Feb. 18, 1936. L. E. THOMPSON 2,031,238

AUTOMATIC VOLUME CONTROL ARRANGEMENT

Filed April 7, 1933

Fig. 1

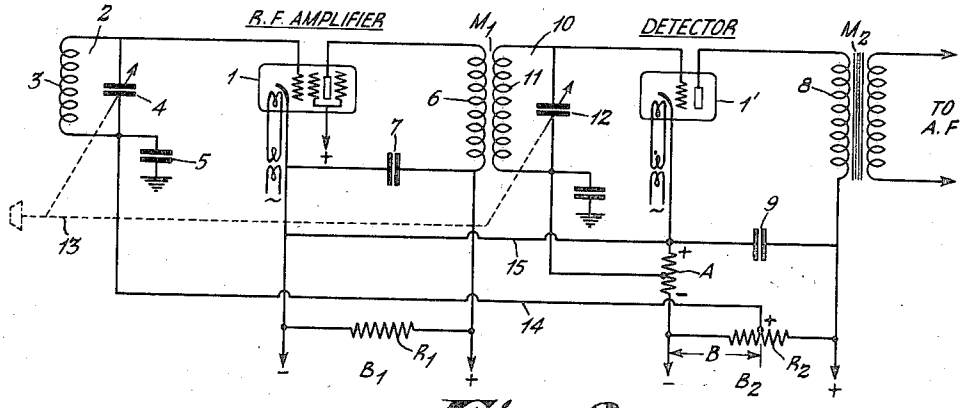


Fig. 2

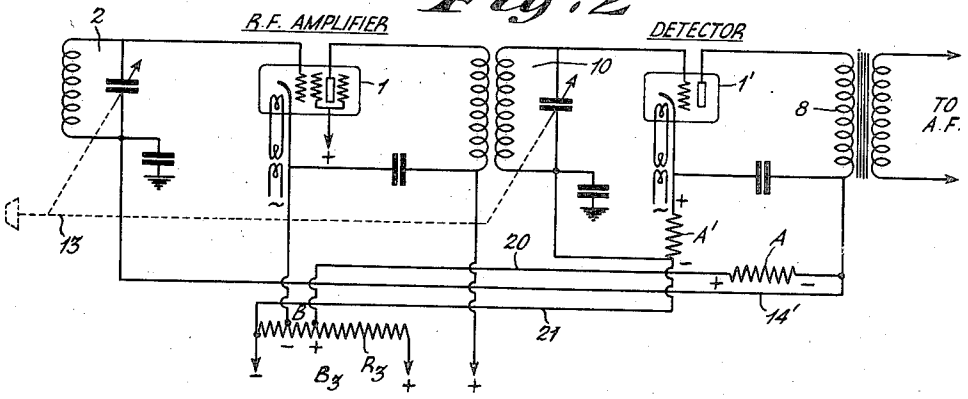
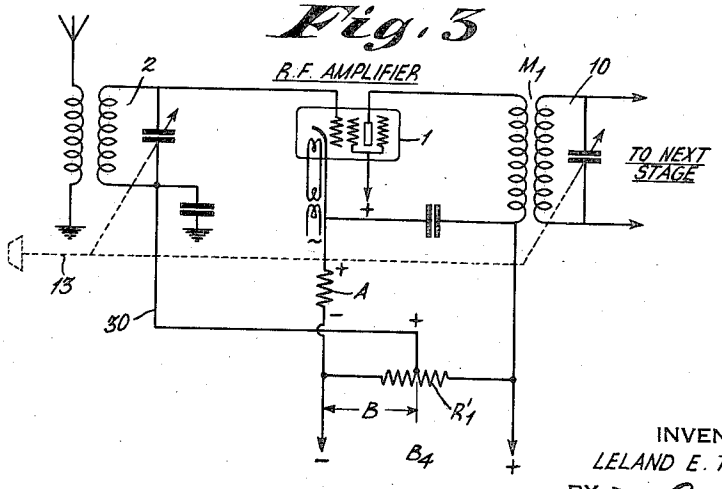


Fig. 3



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AUTOMATIC VOLUME CONTROL ARRANGEMENT

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9 Claims. (Cl. 250—20)

My present invention relates to high frequency receivers, and more particularly to receivers of the type employing automatic volume control networks.

The present invention is useful in the case of a radio receiver provided with high radio frequency gain, and it is an important object of this invention to provide such a receiver with a gain control arrangement which is effective in reducing a very strong signal to the same level as a weak signal.

In commercial C. W., or modulated C. W. receivers when a weak signal is being received a very strong local signal will often "block" the first amplifier tube. It is another object of this invention to provide an arrangement for automatically preventing such "blocking" action whereby the desired signal may come through.

And still other objects of the present invention are to improve generally the simplicity and efficiency of radio receivers equipped with automatic volume control devices, and to particularly provide receivers of this type which are 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 the present invention,

Fig. 2 shows a modified form of the invention,

Fig. 3 shows a modification of the invention applied to a single radio frequency amplifier stage.

Referring now to the accompanying drawing wherein like reference characters in the different figures represent similar circuit elements, Fig. 1 shows a conventional radio receiver embodying a stage of tuned radio frequency amplification. The stage includes a screen grid tube 1, preferably of the indirectly heated cathode type, and there is connected between the grid and ground a tunable circuit 2. The latter includes the coil 3 and variable tuning condenser 4. A radio frequency by-pass capacitor 5 connects the low potential side of circuit 2 to ground. The potential for the anode of tube 1 is derived from a source B_1, shunted by a resistor R_1, the anode being connected to the positive terminal of source B_1 through a path including the primary winding 6, of radio transformer M_1. A radio frequency by-pass condenser 7 is connected between the anode and cathode of tube 1.

The succeeding tube 1', also of the indirectly heated cathode type, functions as the detector tube. A source of potential B_2 furnishes the grid and anode direct current potentials of the detector tube. There is connected across the potential source B_2 a resistor R_2, and the positive side of this resistor is connected to the anode of tube 1' through a path which includes the primary winding 8 of the audio frequency coupling transformer M_2. The cathode of the detector tube is connected to the negative side of the resistor R_2 through a resistor A.

A radio frequency by-pass condenser 9 is connected between the cathode and one side of the winding 8. Between the control grid of the tube 1' and a point more negative than the high potential side of the resistor A is connected the tunable input circuit 10 of the detector circuit. This input circuit comprises the secondary winding 11 of the coupling transformer M_1, and the variable tuning condenser 12. The dotted lines connecting the arrows through the condensers 4 and 12, which dotted lines are designated by the reference numeral 13, represents any conventional type of uni-control mechanism for the rotors of these two tuning condensers.

The ground side of the tunable input circuit 2 of the radio frequency amplifier is connected to an intermediate point on the resistor R_2 through the lead 14. This intermediate point is so chosen as to be a predetermined voltage B from the negative side of the resistor R_2. A lead 15 connects the cathodes of tubes 1 and 1'.

The audio frequency coupling transformer M_2 functions to couple the anode circuit of the detector tube to any desired audio frequency network, and this network may comprise one or more stages of audio frequency amplification followed by the usual reproducer. The arrangement for securing automatic volume control, as shown in Fig. 1, is satisfactory. Suppose that the plate current of the detector was to increase 20% due to a strong signal, and the voltage drop across the resistance A was originally 20 volts. The voltage would then rise to 24 volts; that is the original voltage drop across the resistor A would rise from 20 volts to 24 volts, an increase of 20%, due to the increase in signal strength.

The drop across the section of the bleeder re-

sistance R_2, the section being designated B, is adjusted to remain about 18 volts. This voltage is opposite in direction to that of the potential drop across the resistor A, and, therefore, normally there is a bias voltage of 2 volts on the grid of the radio frequency amplifier. Now, when the voltage drop across the resistor A is increased to 24 volts there is a resultant bias of −6 volts on the radio frequency amplifier grid. That is to say, there has been an increase of 300% in the control biasing voltage for an increase of 20% in the detector plate current. With the ordinary type of volume control a 20% increase in the detector plate current would increase the radio frequency control bias only 20%.

Thus, it will be seen that an arrangement of the type shown in Fig. 1 is particularly useful in connection with low priced radio receivers which use only one or two tuned radio frequency stages ahead of the detector stage, and use comparatively high audio frequency amplification. However, even where the gain of the amplifier preceding the detector is high, the present arrangement should be more effective in reducing a very strong signal to the same level as a weak signal. Of course, the arrangement shown in Fig. 1, is not limited to a tuned radio frequency type of receiver. The receiver may be of the superheterodyne type, and, in that case, the tube 1 and its associated circuits could comprise the intermediate frequency amplifier preceding a second detector. In that case the condensers 4 and 12 would be fixed to resonate their respective input circuits to the operating intermediate frequency. In such a case, the case of superheterodyne reception, there would be employed one or more stages of radio frequency amplification ahead of the first detector which in turn would precede the tube 1. Connections could be had from the lead 14 to these preceding amplifier stages. It is also pointed out that the gain control action need not be developed from the detector of the receiver. For example, the tube 1′ may be a rectifier independent of the usual detector, and such arrangements are well known in the prior art. Additionally, the various electrode circuits of the receiver may be energized from an alternating current source, and there may be employed a common filament and plate supply.

Fig. 2 shows the application of the present invention to an alternating current receiver with common filament and plate supply. The divider R_3 is connected across the voltage source B_3. This voltage source may be the usual output of the filter network following the alternating current rectifier (not shown to preserve simplicity of disclosure). The cathode of the amplifier tube 1 is connected to a point on the divider R_3 which is negative with respect to the points to which the anode of tube 1 and the anode of tube 1′ is connected.

The anode of the detector tube 1′ is shown connected to a point of appropriate positive potential through a path which includes the audio frequency transformer primary winding 8, the resistor A and the lead 20. The cathode of the detector tube 1′ is connected to the negative end of the divider R_3 through a path which includes the resistor A′ and the lead 21. The low potential side of the input circuit 10 is connected to the negative side of the bias resistor A′. The lead 14′ connects the low potential side of the input circuit 2 to the negative side of the resistor A. This resistor is the usual self-biasing resistor for the detector. This bias voltage may be obtained from a battery or any source of negative potential. Also in this figure, the anode of tube 1 may be connected to the resistor R_3 at any point of positive potential with respect to the cathode connection, but preferably to the positive end.

The operation of the arrangement shown in Fig. 2 is similar to that of the arrangement in Fig. 1. The normal bias voltage on the grid of the amplifier tube 1 is again equal to the difference between the potential drop across resistor A and the potential drop across the divider portion B. It will be noted that the polarity of the voltages developed across these resistances A and B are in opposition, as in Fig. 1.

Referring to Figs. 1 and 2, an increase of detector plate current causes an increase of potential drop across resistor A. Now, considering just the detector circuit alone, this increase in potential drop increases as the resistance A is increased, up to the point where the resistance A is of the same order of magnitude as the internal plate resistance of the tube. Suppose the resistance A is of this magnitude. Suppose the no-signal drop across A is 20 volts and a signal causes this potential drop to increase to 24 volts. Supposing this signal is modulated 100%, if the audio frequency impedance in the detector plate circuit is of the same order of magnitude as the detector plate impedance, and the resistance A, which it usually is, the audio frequency voltage across the audio frequency transformer primary 8 will be roughly 4 volts.

Since several volts of direct current potential are necessary across A to adequately control the previous radio frequency stages, the audio frequency signal output of the detector will also be of several volts magnitude. This system, then, works only on a high radio frequency gain receiver with low audio frequency gain, the same as the ordinary automatic volume control. The advantage resides in the fact that the action is such that signals of widely different intensity would be kept nearer to the same intensity in the speaker or other indicator. The reason for the advantage is, then, that a higher resistance may be used in the detector or automatic volume control tube so that the bias controlling direct current component of the detected signal is greater, for a given signal.

In Fig. 3 there is shown the application of the principle of the present invention to the first radio frequency amplifier of a receiver. In a commercial C. W., or modulated C. W. receiver, when a weak signal is being received, a very strong local signal will "block" the first tube.

The idea here would be to prevent blocking by a very strong signal of different frequency from the desired frequency. In the present C. W. telegraph receivers, a very strong signal will cause the grid of the first radio frequency tube to go positive over a part of the radio frequency cycle. Even though the selectivity of the succeeding amplifier stages is sufficient to attenuate this interfering frequency, the weak signal disappears due to the first radio frequency tube being rendered insensitive by the strong signal. Using the present idea, the grid of the first radio frequency tube would never become positive and the G_m of the tube would remain about the same.

With the arrangement shown in Fig. 3, by properly choosing the value of the resistor A and the potential drop across the resistor portion B, it should be possible to prevent the first tube

from "blocking" or overloading, so that the desired signal comes through. In Fig. 3 the screen grid tube 1, of the indirectly heated cathode type, is shown as having its anode energized from a source of positive potential B_4. The resistor R_1' is shunted across the terminals of this potential source, while the low potential side of the tunable input circuit 2 is connected, through a lead 30, to a point on the resistor R_1' which is at B volts from the negative terminal of the resistor. The resistor A is connected in the cathode circuit of the tube as shown.

The operation of the arrangement shown in Fig. 3 is substantially similar to that shown in Fig. 1. In this case there is a normal bias on the grid of the tube which is determined by the difference between the potential drop across the resistor A and the potential drop across the resistor portion B. As the signal input to the tube 1 increases the effective bias on the grid of the tube increases, but at a much more rapid rate than the increase in the signal strength. This serves to prevent the overloading of the tube by the undesired strong signal.

Referring to Fig. 3, the resistances A and B are so chosen that the tube is working at a point of its grid voltage-plate current characteristic curve which gives good amplification of weak signals, and where strong signals will cause an increase in plate current. This increase in plate current produces the increase in grid bias, and, thus, tends to hold the plate current of the tube constant. These resistance values are not critical, and theoretically, this condition can be obtained. The tube is, therefore, held at nearly constant plate current, increasing slightly with a strong received signal, and, therefore, the amplification of the tube remains nearly constant to a weak signal. The weak signal will, however, be "cross-modulated" by the strong signal. This causes no interference if the strong signal is an unmodulated C. W. carrier. If the strong signal is modulated, this modulation will appear on the weak signal in the output of the receiver, but this is not bothersome to telegraph signals.

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 high frequency receiving system including an electron discharge tube having an input and output circuit, a pair of resistors connected in series between the anode and cathode of said tube, a source of anode voltage connected across one of the resistors, said resistors being so arranged that voltages developed thereacross are of opposing polarity, and a direct current connection from the input circuit of said tube to a point on one of said resistors which is at a positive potential with respect to the point thereon to which the cathode of said tube is connected, said point being so chosen that there is a normal resultant negative biasing potential impressed on an input electrode of said tube.

2. In combination with a high frequency receiving system including an electron discharge tube having an input and output circuit, a pair of resistors connected in series between the anode and cathode of said tube, a source of anode voltage connected across one of the resistors, said resistors being so arranged that voltages developed thereacross are of opposing polarity, and a direct current connection from the input circuit of said tube to a point on one of said resistors which is at a positive potential with respect to the point thereon to which the cathode of said tube is connected, said point being so chosen that there is a normal resultant negative biasing potential impressed on the grid electrode of said tube.

3. In combination with a high frequency receiving system including an electron discharge tube having an input and output circuit, a pair of resistors connected in series between the anode and cathode of said tube, said resistors being so arranged that voltages developed thereacross are of opposing polarity, and a direct current connection from the input circuit of said tube to a point on one of said resistors which is at a positive potential with respect to the point thereon to which the cathode of said tube is connected, said point being so chosen that there is a normal resultant negative biasing potential impressed on an input electrode of said tube, and a source of anode potential being connected across said one resistor.

4. In combination with a high frequency receiving system including an electron discharge tube having an input and output circuit, a pair of resistors connected in series between the anode and cathode of said tube, said resistors being so arranged that voltages developed thereacross are of opposing polarity, and a direct current connection from the input circuit of said tube to a point on one of said resistors which is at a positive potential with respect to the point thereon to which the cathode of said tube is connected, said point being so chosen that there is a normal resultant negative biasing potential impressed on an input electrode of said tube which increases at a more rapid rate than increase in high frequency signals impressed on said input circuit whereby overloading of said tube by an undesired strong signal is prevented.

5. In a radio receiver, provided with a radio frequency amplifier and a succeeding rectifier, a pair of impedances connected in series in the anode circuit of said rectifier, said impedances being arranged in said anode circuit so that the potential drops across said impedances are of opposite polarity, and a direct current connection from a point on one of said resistors which is at a positive voltage with respect to the point thereon to which the rectifier cathode is connected to a gain control electrode of said amplifier.

6. In a radio receiver, provided with a radio frequency amplifier and a succeeding rectifier, a pair of impedances connected in series in the anode circuit of said rectifier, said impedances being arranged in said anode circuit so that the potential drops across said impedances are of opposite polarity, and a direct current connection from a point on one of said resistors which is at a positive voltage with respect to the point thereon to which the rectifier cathode is connected to a gain control electrode of said amplifier, said amplifier and rectifier each including a tunable input circuit.

7. In a radio receiver, provided with a radio frequency amplifier and a succeeding rectifier, a pair of impedances connected in series in the anode circuit of said rectifier, said impedances being arranged in said anode circuit so that the potential drops across said impedances are of opposite polarity, and a direct current connection from a point on one of said resistors which

is at a positive voltage with respect to the point thereon to which the rectifier cathode is connected to a gain control electrode of said amplifier, and a common potential source for maintaining the grid, cathode and anode circuits of said amplifier and rectifier at appropriate potentials.

8. In combination, a radio frequency amplifier including a screen grid tube, a succeeding detector tube, a tunable circuit coupling the anode circuit of said amplifier tube to the input electrodes of said detector tube, an audio frequency network coupled to the anode circuit of said detector tube, a resistor in the cathode circuit of said detector tube, a direct current connection between the grid electrode of said detector tube and a point of positive potential of said resistor, a source of potential for the anode of said detector connected between the anode of said detector and the negative side of said resistor, a second resistor connected across said potential source, a direct current connection between the grid circuit of said amplifier tube and a point of positive potential on the second resistor, said detector cathode being connected through said first resistor to a point on the second resistor which is negative with respect to the positive point thereon, said point on the second resistor being so chosen that there is an effective negative biasing voltage impressed on the amplifier control grid which increases at a more rapid rate than increase in signal intensity to maintain the signal input to the detector tube substantially constant.

9. In a signal receiving system, an electron discharge tube having a tuned input circuit connected between its input electrodes, an output circuit connected between the output electrodes of said tube, a resistor connected in the space current path of said tube, a source of anode voltage for the tube, a second resistor connected across the said source, said two resistors being connected in series between the anode and cathode of the said tube, the voltages developed across said resistors being in opposition, and a direct current connection from the signal control grid of said tube to a predetermined point on one of said resistors.

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