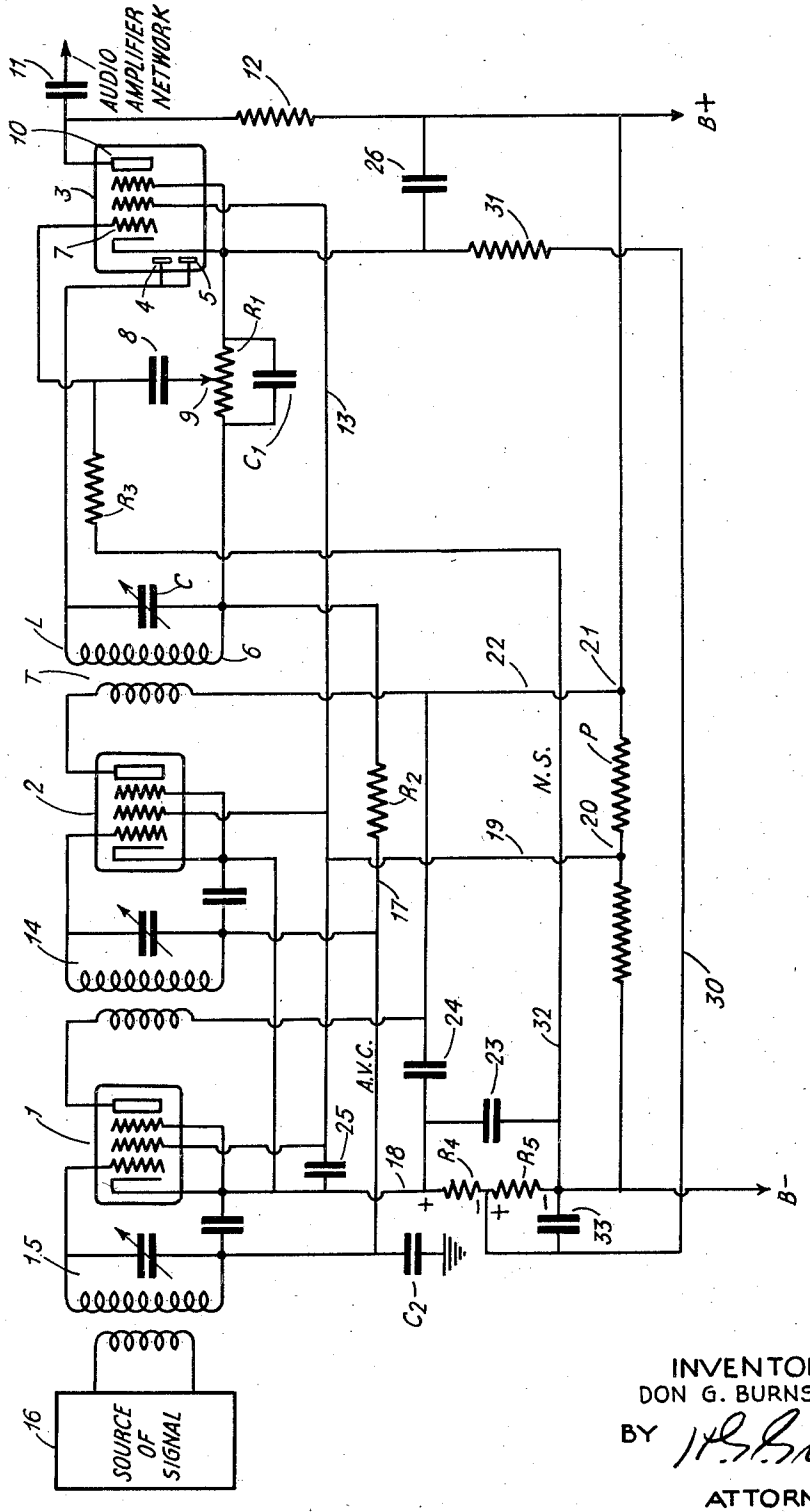
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AUTOMATIC VOLUME CONTROL

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AUTOMATIC VOLUME CONTROL

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9 Claims. (Cl. 250—20)

My present invention relates to automatic control systems for high frequency transmission networks, and more particularly to a novel method of automatically controlling the volume of a radio receiver.

Multiple function tubes are well known at the present time, and such tubes usually comprise independent electron discharge device sections disposed within a single tube element, these sections being interrelated with respect to electrical functions. Tubes of this type have been used for simultaneous signal demodulation, audio amplification and signal rectification for automatic volume control.

It may be stated that it is one of the main objects of my present invention to include still another function in the group of functions performed by present-day multiple duty tubes, the present invention providing a tube which is adapted to act as a demodulator, automatic volume control, audio amplifier and background noise suppressor.

Another important object of the invention is to utilize a tube known as a duplex diode pentode for signal demodulation, audio amplification, signal rectification for automatic volume control, the audio amplifier section of the multiple duty tube being employed for background noise suppression, and the suppression control voltage being derived from the controlled amplifier network.

Still other objects of the invention are to improve generally the simplicity and efficiency of radio receiver circuits, employing automatic volume control, and especially to provide a radio receiver of the automatic volume control type employing background noise suppression which is not only reliable in operation, but economically manufactured and assembled.

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 one circuit organization whereby my invention may be carried into effect.

Referring to the accompanying drawing, which shows a conventional type of radio receiver, the numeral 3 designates a tube of the duplex diode pentode type. This tube is of a well known form of construction to those skilled in the art, and it is only necessary to point out for the purposes of the present application that the tube consists of two diodes and a pentode in a single tube envelope. The cathode may be of the indirectly heated type, or 6B7 type, or it may be of the 85 type wherein a triode is used in place of the pentode section. In either case, a common cathode is employed for the two diode sections and the amplifier section, the diode anodes being disposed outside the electron stream to the grid and plate of the amplifier section. The functions and uses of a tube such as designated by the numeral 3 as a combined demodulator-audio amplifier-automatic volume control tube are described in my copending application Serial No. 644,149, filed November 25th, 1932, RCA—7098.

The diode anodes 4 and 5 of tube 3 are strapped together, and are connected to the cathode of the tube through a path which includes in series the tuned circuit 6 and the resistor R_1, the latter being shunted by a radio frequency by-pass condenser C_1. The tuned circuit 6 includes the secondary L of the coupling transformer T, the coil L_1 being shunted by the condenser C. Signals impressed upon the tuned circuit 6 are rectified in the half wave diode circuit, and there is developed across the load resistor R_1 a direct current component and an audio component of rectified signal current.

The audio component of rectified signal current is impressed upon the signal grid 7 of tube 3 through a path which includes the condenser 8, one side of the condenser 8 being connected by an adjustable tap 9 to the load resistor R_1. The plate 10 of the pentode section of tube 3 is maintained at a positive operating voltage by connecting it to the positive side of the voltage supply bleeder P. An audio frequency coupling condenser 11 transmits the amplified audio component to a succeeding audio amplifier network, and the latter may comprise one or more stages of audio amplification and a final reproducer. It will be noted that the plate 10 is connected to the +B side of the supply bleeder through a resistor 12, and that the screen grid electrode of tube 3 is connected by a lead 13 to a point on the bleeder resistor P which will supply the desired positive voltage to the aforesaid screen electrode.

The network preceding the tuned circuit 6 is shown comprising a pair of cascaded tuned radio frequency amplifier stages. The first of these stages includes a tube 1 of the pentode type, and the second stage may also include a tube 2 of the same type. The tuned input circuit 14 of tube 2 is coupled to the plate circuit of tube 1, and the tuned input circuit 15 of tube 1 is coupled to any

desired source of signal energy conventionally represented by the numeral 16.

If the receiver is of the tuned radio frequency amplifier type, then the tuning condensers in the circuits 15, 14 and 6 will be variable and arranged for uni-control adjustment. In such a case the half wave diode rectifier circuit functions as the signal detector, and the network 16 may comprise additional tuned radio frequency amplifier stages, or the usual antenna circuit. However, if the receiver is of the superheterodyne type, then the diode circuit functions as the second detector of the receiver, and the preceding amplifier stages function as the intermediate frequency amplifiers.

The network 16 preceding the tuned circuit 15 would then comprise the usual first detector circuit, and the latter could be fed by an antenna circuit or a stage of tuned radio frequency amplification. The tubes 1 and 2 are shown as pentode tubes, but it is to be clearly understood that they could be tubes of any other type. The mutual conductances of these tubes are varied, and consequently their gains, by changing the negative voltage on the signal grids thereof. To accomplish this in an automatic fashion, and in dependence upon variation in signal amplitude, the signal grids of tubes 1 and 2 are connected by a lead 17, including filter resistor R_2, to the negative side of resistor R_1. A capacitor C_2 is connected to ground from the lead 17 and provides with the resistor R_2 a radio frequency filter network. The lead 17 is designated "AVC" to show that this is the automatic volume control connection to the amplifiers 1 and 2.

The cathodes of tubes 1 and 2 are connected together to a common lead 18, the latter being connected to the high potential side of a resistor divided into two portions R_4 and R_5. The negative side of this resistor is connected to the minus B side of the bleeder P. The lead 13 connects together the screen grids of tubes 1, 2 and 3, and a common lead 19 connects the lead 13 to point 20 on the bleeder P, this point 20 being of less positive voltage than the point 21 to which the anodes of tubes 1 and 2 are connected by lead 22. Appropriate radio frequency by-pass condensers 23, 24, 25, 26 are connected at well known radio frequency by-passing points in the system, and direct current blocking condensers are inserted between the grids and cathodes of tubes 1 and 2.

The cathode of tube 3 is connected to an intermediate point on the resistor disposed in the cathode circuit of tube 1, and this connection is made through a lead 30 including a resistor 31 in its circuit. A lead 32 connects the negative side of resistor R_5 to the grid side of condenser 8 through a resistor R_3, a radio frequency by-pass condenser 33 being connected between lead 30 and the negative side of resistor R_5.

When signals are impressed upon the tuned input circuit 6 of the half wave diode rectifier the grids of tubes 1 and 2 connected to the negative side of resistor R_1 become increasingly negative in voltage. As the signal input to the rectifier rises to a maximum, the gain of each of tubes 1 and 2 approaches a minimum. In other words, the maximum sensitivity of amplifiers 1 and 2 is achieved when no signals are impressed upon the receiver. In the no-signal condition the amplifiers 1 and 2, because they are at maximum sensitivity, will greatly amplify undesired background noises. Such amplified noise impulses will be demodulated and amplified, and finally reproduced. To prevent such reproduction of undesired noise impulses when little or no signals are received, the transmission of the audio component of demodulated energy to the pentode section of tube 3 is prevented. This is accomplished because with no signal impressed on the receiver the plate currents of tubes 1 and 2 are normal, the normal bias being supplied by the sum of the plate currents flowing through resistor section R_4 to give the desired voltage drop. Furthermore, the same plate current flowing through resistor section R_5 provides a voltage drop of such value that when it is applied to the control grid 7 of tube 3 through the leak R_3 it causes cut-off.

Since an increasing incoming signal causes the negative biases on tubes 1 and 2 to increase by virtue of the automatic volume control action, the sum of the plate currents of the controlled tubes decreases. This decrease is most rapid at first, which is the condition for best noise control, since it is desirable to have the tube 3 go from "non-operation" to "operation" as suddenly as possible once the signal has reached a definite value. Amplifier tubes having high values of mutual conductance provide the most suitable control since small changes in control grid bias cause large changes in plate current. A movable contact on resistor R_5 could be used to provide a manually adjustable degree of sensitivity or noise suppression.

Additionally, by means of a switch to provide contact to either the upper end of resistor section R_5 or to the lower end, suppression or non-suppression may be had at will. When adjusted by whatever means for maximum suppression the receiver output will remain at zero until the carrier signal reaches a definite value above the noise level, or until the bias of tube 3 has dropped to a point which permits the amplifier section to become operative. In other words, in the no-signal condition the grid 7 of the pentode section of tube 3 is based to maintain a zero mutual conductance, which means that signals will not be transmitted to the succeeding audio network. As soon as signals are received, however, this negative cut-off bias decreases to a point such that the pentode section of tube 3 becomes normally operative.

The present invention is not restricted to the use of a half wave diode rectifier, since a full wave rectification arrangement may be employed. Furthermore, the two diode anodes 4 and 5 may be operated independently to provide delayed automatic volume control. This feature may be provided by additional sections being added to the cathode resistor network and independent operation of the two diodes so that for one or more of the amplifier tubes delayed bias results. As a matter of fact, separate diode operation may be obtained by any of the several commonly employed ways, as disclosed, for example, in my aforesaid copending application. Satisfactory voltages for the pentode section of tube 3 include a bias of −4.5 volts on the grid 7 and a screen voltage of 50. Under these circumstances the cut-off bias is reduced from a normal of about −17 volts to nearer 10 volts so that a change of about 5.5 volts in the drop across the resistor section R_5 will account for complete control.

It will now be seen that my present invention has provided suppression of inter-channel noise, or making the pentode section of the multiple duty tube 3 non-operative between carrier sig-

nals, in combination with other well known functions of the tube. Furthermore, it should be clearly understood that while I have indicated and described one circuit arrangement 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 circuit shown and described, but that many modifications may be made without departing in any way from the scope of my invention as set forth in the appended claims.

What I claim is:

1. A method of controlling the reception of signals which includes the steps of amplifying collected signals, rectifying the amplified signals, deriving a direct current component and an audio component from the rectified signals, changing the gain of a signal amplifier with the direct current component, amplifying the audio component, and causing the changing space current of the signal amplifier to vary the amplification of said audio component.

2. In combination in a radio receiver, a signal amplifier including an impedance in its cathode circuit, a signal rectifier including an impedance in its circuit across which rectified signal energy is developed, a direct current connection between the signal grid of said signal amplifier and the negative side of said second impedance, an audio amplifier having an input electrode connected to said second impedance, and a direct current connection between the negative side of said first impedance and said audio amplifier input electrode for regulating the conductivity of said audio amplifier.

3. In a receiver as defined in claim 2, a common tube envelope housing the electrodes of said audio amplifier and said signal rectifier.

4. In a receiver as defined in claim 2, both said impedances being resistors, and a direct current connection between the positive side of said first impedance and the positive side of said second impedance.

5. In a receiver as defined in claim 2, a common tube envelope housing the electrodes of said audio amplifier and said signal rectifier, and a direct current connection between the positive side of said first impedance and the positive side of said second impedance.

6. In combination, a signal amplifier comprising a pentode tube having a resistor in its cathode circuit, a multiple duty tube including a pentode section and a diode section, said diode section including in its circuit a tuned signal input network and a load resistor, an audio frequency coupling path between the signal grid of the pentode section and a point on said load resistor, a direct current connection between the negative side of said first resistor and the signal grid of said pentode section, a direct current connection between an intermediate point on said first resistor and the common cathode of said multiple duty tube, and a third direct current connection between the negative side of said diode load resistor and the signal grid of said signal amplifier.

7. In a signal transmission system which includes a signal transmission tube and a signal demodulator following the tube, an electron discharge device having an input electrode coupled to said demodulator and adapted to have demodulated signals impressed thereon for amplification, an automatic gain control connection between a point in the demodulator circuit and a gain control electrode of said signal transmission tube and arranged to impress the direct current component of demodulated signals upon the said gain control electrode, an impedance in the space current path of the signal transmission tube, and a gain control connection between a point on said impedance which is negative with respect to the potential of the cathode of said electron discharge device and the said input electrode.

8. In a signal transmission system which includes a signal transmission tube and a signal demodulator following the tube, an electron discharge device having an input electrode coupled to said demodulator and adapted to have demodulated signals impressed thereon for amplification, an automatic gain control connection between a point in the demodulator circuit and a gain control electrode of said signal transmission tube and arranged to impress the direct current component of demodulated signals upon the said gain control electrode, an impedance in the space current path of the signal transmission tube, and a gain control connection between a point on said impedance which is negative with respect to the potential of the cathode of said electron discharge device, and a common tube envelope housing the electrodes of said demodulator and the electron discharge device and the said input electrode.

9. In combination with a multiple function tube provided with at least one diode section and an amplifier section, a demodulator network including a load impedance connected to said diode section, a signal amplifier preceding said tube, an impedance in the signal amplifier space current path, a signal transmission network coupling the amplifier and said tube, a path of low impedance to the audio component of demodulated signals connected between an input electrode of said amplifier section and the said impedance of said diode section, a connection of low impedance to the direct current component of demodulated signals between the circuit of said diode section and a gain control electrode of said signal amplifier, a connection of low impedance to the direct current component of the space current flow of said signal amplifier between said input electrode and a point on the space current impedance of said signal amplifier which is negative with respect to the cathode of said amplifier section.

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