Sept. 22, 1936. W. R. KOCH 2,054,825

AUTOMATIC GAIN CONTROL CIRCUITS

Filed March 18, 1933

Fig. 1

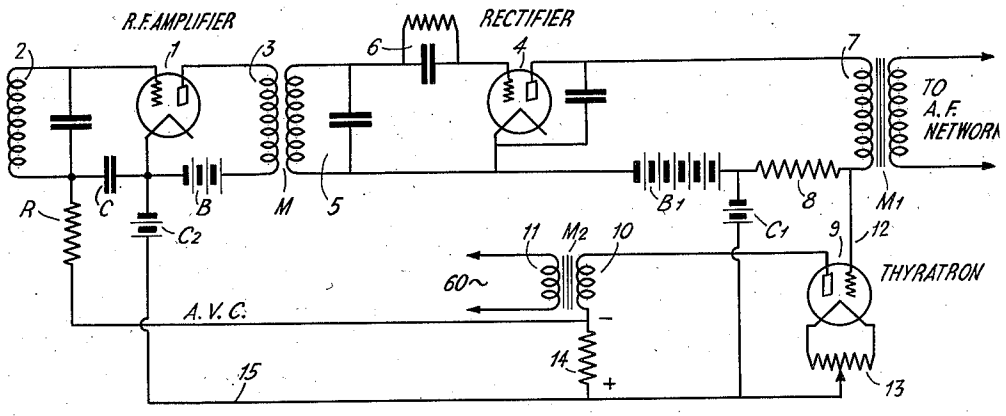
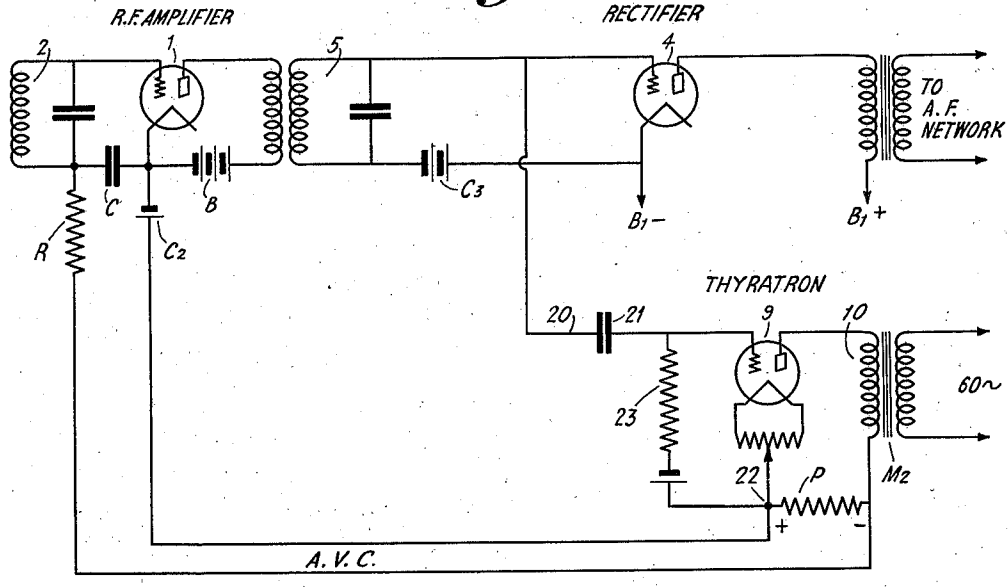


Fig. 2



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AUTOMATIC GAIN CONTROL CIRCUITS

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8 Claims. (Cl. 250—20)

My present invention relates to high frequency receivers, and more particularly to automatic volume control arrangements for such receivers utilizing a control tube of the thyratron type.

It has previously been proposed to provide radio receivers with automatic volume control devices whereby the ultimate sound output is rendered substantially independent of fading and other phenomena which tend to cause the amplitude of an incoming signal to greatly vary. In the operation of receivers equipped with such automatic volume control devices, however, some dissatisfaction has been experienced by reason of the fact that such devices did not hold the signal strength sufficiently close to a constant value at the grid of the receiver detector.

Accordingly, it may be stated that it is one of the main objects of my present invention to provide an improved automatic volume control arrangement for a radio receiver, the arrangement functioning to maintain the signal strength substantially constant at the grid of the detector, the automatic volume control circuit employing a control tube of the thyratron type.

Another important object of the present invention may be stated to involve the provision of an automatic volume control tube for an automatic gain control network, adapted for use in a radio receiver, wherein the control tube is a grid controlled rectifier, the function of the grid being to control the starting of the anode current, and an alternating voltage being applied to the anode.

And still other objects of the present invention are to improve generally the efficiency of gain control circuits for radio receivers, and to especially provide an automatic volume control network for a radio receiver 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, 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 several circuit organizations whereby my invention may be carried into effect.

In the drawing,

Fig. 1 diagrammatically shows a radio receiver embodying a control tube according to the present invention,

Fig. 2 shows a modification of the circuit shown in Fig. 1.

Referring now to the accompanying drawing wherein like reference characters designate corresponding circuit elements in the different figures, there is shown in Fig. 1 in purely conventional form the elements of a radio receiver which are essential to an understanding of the present invention. The numeral 1 designates an amplifier tube, which may be any of the well known radio frequency amplifier tubes employed at the present time. The tube is shown used in a radio frequency amplifier stage. The resonant input circuit 2 of the tube has its high radio frequency potential side connected to the grid of the tube, while the low potential side is connected, through a capacitor C, to the negative leg of the cathode of tube 1. The anode of tube 1 is connected to the positive terminal of the anode potential source B through the primary winding 3. The coupling transformer M couples the anode circuit of the tube 1 to the input electrodes of the rectifier tube 4.

The resonant input circuit 5 of the rectifier tube has its high potential side connected to the grid of the tube 4 through the well known leaky condenser rectification network 6, the negative side of the cathode of tube 4 being connected to the low potential side of the input circuit 5. The anode of the rectifier tube is connected to the positive terminal of the rectifier plate potential source B_1 through a path which includes in series the primary winding 7 and the resistor 8. The audio frequency coupling transformer M_1 couples the anode circuit of the rectifier to any appropriate audio frequency network, the latter including, if desired, one or more stages of audio frequency amplification, and a final reproducer.

The automatic volume control network comprises the tube 9 of the thyratron type. In carrying out the present invention it is preferred to utilize a grid controlled rectifying device as now very well known under the registered trade-mark "Thyratron". This rectifying device, which hereinafter will be referred to for the sake of brevity as a "thyratron", is supplied with alternating potential and the grid thereof is normally so biased that rectified current flows in the output circuit. The anode of the thyratron tube 9 is supplied with an alternating potential, of for example 300 volts, which potential may conveniently be derived from the secondary winding 10 of a power transformer M_2, the primary winding 11 being connected to a source of 60 cycle voltage. This transformer M_2 could, also, be used to energize a rectifier (not shown) for supplying direct current potential for the various cold electrodes of the

tubes 1 and 4, and to supply heating current to the various cathode heating currents of the receiver.

The control electrode of the tube 9 is connected, through a lead 12, to one side of a resistor 8, while the other side of the resistor 8 is connected to the electrical midpoint of the cathode resistor 13 through a path which includes the biasing potential C_1, the negative terminal of this biasing potential source being connected to the control electrode of the tube 9. The anode of tube 9 is connected to the electrical midpoint of the resistor 13 through a path which includes the power transformer winding 10 and the volume control resistor 14 in series.

The negative side of the resistor 14 is connected to the low radio fequency potential side of the input circuit 2 through a path, designated "A. V. C.", which includes the filter resistor R. The positive terminal of the resistor 14 is connected to the negative leg of the cathode of tube 1 through a path comprising the lead 15 and the biasing potential source C_2, the positive terminal of this source being connected to the positive side of resistor 14.

The plate current of the thyratron tube, with alternating voltage on the plate, can be controlled to a certain extent by the bias voltage. The mutual conductance under these conditions is much better than the ordinary electron discharge tube. Because of the extremely high mutual conductance of the thyratron tube, it may be used in a radio receiver to automatically adjust the sensitivity of the receiver so as to keep the signal level at the detector grid at a substantially constant level. With alternating current voltage applied to the plate of the thyratron the plate current over part of the range depends upon the bias voltage applied.

The function of the grid of the thyratron tube is to control the starting of the plate current. A negative grid potential, of sufficient value with respect to the cathode, will prevent the occurrence of a discharge. Once the discharge has started the grid potential, as usually applied, does not control the anode current. If an alternating voltage is applied to the anode, the grid has an opportunity to regain control during the negative half of each cycle, and to retain this control for as long a period during the extent of the cycle as its potential is sufficiently negative. By thus controlling the time of starting of the anode current in each positive half cycle the average anode current is controlled.

An increase in signal strength on the grid of the grid leak detector tube 4 decreases the flow of anode current in the anode circuit of the detector. The potential drop across the resistor 8 becomes less, which reduces the bias on the thyratron, and, accordingly, increases the thyratron plate current. There results an increase, therefore, in the potential drop across the resistor 14, and this increase in potential drop is employed to bias off the amplifier tube 1 so as to reduce its amplification. The reverse operation takes place when the signal strength applied to the grid of the detector tube 4 decreases below a predetermined signal level.

The alternating current ripple in the voltage across the resistor 14 is filtered out by the resistor R and capacitor C. It is desirable that the thyratron be shielded and its leads filtered to keep its radio interference confined. It should be noted that a change of only a few tenths of a volt on the grid of the thyratron is ample. It should be observed that the thyratron control tube is controlled indirectly by the detector tube.

Of course, the present invention is not limited to a radio receiver employing but a single stage of radio frequency amplification preceding a grid leak type of detector. For example, the receiver may be of the tuned radio frequency type or the superheterodyne type. In the case of the former, one or more stages of radio frequency amplification could be used ahead of the grid leak detector tube 4, and in such case all the resonant input circuits of the various tubes would include variable tuning condensers having their rotors uni-controlled in the well known manner. In this case, also, the thyratron tube 9 could be used to control the amplification of all the radio frequency amplifier tubes.

In the case of a superheterodyne receiver, the tube 1 may be considered to represent the intermediate frequency amplifier, with its input circuit fixedly resonant to the operating intermediate frequency. The rectifier tube 4 would then be employed in the second detector stage. Of course, in such a receiver the resonant circuit 2 would be coupled to the output of the first detector stage, and the thyratron tube 9 could be used to control the amplification of a radio frequency amplifier ahead of the first detector, as well as the tube 1.

The plate current in the thyratron tube 9 may be controlled from the signal, and the rectifier tube 4 may be of the biased detector type. Such an arrangement is shown in Fig. 2. In this figure the control electrode of the thyratron tube 9 is connected to the grid circuit of the rectifier tube 4 through a path which includes the lead 20 and radio frequency coupling condenser 21.

The resistor P has one side thereof connected to the anode of tube 9 through the primary winding 10 of the power transformer M_2. The electrical midpoint of the cathode resistor 13 is connected to point 22 of the resistor P, while the grid of the tube 9 is connected to the point 22 through a bias resistor 23 and a bias source. The negative side of the resistor P is connected to the amplifier resonant input circuit through the control path which includes the lead designated A. V. C. and the filter resistor R.

The potential source C_3 in the grid circuit of the rectifier tube 4 biases the grid of the rectifier tube to a point on the tube characteristic such that the tube functions as a bias detector. With alternating current voltage applied to the plate of the thyratron tube 9, the plate current, over part of the range, depends on the bias voltage applied. The signal tends to reduce the effective bias, making the thyratron pass more plate current, which tends to bias off the amplifier and reduce the amplification.

In Fig. 2, a signal voltage tends to give the same effect as a reduction of bias on the grid of the thyratron tube. When a strong signal is applied to this grid, the thyratron plate current will start sooner in each cycle of the plate voltage. The drop in the plate resistor will then be greater, and the bias on the amplifier tube larger.

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 combination with a signal amplifier and a detector, a source of alternating current volt-

age, a grid controlled rectifier having its plate circuit coupled to the alternating voltage source for energization of the rectifier anode, a resistor in the anode circuit of the rectifier, direct current connections connecting the input electrodes of said signal amplifier across said resistor, and a connection between the detector and the grid of said rectifier.

2. In combination with a signal amplifier and a detector, a source of alternating current voltage, a grid controlled rectifier having its plate circuit coupled to the alternating voltage source for energization of the rectifier anode, a resistor in the anode circuit of the rectifier, direct current connections connecting the input electrodes of said signal amplifier across said resistor, and a connection between the detector and the grid of said rectifier, said rectifier having an extremely high mutual conductance whereby the rectifier is adapted to adjust the sensitivity of the amplifier, in response to variations in signal energy input to the detector, to keep the signal level of the detector grid at a substantially constant level.

3. In combination with a signal amplifier and a detector, a source of alternating current voltage, a grid controlled rectifier having its plate circuit coupled to the alternating voltage source for energization of the rectifier anode, a resistor in the anode circuit of the rectifier, direct current connections connecting the input electrodes of said signal amplifier across said resistor, and a connection between the detector and the grid of said rectifier, the characteristics of said rectifier being such that a change of only a few tenths of a volt on the rectifier grid is sufficient to cause a variation in the gain of said signal amplifier.

4. In combination with a high frequency amplifier and a signal rectifier, a gain control network for said amplifier, said network including a grid controlled rectifier having its grid connected to the signal rectifier circuit, means for impressing an alternating current voltage on the anode circuit of said grid controlled rectifier, a direct current connection between the anode circuit of said control network rectifier and a gain control electrode of said amplifier, a potential change of less than a volt on the grid of the control rectifier being ample to cause a change in the amplifier gain.

5. In combination with a high frequency amplifier and a signal rectifier, a gain control network for said amplifier, said network including a grid controlled rectifier, means for impressing an alternating current voltage on the anode circuit of said grid controlled rectifier, a direct current connection between the anode circuit of said control network rectifier and a gain control electrode of said amplifier and a radio frequency signal connection between the control electrode of said control network rectifier and the control electrode of said rectifier.

6. In combination with a high frequency amplifier and a signal rectifier, a gain control network for said amplifier, said network including a grid controlled rectifier, means for impressing an alternating current voltage on the anode circuit of said grid controlled rectifier, and a direct current connection between the anode circuit of said control network rectifier and a gain control electrode of said amplifier, said first rectifier being of the leaky condenser type, a resistor in the anode circuit of said first rectifier, and means for connecting the input electrodes of said control network rectifier across said resistor.

7. In combination with a signal amplifier and a signal demodulator, a source of alternating current voltage, a grid controlled rectifier having its plate circuit coupled to the alternating voltage source for energization of the rectifier anode, a resistor in the space current path of the rectifier, direct current connections connecting the input electrodes of said signal amplifier across said resistor, and a signal connection between the demodulator and the grid of said rectifier.

8. In a system as defined in claim 7, said source of alternating current voltage having a frequency of the order of 60 cycles.

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