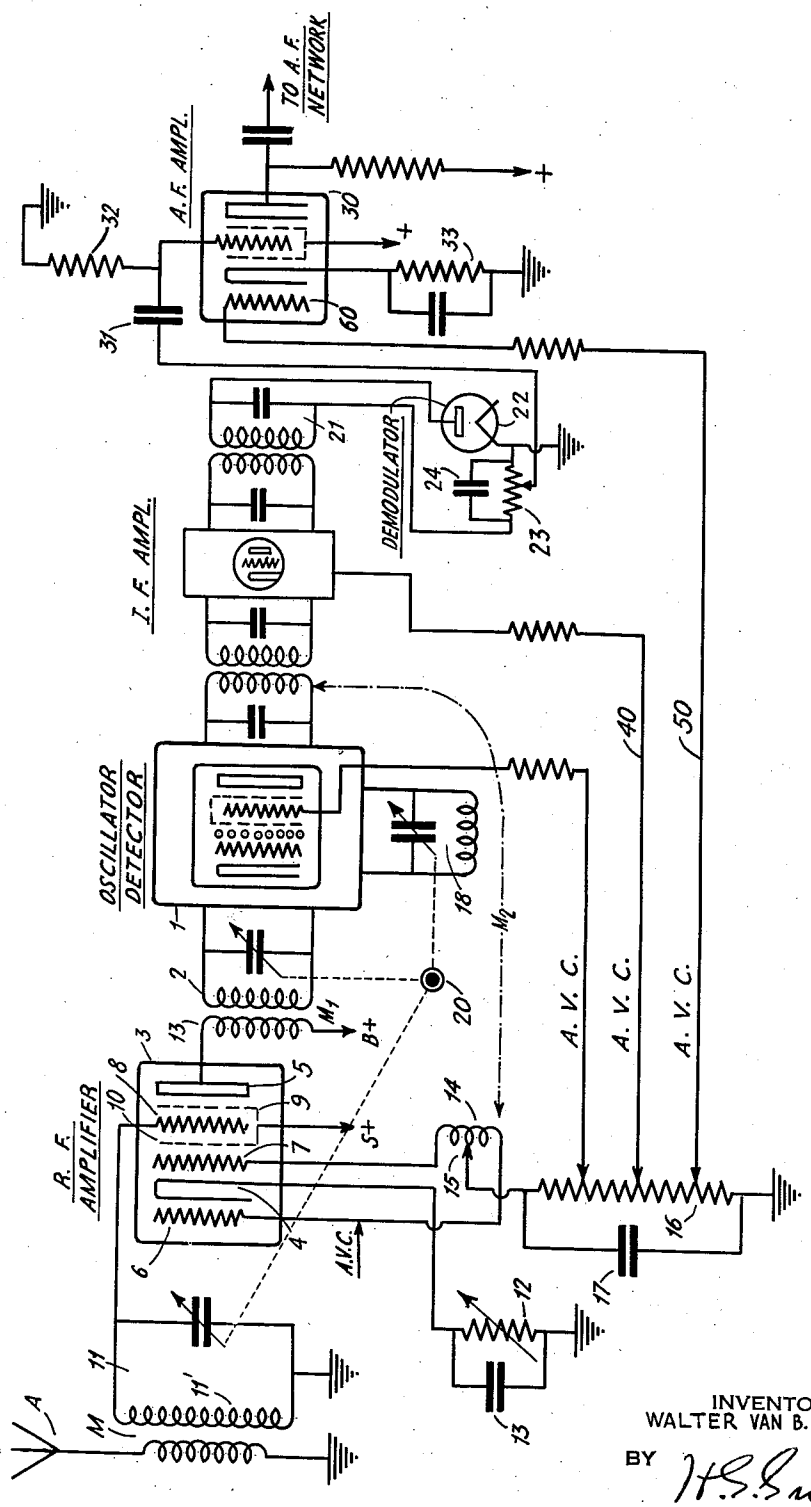
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SELF CONTROLLED AUTOMATIC GAIN CONTROL CIRCUIT

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INVENTOR
WALTER VAN B. ROBERTS
BY H.S. Grover
ATTORNEY

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SELF-CONTROLLED AUTOMATIC GAIN CONTROL CIRCUIT

Walter van B. Roberts, Princeton, N. J., assignor to Radio Corporation of America, a corporation of Delaware

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10 Claims. (Cl. 250—20)

My present invention relates to radio receiving sets employing gain control circuits, and more particularly to an automatic volume control circuit for a radio receiver of the type wherein a controlled high frequency amplifier provides its own gain control voltage.

In automatic volume control circuits for radio receivers known in the prior art the gain of a high frequency amplifier is usually regulated by a control voltage developed in a network of the receiving system other than the network including the amplifier to be controlled. Usually the controlling network is a rectifier circuit following the controlled amplifier stage.

It may be stated that it is one of the main objects of the present invention to provide an automatic volume control arrangement for a high frequency amplifier of a radio receiving system, the volume control arrangement being a part of the controlled high frequency amplifier whereby the need for certain additional circuit elements, or tubes, for the volume control function is eliminated.

In an automatic volume control system the signal voltage fed to the volume control unit should be of a substantially high intensity level in order to provide sufficient control voltage to effect a suitable gain control of the controlled high frequency amplifier. For this reason it is customary to amplify the signal voltage fed to the volume control unit of prior art systems, or to amplify the control voltage after it is produced. Here again it is essential to employ additional circuit elements for providing this amplified control voltage.

It is, therefore, another important object of this invention to secure the gain control voltage for a high frequency amplifier of a radio receiving system in the same stage which comprises the amplifier whose gain is to be controlled, and the signal voltage supplied the gain control mechanism being derived from a later network in the receiving system so that the signal voltage supplied to the gain control mechanism is of a substantially high intensity level.

It is another object of the present invention to provide a radio receiver of the superheterodyne type wherein the radio frequency amplifier is self-controlling with respect to its gain, and the mechanism employed in the radio frequency amplifier stage for the self-controlling function being additionally utilized to vary the gain of any of, or all of, the frequency changer, intermediate frequency amplifier, or audio frequency amplifier networks.

Still other objects of the invention are to improve generally the simplicity and efficiency of automatic volume control networks for radio receivers, and to particularly provide a high frequency amplifier in a radio receiver whose gain is self-regulated by a mechanism economically manufactured and assembled in the 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, both as to 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 a superheterodyne receiver employing in general a signal collector A, which may be a grounded antenna circuit, a tunable radio frequency amplifier stage, a converter, or frequency changer, network, an intermediate frequency amplifier, a demodulator and an audio frequency amplifier. The output of the audio frequency amplifier may be impressed upon any desired type of audio network, such as one or more stages of audio amplification followed by a reproducer of any well known type. The converter and intermediate frequency amplifier networks are conventionally designated, since their constructions form no part of this invention, and it is pointed out that the numeral 1 designates a circuit which may be of the combined local oscillator-first detector type utilizing a 2A7 type tube (also known as a pentagrid converter tube) which is disclosed by J. C. Smith in application Serial No. 654,421, filed January 31, 1933.

The network 1 may also, if desired, comprise a pentagrid converter tube of the type disclosed in my co-pending application Serial No. 727,377, filed May 25, 1934. Of course, the network 1 may comprise independent local oscillator and first detector tubes arranged in a manner well known to those skilled in the art.

The network preceding the tunable signal input circuit 2 of the converter network 1 comprises a radio frequency amplifier tube 3 which includes a cathode 4 and a plate 5, the cathode being disposed within a pair of symmetrical grids 6 and 7, and the signal grid 8 being disposed between a pair of screen grids 9 and 10.

The screen grids 9 and 10 are, in turn, disposed between the grids 6 and 7 and the plate 5. The tunable signal input circuit 11 has its high alternating voltage side connected to the signal grid 8, while its low alternating voltage side is grounded. The input coil 11' of the input circuit is coupled to the signal collector A, as at M. A normal fixed negative bias is established between the signal grid 8 and the cathode 4 by connecting in the grounded cathode lead a grid bias resistor 12, which is shunted by a condenser 13 to by-pass radio frequencies. The resistor 12 may be made adjustable in order to provide a manual volume control mechanism.

The plate 5 is connected to a source of positive voltage B, which source is not shown, through the primary winding 13 of the coupling transformer M_1. The positive terminal of a voltage source S, also omitted for simplicity of disclosure, is connected to the screen grids 9 and 10. The grids 6 and 7 are connected by a coil 14, an intermediate point of which is connected to ground through a path including the adjustable tap 15 and resistor 16, the reference numeral 17 denoting a radio frequency by-pass condenser connected across resistor 16. The reference numeral 18 denotes the tunable local oscillator circuit of the converter network 1, and the unicontrol mechanism for the tuning condensers of circuits 11, 2 and 18 is denoted by the reference numeral 20.

The intermediate frequency output of the converter network 1 is impressed upon the resonant input circuit 21 of the demodulator device 22 through the intermediate frequency amplifier network, and the latter may be of any conventional construction. The input circuit 21 is tuned to the operating intermediate frequency, and the demodulator 22 is shown as being of the diode type. The anode of the diode is connected to the cathode through a series path which includes the input circuit 21, the load resistor 23, the load resistor being shunted by a by-pass condenser 24. The demodulator, or second detector, furnishes aduio frequency energy for the audio frequency amplifier 30 through a path which includes the condenser 31 connected to an intermediate point on the load resistor 23. The connection to the resistor 23 from the signal grid of the amplifier 30 may be made adjustable so that the adjustable connection can function as a manual volume control device, if desired.

The signal grid of tube 30 is connected to ground through a resistor 32, and the grounded cathode lead of tube 30 includes a grid bias network 33. The plate of tube 30 is shown arranged for coupling to the following audio network. The electron discharge devices 22 and 30 may be combined as a single tube, and such construction may be of the 2B7 type wherein diode and pentode sections are provided with a common cathode, or it may be of the 12A7 type, wherein the diode section has a cathode independent of the cathode of the pentode section, a common heater being used for both cathodes.

The coil 14 is coupled to the resonant output circuit of the converter network 1, and in this way intermediate frequency energy is impressed upon the electrodes 6 and 7. The coupling between the intermediate frequency circuit and coil 14 is specifically shown as magnetic, and the coupling is represented by the dotted lines of the reference character M_2. Of course, any other type of coupling may be utilized, and it is also to be clearly understood that any other portion of the intermediate frequency amplifier network may be coupled to coil 14.

The intermediate frequency currents impressed upon grids 6 and 7 are rectified in the diode circuit which comprises the cathode 4, the resistor 12, the resistor 16 and the grids 6, 7. The rectified current flowing through the resistor 16 renders the ungrounded side of resistor 16 negative, and, as a result, the grids 6 and 7 become negative with respect to the cathode 4. In other words, as the signal amplitude increases, the ungrounded side of resistor 16 becomes increasingly negative, and the mutual conductance of tube 3 becomes less. In this way the gain of the tube 3 is decreased with increasing signal amplitude and it will be observed that this is accomplished without impressing any variable bias on the signal grid 8.

In order to substantially eliminate any modulation effect due to the signal currents impressed on grids 6 and 7, these two grids are co-planarly wound. In this way the intermediate frequency component in the plate circuit of tube 3 is substantially suppressed. As a matter of fact since the signal circuit 2 is tuned to the radio frequency signal currents, any intermediate frequency component transmitted thereto will be prevented from being transmitted therethrough. The direct current voltage component produced across resistor 16 may also be utilized for controlling the gain of any of the subsequent stages. Thus, the signal grid of the converter network 1 is shown connected for direct current potential purposes to a point on resistor 16 which is less negative than the point to which grids 6 and 7 are connected. A connection 40 may be made from a still less negative point on resistor 16 to the grid circuit, or circuits, of the intermediate frequency amplifier, and a connection 50 may be made from a still less negative point on resistor 16 to grid 60 in the audio frequency amplifier tube 30.

It will be observed that the co-planar grids 6 and 7 function as full wave rectifier anodes, which together with the cathode 4 act to rectify the intermediate frequency voltage impressed upon coil 14. The resultant negative potential of these two co-planar grids reduces the gain of the radio frequency amplifier tube 3 without producing modulation effects in the plate circuit of the tube. It will be understood, of course, that such negative potential increase occurs when the signal amplitude increases. A portion of the volume control voltage thus developed is further used to control the conversion gain, intermediate frequency amplifier gain and, where desired, the audio frequency amplifier gain to obtain complete flatness. It will be further observed that the grid 60 functions as a volume control grid in the audio amplifier 30, and that the variable control bias is not applied to the signal grid of the tube.

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 I claim is:—

1. In a radio receiver including a high frequency amplifier provided with a tube having a cathode, a plate, a signal grid and at least two gain control electrodes, arranged electrostatically to influence the electron flow from the cathode to said plate, at least one of the gain control

electrodes being disposed in the electron stream between the cathode and plate, a connection between the cathode and the two gain control electrodes including a load resistor, a signal transmission network coupled to the plate circuit of said amplifier, a signal coupling path between the two gain control electrodes of the amplifier and a point in said signal transmission network, a signal input circuit coupled between the signal grid and the cathode of said amplifier, and said two gain control electrodes being adapted to become increasingly negative in direct current voltage as the received signal amplitude increases.

2. In a radio receiver including a high frequency amplifier provided with a tube having a cathode, a plate, a signal grid and at least two gain control electrodes constructed and arranged to control the flow of electrons from said cathode to said plate, a connection between the cathode and the two gain control electrodes including a load resistor, a signal transmission network coupled to the plate circuit of said amplifier, a signal coupling path between the two gain control electrodes of the amplifier and a point in said signal transmission network, a signal input circuit coupled between the signal grid and the cathode of said amplifier, and said two gain control electrodes being adapted to become increasingly negative in direct current voltage as the received signal amplitude increases, said two gain control electrodes being co-planarly wound and surrounding the cathode.

3. In a radio receiver including a high frequency amplifier provided with a tube having a cathode, a plate, a signal grid and at least two gain control electrodes, a connection between the cathode and the two gain control electrodes including a load resistor, a signal transmission network coupled to the plate circuit of said amplifier, a signal coupling path between the two gain control electrodes of the amplifier and a point in said signal transmission network, a signal input circuit coupled between the signal grid and the cathode of said amplifier, and said two gain control electrodes being adapted to become increasingly negative in direct current voltage as the received amplitude increases, said transmission network including a demodulator and an audio frequency amplifier, and a direct current connection between a point on said load resistor and a gain control electrode of said audio amplifier.

4. In a radio receiver including a high frequency amplifier provided with a tube having a cathode, a plate, a signal grid and at least two gain control electrodes arranged for electrostatic control over the tube space current, at least one of the gain control electrodes being disposed in the electron stream between the cathode and plate, a connection between the cathode and the two gain control electrodes including a load resistor, a signal transmission network coupled to the plate circuit of said amplifier, a signal coupling path between the two gain control electrodes of the amplifier and a point in said signal transmission network, a signal input circuit coupled between the signal grid and the cathode of said amplifier, and said two gain control electrodes being adapted to become increasingly negative in direct current voltage as the received signal amplitude increases, said two gain control electrodes being connected by a coil, and said signal transmission network including a converter circuit having an output network tuned to an intermediate frequency, the said coil being coupled to said intermediate frequency output circuit.

5. In combination with a signal transmission tube of a type including a cathode, an output electrode and signal input electrode, a signal input circuit coupled between the input electrode and cathode, an output network coupled to said output electrode, means for automatically regulating the gain of said tube in response to received signal amplitude changes, said means including at least one electrode disposed in said tube between the cathode and signal input electrode to electrostatically affect the electron stream to the output electrode, a signal rectifier network, independent of said signal input circuit, connecting the one electrode and said cathode and including an impedance in series between the latter, and means for impressing signals on the rectifier network whereby variations in signal amplitude cause corresponding variations in the direct current potential of said one electrode with resultant changes in the said electrostatic effect.

6. In combination with a signal transmission tube of a type including a cathode, an output electrode and signal input electrode, a signal input circuit coupled between the input electrode and cathode, an output network coupled to said output electrode, means for automatically regulating the gain of said tube in response to received signal amplitude changes, said means including at least one electrode disposed in the electron stream flowing from the cathode to electrostatically affect the electron stream to the output electrode, a signal rectifier network, independent of said signal input circuit, connecting the one electrode and said cathode and including an impedance in series between the latter, and means for impressing signals on the rectifier network whereby variations in signal amplitude cause corresponding variations in the direct current potential of said one electrode with resultant changes in the said electrostatic effect.

7. In combination with a signal transmission tube of a type including a cathode, an output electrode and signal input electrode, a signal input circuit coupled between the input electrode and cathode, an output network coupled to said output electrode, means for automatically regulating the gain of said tube in response to received signal amplitude changes, said means including at least one electrode disposed in said tube between the cathode and output electrode to electrostatically affect the electron stream to the output electrode, a signal rectifier network, independent of said signal input circuit, connecting the one electrode and said cathode and including an impedance in series between the latter, and means coupled to the said output network for impressing signals on the rectifier network whereby variations in signal amplitude cause corresponding variations in the direct current potential of said one electrode with resultant changes in the said electrostatic effect.

8. In combination with a signal transmission tube of a type including a cathode, an output electrode and signal input electrode, a signal input circuit coupled between the input electrode and cathode, an output network coupled to said output electrode, means for automatically regulating the gain of said tube in response to received signal amplitude changes, said means including at least one electrode disposed in said tube between the cathode and output electrode

to electrostatically affect the electron stream to the output electrode, a signal rectifier network, independent of said signal input circuit, connecting the one electrode and said cathode and including an impedance in series between the latter, and means for impressing signals on the rectifier network whereby variations in signal amplitude cause corresponding variations in the direct current potential of said one electrode with resultant changes in the said electrostatic effect, at least one additional transmission tube coupled to the output network, and a direct current connection from a point on the impedance to a gain control electrode of the said last tube.

9. In combination with a signal transmission tube of a type including a cathode, an output electrode and signal input electrode, a signal input circuit coupled between the input electrode and cathode, an output network coupled to said output electrode, means for automatically regulating the gain of said tube in response to received signal amplitude changes, said means including at least one electrode disposed in the electron stream of said tube and between the cathode and output electrode to electrostatically affect the electron stream to the output electrode, a signal rectifier network, independent of said signal input circuit, connecting the one electrode and said cathode and including an impedance in series between the latter, and means for impressing signals on the rectifier network whereby variations in signal amplitude cause corresponding variations in the direct current potential of said one electrode with resultant changes in the said electrostatic effect, a second impedance connected in series between the signal input electrode and cathode, and the second impedance being disposed in the space current path of said tube whereby the voltage drop across the second impedance provides the bias for said input electrode.

10. In a system as defined in claim 6, a demodulator coupled to the said output electrode, a demodulated signal transmission tube coupled to the demodulator output, and a direct current connection between a gain control electrode of the last transmission tube and a point on said impedance.

WALTER VAN B. ROBERTS.