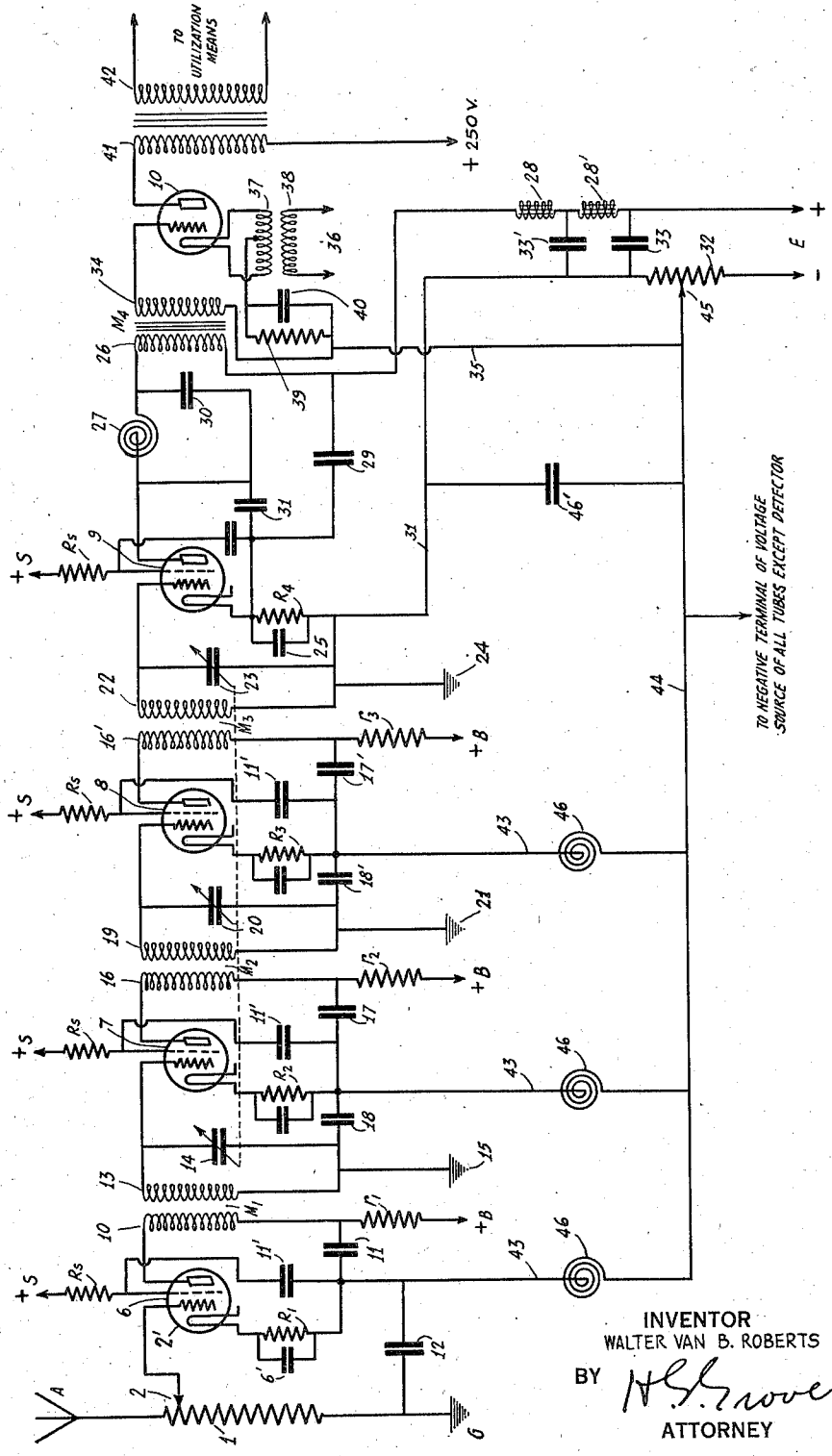
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AUTOMATIC GAIN CONTROL

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AUTOMATIC GAIN CONTROL

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My present invention relates to amplifiers, and more particularly to an improved and novel method of controlling the gain of a high frequency amplifier in an automatic manner.

One of the main objects of the present invention is to provide a method of, and means for, automatically controlling the gain of a high frequency amplifier, specifically used in a radio receiver, wherein the tuning of the amplifier stages are automatically broadened for loud signals, the latter usually not requiring much selectivity but whose side bands should be "untrimmed" for good fidelity.

Another important object of the invention is to provide a method of, and means for, automatically controlling the volume of a radio frequency amplifier in a receiver, which consists in biasing the cathodes of the amplifier stages more or less negative by the direct current component of the detector anode current according as the carrier voltage to the detector is more or less great.

Still another object of the invention is to provide an automatic volume control arrangement for a tuned radio frequency amplifier in a receiver, the arrangement not employing any auxiliary tube, or tubes especially adapted for the volume control function, but in place thereof employing the direct current component of the detector anode current to bias the amplifier cathodes in accordance with variations in carrier voltage, negative potentials on the cathodes resulting in damping of the tuned stages and reduction in amplification.

And still other objects of the invention are to improve generally the simplicity and efficiency of gain controls for amplifiers, and to particularly provide an automatic volume control arrangement for a radio receiver which is reliable in operation, and economically installed 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 one circuit organization whereby my invention may be carried into effect.

Referring to the drawing, which diagrammatically shows a conventional type of tuned radio frequency receiver, an antenna circuit A is shown, the latter being grounded at G, and includes a resistor 1. The control electrode 2', of the first electron discharge tube 6, is connected to the resistor 1 by an adjustable contact 2. The latter functions as the well known manual volume control means on the front panel of the receiver.

The tube 6 includes a cathode and anode, and is preferably shown as being of the screen grid type. The cathode of tube 6 includes in the negative leg thereof a biasing resistor R_1, shunted by a by-pass capacity 6', one terminal of the resistor being connected to the low potential end of inductance coil 10 through a capacity 11, the said resistor terminal, also, being connected to the low potential end of resistor 1 through a capacity 12.

A source B (not shown) is employed to impress a positive potential upon the anode of tube 6, the resistor r_1 and the inductance coil 10 being connected in series between the source B and the said anode. The inductance coil 10 is the primary of coupling transformer M_1, the secondary thereof being the inductance coil 13 which is connected between the input electrodes of screen grid tube 7.

The latter tube, also including a biasing resistor R_2 connected in the negative leg of cathode, has its input circuit tuned by a variable condenser 14, the low potential terminals of the inductance coil 13 and capacity 14 being grounded, as at 15. As in the case of resistor R_1, the resistor R_2 is shunted by a capacity, and is connected to the low potential end of coil 16 through a capacity 17, and to the low potential side of condenser 14 through a capacity 18. The anode of tube 7 is maintained at a positive potential by a source B, the resistor r_2 and coil 16 being connected in series between the anode and the source.

It will, thus, be seen that the input circuit of tube 6 is untuned, or aperiodic, while the input circuit of tube 7 is tuned. The inductance coil 16 constitutes the primary of coupling transformer M_2, the secondary of the latter comprising the inductance coil 19 connected between the input electrodes of screen grid tube 8. The input circuit of tube 8 is tuned by a variable condenser 20, the low potential side of the tuned input circuit being grounded, as at 21. The remaining elements in this second stage of tuned radio frequency amplification comprise the same electrical elements as in the case of the first tuned stage, and include the capacities 18' and 17', the primary inductance coil 16', the biasing resistor R_3, and the anode resistor r_3. If desired, a common source of current can be used to main-

tain the anodes of tubes 6, 7, 8 and 10 at a positive potential.

The secondary inductance coil 22, of the coupling transformer M_3 is connected between the input electrodes of the detector screen grid tube 9, the input circuit of the latter being tuned by a variable condenser 23, the tuned input circuit being grounded, as at 24. Here, again, a biasing resistor R_4 is connected in the negative leg of the cathode, while the resistor is shunted by a radio frequency by-pass capacity 25. The output circuit of detector tube 9 is coupled to the input circuit of a stage of audio frequency amplification by an audio frequency transformer M_4, the primary inductance coil 26 thereof being connected in series with a radio frequency choke coil 27, between the anode of the detector tube 9 and the positive terminal of a source of current E, which source is independent of the source B supplying the anodes of the other tubes.

The positive terminal of the source E is connected to one end of the coil 26 by a pair of audio frequency choke coils 28, 28' in series. The low potential end of the coil 26 is also connected to the cathode of tube 9 through a capacity 29, a capacity 30 being connected in shunt with the choke coil 27 in the anode circuit of tube 9, while a second capacity 31 is connnected in series with the capacity 30 between the cathode of tube 9 and one terminal of the capacity 30. The negative terminal of source E is connected by a lead 31 to the low potential terminal of the resistor R_4, the lead 31 including a resistor 32. A pair of capacities 33 and 33' are connected in shunt with the source E, and with the choke coils 28 and 28' comprise a filter arrangement for eliminating any audio frequency fluctuations or pulsations coming from source E.

The audio frequency amplification stage includes an electron discharge tube 10, shown as of the triode type, it being clearly understood that any other type of output tube could be used in place thereof. The control electrode of tube 10 is connected to the secondary inductance coil 34 of the audio transformer M_4, the coil being connected to lead 44 through lead 35. The cathode of the tube 10 is shown as of the alternating current heated type, current being derived from a source of alternating current 36, the midpoint of the secondary coil 37, of the heater transformer 38, being connected to coil 34, through a resistor 39 shunted by a capacity 40. The anode of tube 10 has impressed upon it a high potential, preferably about 250 volts from a source of direct current (not shown), the primary coil 41 of the output transformer 42 being connected in series between the anode of tube 10 and the 250 volt source. As is well understood in the art, the secondary of the output transformer 42 may be connected to subsequent stages of audio frequency amplification, or to a loud speaker arrangement, both broadly being referred to in the diagram by the expression "To utilization means".

The low potential terminal of each of the resistors R_1, R_2, and R_3 is connected by a lead 43 to a common lead 44 connected to an adjustable contact member 45 slidably associated with the resistor 32. Further, each lead 43 includes a radio frequency choke coil 46. The cathodes of the radio frequency amplifier tubes 6, 7 and 8 are made more or less negative in potential by the direct current component of the detector anode current, according as the carrier voltage to the detector is more or less great. In other words, by connecting the biasing resistors of the cathodes of the radio frequency amplifier tubes to the resistor 32 in the detector circuit, a convenient means for automatically controlling the gain of the amplifier stages is provided.

It should be obvious from the diagram and the aforementioned description that if the signal carrier voltage increases, the direct current component of the detector anode current becomes greater, and, consequently, the drop in potential across the resistor 32 increases, thus making the cathodes of all tubes except the detector, more negative with respect to ground, and hence making the cathodes of the radio frequency tubes more negative with respect to their grids, from which it results that the control electrode associated with each radio frequency tube cathode becomes relatively more positive, thereby controlling, in a manner inverse to the increase of carrier voltage the gain of the amplifier stages.

It should, also, be pointed out that a negative potential on the cathodes of each of the radio frequency amplifier tubes, arising as explained heretofore, causes damping of the tuned circuits, as in the tuned input circuits of tubes 7 and 8, as well as a reduction of amplification. This is especially true if resistors r_1, r_2 and r_3 or their equivalents, are provided in the anode supply line of each amplifier tube, to prevent much increase in anode current when the control grids become more positive. These resistors thus further decrease amplification by reducing the voltage on the plates more and more as the grids become more positive.

The amount of amplification is determined by the adjustment of contact member 45, along the resistor 32. Resistors R_1, R_2 and R_3 are chosen rather small, in fact only just large enough for optimum amplification of weak signals when slider 45 is at the grounded end of resistance 32. Any movement of the slider along 32 will then reduce the amplification, and, also, increase the effectiveness of the automatic control action. It will be noted that chokes 46 have been provided as precautions against interstage radio frequency coupling. These in cooperation with condenser 46' may be necessary to prevent coupling through the resistance 32.

Again, as there is very little bias provided by the resistors R_1, R_2, and R_3, unusually low voltage would be used for the radio frequency tubes, plates and screen grids, it being pointed out that the bias provided by the resistors R may be only a fraction of a volt when the amplication is greatest. The actual voltage of the source however may be greater, depending on the values of resistors r_1 r_2 r_3 etc. Of course, a common source of screen grid voltage may be used in place of the plurality of sources S shown, and it is also to be understood that the potential of the screen grids may be varied to effect manual adjustment of the volume output of the receiver or automatically varied as in the case of the anodes. Each of the screens includes a resistor R_5, a capacity 11' providing a path for radio currents in such case to the cathode. As is well known to those skilled in the art, the rotors of the variable condensers 14, 20 and 23 may be mechanically coupled, as shown by the dotted line in the diagram, for uni-control manipulation. It will thus be seen that an improved and effective type of automatic volume control has been provided, which control arrangement does not require the use of an auxiliary volume control tube as employed by devices of the prior art.

The fundamental operation of the device may be summarized as follows:

(1) The radio frequency tube plate and screen supplies are through high resistances which drop the plate and screen voltage to such values that maximum amplification is obtained with grid bias of only a fraction of a volt;

(2) Grid bias, positive in sign, is produced on all radio frequency tubes by, and in proportion to, detector plate current and hence more or less in proportion to strength of audio output;

(3) The amount of the bias for a given detector plate current is manually adjustable;

(4) In virtue of (1), the application of positive bias as explained in (2) reduces radio frequency amplification and also as well known broadens tuning of circuits;

(5) Hence, decreased amplification with increased fidelity is obtained either manually for a given station by adjusting a slider, or automatically as the receiver is tuned from a weak signal to a strong one with slider setting fixed.

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 receiving system including a signal amplifier provided with at least one amplifier tube, a detector tube coupled to the amplifier output circuit through a resonant network tuned to a desired signal frequency, a signal tuned network being coupled to the input electrodes of the amplifier tube, means electrically associated with the space current path of the amplifier tube for producing a negative bias on the grid thereof, a separate means, electrically associated with the detector space current path and being connected to the grid and cathode of the amplifier, for producing a positive bias on the amplifier grid, the bias developed by the separate means being dependent on, and varying in the same sense as, the detector signal input, the bias developed by the first means being dependent on, but varying in numerical magnitude more slowly than, the said positive bias whereby the net bias of the amplifier grid increases algebraically with increasing detector signal inputs and is positive for large detector inputs.

2. In a system as defined in claim 1, means for manually adjusting the positive bias produced by a given detector input.

3. A method of receiving radio signals which comprises impressing received signals upon an amplifier, detecting the amplified signals, deriving two amplifier biasing voltages from received signals, one of the voltages being positive and the other negative and both being dependent upon the amplitude of the said amplified signals, the numerical rate of increase of the positive voltage with increasing amplified signal amplitude exceeding that of the negative voltage, and impressing the two biasing voltages upon the amplifier whereby the net amplifier bias is small for weak signals and positive for amplified signals of large amplitude.

4. A radio receiver comprising at least one amplifier having a resonant grid circuit means in the amplifier space current path for maintaining the cathode of the amplifier at a voltage of the order of a fraction of a volt with respect to the grid in the absence of signals, a detector, an impedance connected between the amplifier and detector cathodes, and acting in proportion to the strength of signals applied to the detector input, for varying the potential of the cathode of the amplifier as signals are received, said impedance having a magnitude such that the amplifier cathode potential is made sufficiently negative with strong signals impressed on the detector input whereby amplifier grid current is caused to flow so that the amplifier gain and selectivity fall off, an impedance in the anode circuit of said amplifier to prevent a substantial increase in the amplifier anode current when the said amplifier grid current flows.

5. In a signal reception system, a signal transmission tube of a type including at least a signal input electrode, a cathode, an anode and a screen electrode disposed between the anode and the input electrode, means for maintaining said screen and anode at positive potentials with respect to said cathode, a signal input circuit connected between the cathode and input electrode, a demodulator having a signal input circuit coupled to receive signal energy from the said tube, means, responsive to an increase in the received signal amplitude at said first signal input circuit, for automatically varying the potential relations between the cathode and input electrode in a sense to decrease the signal transmission efficiency to said demodulator input circuit, and additional means electrically associated with at least the screen electrode circuit, and responsive to variations in space current flow in said transmission tube, for automatically decreasing the positive potential of the screen electrode as said transmission efficiency is decreased.

6. In a signal reception system, a signal transmission tube of a type including at least a signal input electrode, a cathode, an anode and a screen electrode disposed between the anode and the input electrode, means for maintaining said screen and anode at positive potentials with respect to said cathode, a signal input circuit connected between the cathode and input electrode, a demodulator having a signal input circuit coupled to receive signal energy from the said tube, means, responsive to an increase in the received signal amplitude at said first signal input circuit, for automatically varying the potential relations between the cathode and input electrode in a sense to decrease the signal transmission efficiency to said demodulator input circuit, and additional means comprising a resistor electrically associated with at least the screen electrode circuit, and responsive to variations in space current flow in said transmission tube, for automatically decreasing the positive potential of the screen electrode as said transmission efficiency is decreased.

7. In a signal reception system, a signal transmission tube of a type including at least a signal input electrode, a cathode, an anode and a screen electrode disposed between the anode and the input electrode, means for maintaining said screen and anode at positive potentials with respect to said cathode, a signal input circuit connected between the cathode and input electrode, a demodulator having a signal input circuit coupled to receive signal energy from the said tube, means, responsive to an increase in the received signal amplitude at said first signal input circuit, for automatically varying the potential relations between the cathode and input electrode in a

sense to decrease the signal transmission efficiency to said demodulator input circuit, and additional means electrically associated with at least the screen electrode circuit, and responsive to variations in space current flow in said transmission tube, for automatically decreasing the positive potential of the screen electrode as said transmission efficiency is decreased, and a resistor in the anode circuit of the transmission tube for decreasing the anode positive potential as said efficiency decreases.

8. In a radio receiver, a signal amplifier including at least one positive electrode, a demodulator coupled to the amplifier output, an automatic volume control circuit, connected between the amplifier output circuit and the input circuit thereof, for varying the potential between the input electrodes of the amplifier in response to signal amplitude changes at the amplifier input circuit, a resistor in the circuit of the positive electrode of the amplifier for automatically reducing the positive potential of the positive electrode as the said input electrode potential is varied in a sense to decrease the signal transmission to the demodulator.

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