Nov. 8, 1938. W. R. KOCH 2,135,942

AUTOMATIC GAIN CONTROL CIRCUIT

Original Filed July 6, 1934

Fig. 1

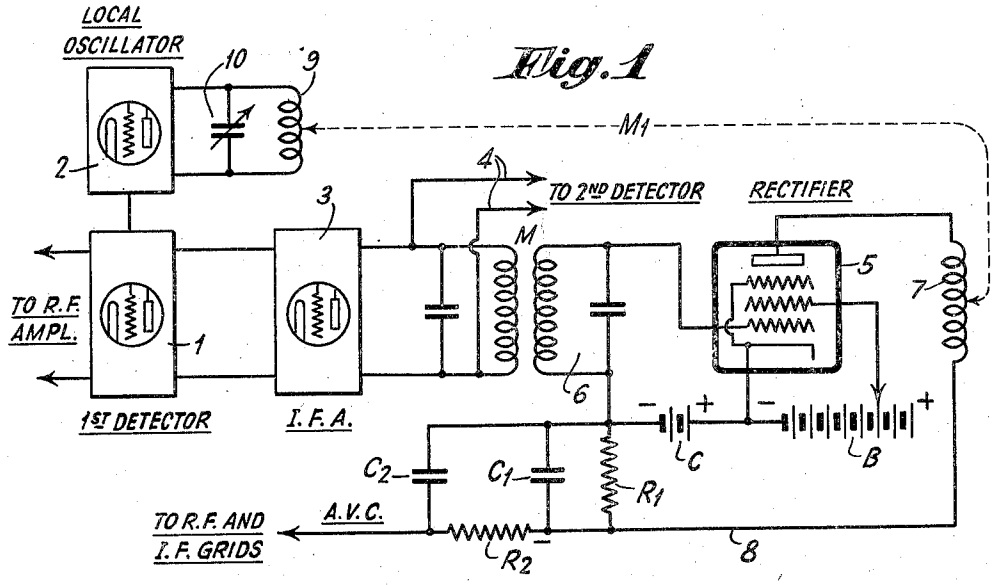
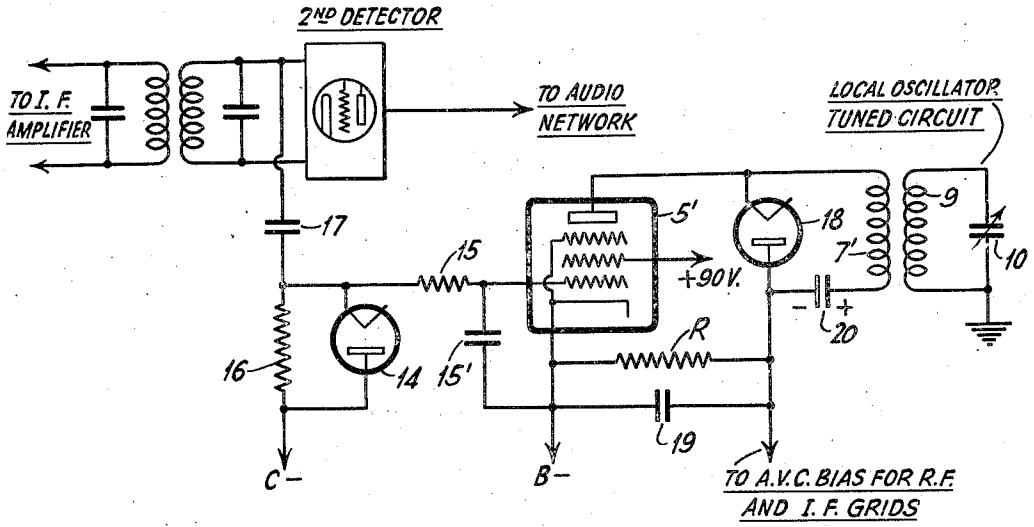


Fig. 2



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AUTOMATIC GAIN CONTROL CIRCUIT

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7 Claims. (Cl. 250—20)

My present invention relates to gain control circuits, and more particularly to such circuits when utilized for automatic volume control. The present application is a division of my application Serial No. 733,987 filed July 6, 1934, Patent No. 2,082,961, dated June 8, 1937.

One of the main objects of the present invention is to provide automatic gain control circuits for amplifiers, whether of high frequency or audible frequency, which circuits embody control tubes having output electrodes adapted to be energized by alternating current energy, the alternating current energy being of local oscillation frequency.

Another important object of the present invention is to provide automatic volume control circuits for radio receivers wherein the automatic volume control tubes may have their plates energized by alternating current energy, in place of the usual direct current sources, and the alternating current energy being derived from an existent source in the receiver, such as the tunable local oscillator circuit of a superheterodyne receiver.

Still other objects of the invention are to improve generally the efficiency of automatic gain control circuits for radio receivers, and more especially to provide in radio receivers automatic volume control circuits which are not only reliable in operation, but readily assembled in a radio 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 several circuit organizations whereby my invention may be carried into effect.

In the drawing:

Fig. 1 diagrammatically shows an automatic volume control system embodying one form of the invention, and

Fig. 2 shows a modification.

Referring now to the accompanying drawing, wherein like reference characters in the different figures correspond to similar circuit elements, there is shown in Fig. 1 an automatic volume control system for a superheterodyne receiver. It is to be clearly understood that the nature of the receiver with which the volume control network is associated is of comparatively little importance as far as the present application is concerned. The superheterodyne type of receiver has been employed as an illustration because it is at the present time substantially universally employed in broadcast reception in the United States and in many foreign countries. For this reason the various networks of the receiver are conventionally shown in Fig. 1, and it will be observed that the numeral 1 designates a first detector upon which is impressed energy of local oscillation frequency from a local oscillator 2. The intermediate frequency output of the network 1 is impressed upon an intermediate frequency amplifier 3.

The signal input circuit to the first detector may be connected to a signal collector, or to one or more stages of tuned radio frequency amplification. The amplified output of network 3 is then impressed upon a second detector, or audio demodulator, through leads 4. The demodulated energy is utilized in one or more stages of audio amplification, and then finally reproduced. The receiving system could be employed as a portable receiver in an automobile, or in a cabinet in the home of the user. The operating range of the receiver can be in the broadcast range, or the receiver may be of the multi-range variety, and in that case it could also be operated in the various short wave bands outside the broadcast band.

The automatic volume control system is utilized in the receiver, as is well known at the present time, in order to maintain a substantially constant carrier energy level at the input of the audio demodulator. Because of fading phenomena, or other causes which result in effects analogous to fading, the signal energy level at the audio demodulator tends to fluctuate. The automatic volume control system overcomes this tendency, and for this reason is utilized in modern radio receivers. The automatic volume control network shown in Fig. 1 embodies a tube 5 which is of the pentode type, and its resonant input circuit 6 is connected between its signal grid and cathode. The resonant input circuit 6 is coupled to the resonant output circuit of the intermediate frequency network 3, and the coils of both resonant circuits may comprise the primary and secondary windings of the coupling transformer M.

The voltage source B is employed to provide positive potential for the screen grid of tube 5, and the voltage source C furnishes negative bias for the signal grid of tube 5. The plate of the pentode tube is connected to the low alternating voltage side of input circuit 6 through a path

which includes the secondary winding 7 of the transformer M_1, lead 8 and resistor R_1, a by-pass condenser C_1 being connected in shunt across resistor R_1. A resistor R_2 is connected to the lead 8, and is arranged in series with coil 7, a by-pass condenser C_2 being connected in shunt across resistors R_1 and R_2. The primary winding 9 of transformer M_1 has a tuning condenser 10 connected across it.

The circuit 9—10 is the tunable local oscillator circuit of the local oscillator 2, and the variable condenser 10 is, of course, mechanically uni-controlled with the variable tuning condensers of the first detector and radio frequency amplifier stages in a manner well known to those skilled in the art. The symbol M_1 has been shown disposed between dotted line arrows coupling coils 9 and 7, and it will be understood that these two coils are magnetically coupled so that local oscillator energy may be impressed upon the coil 7. The physical connection between these two coils may be made in any desired manner, and these coils may be the actual windings of a transformer, or a link circuit may be used to couple them.

The tube 5 functions as the AVC rectifier, and derives its signal energy from the output of the intermediate frequency amplifier. For this reason the input circuit 6 is fixedly tuned to the operating intermediate frequency. Instead of using a separate source of direct current voltage for the plate of the tube 5 which produces the control voltage for gain control, the tube is operated with alternating current on the plate. The alternating current is obtained from a source present in the receiver, and it will be observed that this source is the local oscillator. This permits the utilization of common A, B and C battery operation, and no more than the usual voltage need be used. Thus, AVC voltage requirements are simplified, and improved AVC is permitted with a battery operated receiver, such as used in sections where power lines are not available, or in automobiles.

The rectifier 5 is normally biased somewhat more negative than is required to reduce the plate current to zero. When a signal is tuned in, the intermediate frequency energy impressed on the signal grid of rectifier tube 5 will cause the plate current to flow, and this will make the plate end of resistor R_1 more negative. In turn, this increases the bias on the amplifier tubes to control the amplification of the signal energy. The lead connected to the negative end of resistor R_1 has been designated AVC to denote the direct current gain control connection to the grids of the various controlled amplifier tubes. It is to be clearly understood that the AVC connection may be made to the various radio frequency amplifier tubes, the intermediate frequency amplifier tubes, and, if desired, to the first detector tube as well. The alternating current components are filtered out from the control bias voltage derived across resistor R_1 through a filter network including resistor R_2 and condenser C_2. Of course, the same batteries used for the control rectifier 5 may be utilized for the remainder of the tubes in the receiver. If an alternating current operated receiver is utilized, the B and C batteries may be replaced by the resistor across the output of the rectifier and filter.

The tube 5, using alternating current on the plate, really functions only during part of the cycle. During the half cycle in which the end of the transformer winding 7 nearest the plate of the tube 5 is negative, no current can flow. During the following half cycle, this end of the winding becomes positive, and current will flow, provided the grid is not too negative, and condenser C_1 will be charged up.

Sufficient voltage from the local oscillator circuit may be obtained in a superheterodyne receiver, and by proper design there should be no difficulty in obtaining a peak oscillator voltage of 40 to 60 volts. Those skilled in the art will readily be able to design the local oscillator circuit so as to provide a proper operating voltage for the plate of rectifier tube 5.

In Fig. 2 there is shown another arrangement for utilizing the local oscillator voltage of a superheterodyne receiver as the operating voltage for the plate of the automatic volume control tube. In this arrangement a small diode, or other rectifier, is added so that the bias on the controlled amplifier tubes can be made twice as high as the peak oscillator voltage. The circuit shown is similar to that usually employed for voltage doubling, except that the automatic volume control tube is used in place of one of the diodes, and the connection is similar. The signal strength determines the amount of drop appearing across the automatic volume control resistor R, which furnishes the bias for the grids of the controlled amplifier tubes. The pentode rectifier 5' has its signal grid connected to the cathode of diode tube 14 through a resistor 15, resistor 16 being connected between the cathode and anode of diode 14.

The anode side of resistor 16 is connected to the negative terminal of the voltage source C, and a signal coupling condenser 17 connects the cathode side of resistor 16 to the signal network feeding the second detector. The voltage doubling diode 18 has its cathode connected to the plate of tube 5', while the anode of diode 18 is connected to the cathode of tube 5' through the bias voltage resistor R, a by-pass condenser 19 being connected across the resistor R. The cathode and anode of diode 18 are, additionally, connected by a path which includes the coil 7' and the condenser 20. The tunable local oscillator circuit 9—10 is magnetically coupled to the coil 7', and the condenser 20 is charged by the diode anode to have the polarity shown. The function of diode 14 is to change the signal voltage to a steady direct current voltage for controlling the grid of tube 5'. Audio and radio frequency voltages are filtered from the input to this grid by resistor 15 and the condenser 15'. In this way the AVC is rendered independent of the modulation.

While I have indicated and described several systems 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 organizations 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 an automatic gain control system, an amplifier whose gain is to be controlled, a rectifier, the rectifier including a tube provided with a plurality of electrodes, certain of said electrodes comprising input electrodes, means for impressing signals upon the input electrodes, and means for impressing local oscillations generated in the system upon an output electrode of said rectifier tube, a resistor in the space current

path of said rectifier tube, and a gain control connection connected to a negative point on the resistor, a diode coupled between the output electrode of said rectifier tube and said means for impressing the locally generated oscillations on said output electrode.

2. In a system of the type defined in claim 1, a second diode coupled to the input electrodes of the rectifier tube.

3. In combination with a signal transmission tube, a source of alternating current energy, at least two electron discharge devices, each of said devices including at least a cathode and a cold electrode, a load resistor connected in series with the space discharge paths of said devices, the cathode of one of said devices being connected to the cold electrode of the other of said device and the cathode of the latter device being connected to the cold electrode of said one device, means for impressing alternating energy from said source upon one of said devices, means responsive to signal amplitude variations for controlling the conductivity of at least one of said devices, and means for regulating the gain of said signal transmission tube in response to changes in magnitude of direct current voltage developed across said load resistor.

4. In combination with a signal amplifier of a radio receiver, a pair of space discharge devices connected in voltage doubling relationship, a load resistor in series with the space current paths of said devices, means for impressing alternating current voltage to be rectified upon said devices, and additional means responsive to signal amplitude changes for varying the direct current voltage developed across said load resistor.

5. In a radio receiver provided with a signal transmission tube whose gain is to be automatically regulated by changes in signal amplitude, an automatic gain control arrangement which includes a voltage doubling network provided with a load resistor across which a gain control voltage is developed, and means responsive to signal amplitude changes for controlling the magnitude of the direct current voltage developed across said load resistor.

6. In a radio receiver provided with a signal transmission tube whose gain is to be automatically regulated by changes in signal amplitude, an automatic gain control arrangement which includes a voltage doubling network provided with a load resistor across which a gain control voltage is developed, means responsive to signal amplitude changes for controlling the magnitude of the direct current voltage developed across said load resistor, and a source of high frequency oscillations coupled to said network.

7. In a radio receiver provided with a signal transmission tube whose gain is to be automatically regulated by changes in signal amplitude, an automatic gain control arrangement which includes a voltage doubling network provided with a load resistor across which a gain control voltage is developed, means responsive to signal amplitude changes for controlling the magnitude of the direct current voltage developed across said load resistor, and said signal responsive means including a rectifier having a direct current voltage connection to a conductivity control electrode of a space discharge device included in said network.

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