal rectifier, and there being disposed within the tube a waste, or deflecting electrode which is under the control of the signal rectifier so as to divert the electron beam from the output electrode when the signal amplitude increases.

Still other objects of the invention are to improve generally automatic volume control systems for radio receivers, and more especially to

provide an automatic volume control arrangement for a receiver of the type employing an electron beam tube, having a negative mutual conductance characteristic, in a signal amplifier stage, and which control arrangement is not only reliable, free from distortion and cross-talk, and is efficient in operation, but is readily and economically assembled in a receiver.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims; the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically a circuit organization whereby my invention may be carried into effect.

Referring now to the accompanying drawing, there is shown in schematic manner the circuit arrangement of that portion of the radio receiver embodying my present invention. In order to preserve simplicity of disclosure the invention is shown incorporated in the IF amplifier of a superheterodyne receiver. Those skilled in the art will readily understand that the tube 1, whose signal input circuit 2 is fixedly tuned to the operating IF, is preceded by the usual networks employed in a superheterodyne receiver. For example, such networks comprise a signal collector followed by one, or more, stages of tunable radio frequency amplifier, the amplified signals being fed to a first detector. The output of the first detector is fed to the input circuit 2, and it will be understood that there is impressed upon the first detector locally produced oscillations from a local oscillator. The usual variable tuning condensers are employed in the local oscillator, first detector and radio frequency amplifiers, and the rotors of these condensers will be arranged for uni-control adjustment. The operating IF may have a value of from 75 to 465 kc., and it should, also, be understood that the circuit 2 may be preceded by one, or more, stages of IF amplification.

The output circuit of the IF amplifier tube 1 is designated by the numeral 3, and the circuit is resonated to the operating IF, the circuit 3, in turn, is coupled to the tuned input circuit 4 of the second detector diode 5. The circuit 4 is tuned to the operating IF, and the anode of diode 5 is connected to the high alternating potential side of the circuit 4. The cathode of the diode 5 is connected to the low alternating potential side of the circuit 4 through the diode load resistor 6; the latter having connected in shunt therewith the IF by-pass condenser 7. The audio component of the rectified IF current flowing through resistor 6 is impressed upon one, or more, stages of audio frequency amplification

through a path which includes the adjustable tap 8 and the audio coupling condenser 9. The direct current component of the IF current flowing through resistor 6 is employed for automatic volume control (AVC hereinafter), and the numeral 10 denotes the AVC connections. While the AVC connections are shown to the amplifier 1, it will be understood that such connections can be made to one, or more, of the preceding signal transmission tubes, and the usual filter network 11 is employed to suppress the pulsating components in the AVC voltage. Of course, the audio network can be followed by any desired type of reproducer.

The specific connections to the tube 1 will now be considered, and it is first pointed out that the tube 1 is of the electron beam type. The tube, in general, comprises a cathode 12, which may be of the indirectly heated type, a control grid 13 surrounding the cathode 12. A focusing element 13' may be employed adjacent the grid 13, if desired. The tube envelope may be of glass or metal, and between the grid 13 and one side of the envelope there are disposed the electrodes 15, 16 whose planes are parallel to one another. Between the grid 13 and the electrodes 15 and 16 are disposed electrodes 17 and 18. These electrodes 17 and 18 are parallel to one another, but the planes thereof are perpendicular to the planes of electrodes 15 and 16. It will be observed that the electron beam projected from cathode 12, and passing through grid 13, is required to pass between electrodes 17 and 18, before impinging upon electrodes 15 or 16.

The dotted line 20 denotes an electron beam; it will be noted that the beam is caused to impinge upon the electrode 15 by virtue of the positive potential on electrode 18 as well as by virtue of the positive potential of electrode 15. It will, also, be noted that the electrode 15 is spaced inwardly from the electrode 16, and is in overlapping relation thereto. A tube of the type just described may be constructed in many different forms. Since the present invention is not directly concerned with the specific construction of tube 1, but rather in its utilization in an automatic volume control circuit, reference is made to the pending application Serial No. 29,808 of H. C. Thompson, filed July 5, 1935 which discloses various features of construction which may be employed for the tube 1.

In general, the aforesaid Thompson application shows a tube having negative mutual conductance characteristics due to the construction of the tube, as well as the manner in which the electrodes may be energized. The connections from the signal circuits to the electrodes of tube 1 will now be described. The direct current energization potentials are derived from a voltage source 21, and the latter may be any well known type of direct current voltage supply bleeder resistor. The bleeder resistor 21 has one side thereof grounded and may comprise the negative terminal, whereas the other side of the resistor may be established at a value of approximately 250 volts. The cathode 12 is connected to the grounded side of bleeder 21 through the usual signal grid biasing network 22, and the low alternating potential side of the input circuit 2 is grounded. The signal grid 13, being connected to the high alternating potential of input circuit 2, is at a negative direct current potential with respect to cathode 12 which is equal to the voltage drop across the grid bias resistor 22.

The electrode 15 is connected by lead 24 to the high alternating potential side of the IF output circuit 3. Accordingly, it will be seen that electrode 15 is the working, or output, electrode of the network. The electrode 18 is connected by lead 25 to a point 26 on bleeder 21; point 26 being at a positive potential with respect to ground, but being less positive than the point 27 to which the low alternating potential side of the signal output circuit 3 is connected. The electrode 16 is connected by lead 29 to the positive potential point 27. It will be noted that electrode 16 connected to the low alternating potential side of the IF output circuit 3, and hence functions as a waste, or diversion, electrode. In other words, when the electron beam 20 is shifted, or diverted, from electrode 15 and strikes electrode 16, the electron flow through output circuit 3 is decreased, such electrons being diverted through the path including lead 29.

The electrode 17 controls the electron beam, and this is accomplished by connecting electrode 17 to the AVC connection 10 through lead 31. The AVC lead 10 is connected to the cathode side of the load resistor 6, and the anode side of the resistor is connected by lead 32 to the point 33 of bleeder 21. The point 33 is at a direct current potential which has a value lower than the potential value of point 26.

In considering the operation of the arrangement described heretofore, it is first pointed out that with no signals impressed on input circuit 2 the voltage drop across resistor 6 will be substantially zero. This means that the gain control electrode 17 has a potential determined by point 33. The electron beam 20 will be in the position shown in the drawing since the electrode 18 attracts the electron beam in its direction by virtue of the positive potential impressed on it from point 26. When signals are impressed on input circuit 2 there is a voltage drop across resistor 6, and the cathode side of the resistor 6 becomes increasingly positive. This causes the electrode 17 to increase in positive potential, and shift the position of the beam 20 so that it now falls upon the waste electrode 16. This means that the signal current output in circuit 3 will be a maximum when the received signal carrier amplitude is a minimum. As the received signal carrier amplitude increases in value, the positive potential of electrode 17 will increase, and cause the diversion of the electron beam from the output electrode to the waste electrode. This causes a reduction in the signal current output in circuit 3; which means that the signal energy output of the IF amplifier 1 decreases with increasing signal amplitude. In this way the IF carrier amplitude at the input circuit 4 of the second detector is maintained substantially uniform regardless of fading effects. It will be appreciated that the reduction in gain of the controlled signal transmission network is accomplished even though the controlling electrode is increasing in positive direct current potential.

The output electrode 15 overlaps the waste electrode 16 slightly in order to make the operation of the beam tube more definite. If there were a space between the adjacent edges of electrodes 15—16, the current change in the tube would not be as sharp and definite as it is when the slight overlapping exists. The electrode 18 positions the beam 20 on the output electrode 15 and at the lower edge thereof when there is no signal being received. Further, the electrode 18 draws the beam back onto the output electrode 15 whenever the signals entirely disappear. The po-

tential adjusting means 40 for the focusing element 13' is well known as to function, and need not be further described.

While I have indicated and described a system for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organization shown and described, but that many modifications may be made without departing from the scope of my invention, as set forth in the appended claims.

What is claimed is:

1. In combination with an electron beam tube of the type including an emission element, an output electrode arranged to receive an electron beam from the emission element, and a control electrode, said tube having a negative mutual conductance characteristic, means for impressing signals upon the control electrode of the tube, an output circuit connected to the output electrode of the tube, a signal rectifier coupled to the output circuit, at least one electron waste electrode disposed within the tube, a beam deflection electrode disposed within the tube, and a direct current voltage connection from the beam deflection electrode to the signal rectifier such that the electron beam is deflected from the output electrode to said waste electrode as the signal amplitude increases.

2. In combination with an electron beam tube of the type including an emission element, an output electrode arranged to receive an electron beam from the emission element, and a control electrode, said tube having a negative mutual conductance characteristic, means for impressing signals upon the control electrode of the tube, an output circuit connected to the output electrode of the tube, a signal rectifier coupled to the output circuit, at least one electron waste electrode disposed within the tube, a beam deflection electrode disposed within the tube, a direct current voltage connection from the beam deflection electrode to the signal rectifier such that the electron beam is deflected from the output electrode to said waste electrode as the signal amplitude increases, and an electrode within the tube energized to position the beam on said output electrode in the absence of received signals.

3. In combination with an electron beam tube of the type including an emission element, an output electrode arranged to receive an electron beam from the emission element, and a control electrode, said tube having a negative mutual conductance characteristic, means for impressing signals upon the control electrode of the tube, an output circuit connected to the output electrode of the tube, a signal rectifier coupled to the output circuit, at least one electron waste electrode disposed within the tube, a beam deflection electrode disposed within the tube, a direct current voltage connection from the beam deflection electrode to the signal rectifier such that the electron beam is deflected from the output electrode to said waste electrode as the signal amplitude increases, and a second deflection electrode in said tube, means for energizing the said second deflection electrode to draw the beam back to the output electrode in the absence of signals.

4. The combination with an electron beam discharge tube of the type comprising a cathode, an output electrode, a waste electrode adjacent said output electrode, a control grid surrounding

said cathode for modulating and concentrating into a beam the electron discharge from said cathode to said output electrode, and a deflecting electrode between said cathode and said output and waste electrodes and beside the path of the electron beam, of a signal input circuit including said control grid, a signal output circuit connected to said output electrode, a signal rectifier connected to said output circuit for producing a uni-directional positive potential dependent on the signal amplitude, and a direct current voltage connection between said rectifier and said deflecting electrode for rendering said deflecting electrode increasingly positive to pull the electron beam from said output electrode to the waste electrode as the signals increase in amplitude.

5. The combination with an electron beam discharge tube of the type comprising a cathode, an output electrode, a waste electrode adjacent said output electrode, a control grid surrounding said cathode for modulating and concentrating into a beam the electron discharge from said cathode to said output electrode, a deflecting electrode between said cathode and said output and waste electrodes and beside the path of the electron beam, of a signal input circuit including said control grid, a signal output circuit connected to said output electrode, a signal rectifier connected to said output circuit for producing a uni-directional positive potential dependent on the signal amplitude, and a direct current voltage connection between said rectifier and said deflecting electrode for rendering said deflecting electrode increasingly positive to pull the electron beam from said output electrode to the waste electrode as the signals increase in amplitude, and an electrode in said tube, adjacent said deflecting electrode, energized to attract the beam back to the output electrode as the signals decrease in amplitude.

6. In combination with an electron beam tube of the type including an emission element, an output electrode arranged to receive an electron beam from the emission element, and a control electrode, means for impressing signals upon the control electrode of the tube, an output circuit connected to the output electrode of the tube, a signal rectifier connected to be responsive in direct current voltage output to the signal amplitude, a beam deflection electrode disposed within the tube, and a direct current voltage connection from the beam deflection electrode to the signal rectifier such that the electron beam is deflected from the output electrode as the signal amplitude increases.

7. In combination with an electron beam tube of the type including the emission element, an output electrode arranged to receive an electron beam from the emission element, and a control electrode, means for impressing signals upon the control electrode of the tube, an output circuit connected to the output electrode of the tube, a signal rectifier, a beam deflection electrode disposed within the tube, a direct current voltage connection from the beam deflection electrode to the signal rectifier such that the electron beam is deflected from the output electrode as the signal amplitude increases, and means to position the beam on said output electrode in the absence of received signals.

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