Dec. 31, 1935. L. M. PERKINS 2,026,357

AUTOMATIC VOLUME CONTROL

Filed March 19, 1932

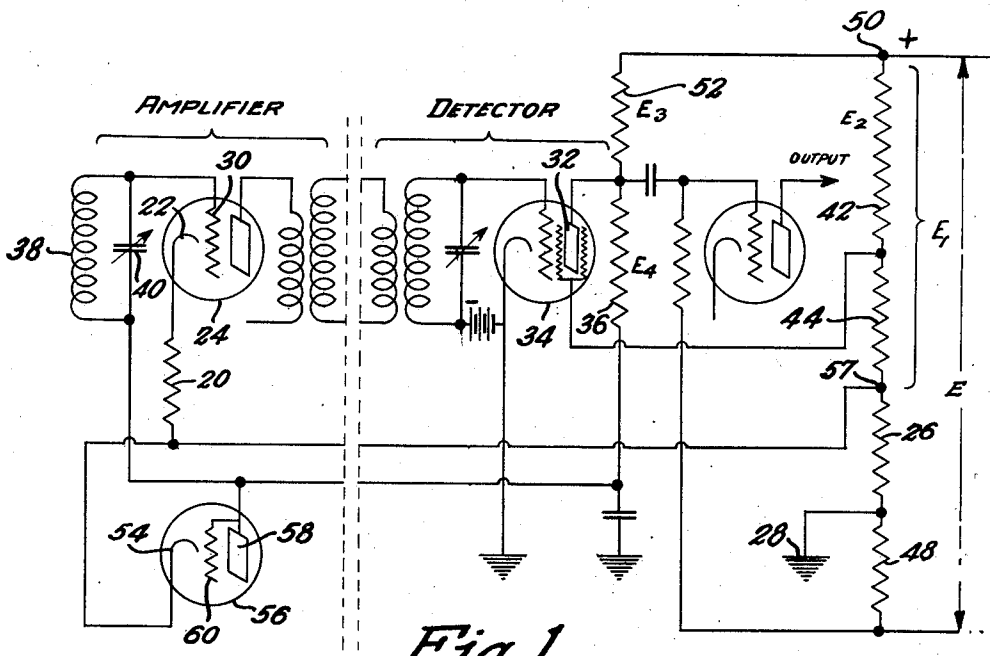


Fig. 1.

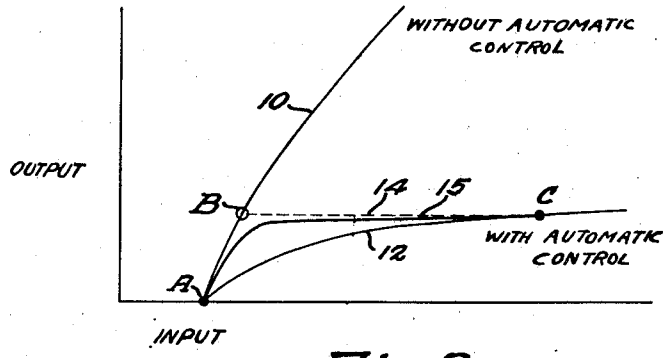


Fig. 2.

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Patented Dec. 31, 1935

2,026,357

UNITED STATES PATENT OFFICE

2,026,357

AUTOMATIC VOLUME CONTROL

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Application March 19, 1932, Serial No. 599,950

13 Claims. (Cl. 250—20)

This invention relates to an automatic volume control for a radio receiver. Most of the commercial systems of automatic volume control use two detectors, one for normal detection of the signal, its output being audio frequency, the other for controlling the volume output of the receiver. The output of this second detector is a substantially continuous current which controls by reason of a change in the drop across the resistor in the output circuit. It is sometimes undesirable to use the two detectors because it unbalances the preceding tuned stage as this stage will have two tubes across it instead of one. It has been proposed to use one untuned circuit supplying two detectors, but this has its disadvantage in that it lowers the amplification.

An object of this invention is to use a single detector, that is, resistance coupled to the following stage. Both the audio frequency output and the direct current voltage change are obtained across the resistor in the plate circuit of the detector. In other words, the detector and the first stage of audio amplification are coupled by a resistance network so that the audio frequency is passed by a condenser to a grid of the succeeding tube. The direct current is blocked by the condenser but is passed through a filter resistance which blocks the audio frequency signal, and yet allows the voltage change to alter the grid bias supplied to one or more of the preceding amplifier tubes.

Another disadvantage of the systems heretofore in use, is that the regulation of the volume starts even on weak signals so that the maximum sensitivity of the receiver is not available when changing from a strong station to a weak station. An ideal automatic volume control should not supply a bias to the preceding stages, that is, a bias that will operate on the upper knee of the characteristic curve of the tube. If it does, it will result in distortion and in a reduction in the sensitivity of the receiver, when weak signals are received.

An object of this invention is to utilize the maximum sensitivity of the radio receiver while receiving weak signals. This has been accomplished by the use of a rectifying device in combination with a detector which gives an appreciably greater direct current voltage change than is required on the radio frequency grid for a suitable volume control.

The system is so arranged that if there were no rectifier in the volume control circuit the bias supplied to the RF grids would swing beyond the point of maximum sensitivity. In order to prevent the grid bias from swinging beyond the point of maximum sensitivity a rectifier has been connected so as to prevent the bias swing passing a predetermined fixed point in one direction while allowing free swing in the opposite direction. Thus, with a weak signal the rectifier allows current to pass because its anode is then more positive than its cathode. This current flowing from the anode to cathode flows through the filter resistor previously mentioned, which causes a voltage drop so that the actual voltage on the RF grids is different from the plate voltage supplied to the detector. As the signal intensity increases the anode becomes less positive, and at the desired output, the anode is at the same potential as the cathode of the rectifier. Up to this signal strength the bias on the RF grids is held almost constant, varying only by the change in voltage across the rectifier device which change may be limited to one volt or less by the proper design. As soon as the rectifier ceases to pass current, due to its anode being negative with respect to its cathode, the RF grids are controlled directly by the plate voltage supplied to the detector so that a very accurate volume control is obtained.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred embodiment of one form of the present invention is clearly shown.

In the drawing:

Fig. 1 discloses a schematic wiring diagram of a portion of a radio receiver provided with an automatic volume control.

Fig. 2 discloses a group of curves obtained from the radio receiver.

As may be seen from Fig. 2, a radio receiver having the input plotted as abscissæ and the output as ordinates has a curve as represented by the curve 10 where no automatic volume control is used. If an automatic volume control is used that is effective for all signals, a curve similar to the curve disclosed by the full line 12 would be obtained. From C to A the curve 12 drops and holds the output lower than that desired. The ideal condition would be to follow the curve 10 from A to B, then follow the horizontal curve represented by the dashed line 14 from B to C. From A to B, the receiver operates at its maximum sensitivity as a change in the grid bias in either direction tends to reduce the sensitivity. The full line curve 15 is obtained in a radio receiver embodying the disclosure made in Fig. 1. That is, curve 15 approaches the ideal condition,

it failing to follow the ideal condition in that a small variation in the voltage drop across the rectifier causes the curve to deviate from the ideal curve. As this automatic volume control operates equally as well regardless of the number of stages of amplification only one stage of amplification has been disclosed. This may be a radio frequency amplifier, or it may be an amplifier in a superheterodyne receiver. The output of the amplifier or amplifiers is supplied to a detector stage followed by one or more stages of audio frequency amplification. As far as this invention is concerned it makes no difference as to what circuit the output of the detector is supplied.

A resistor **20** connected in series with a cathode **22** of an amplifier **24** has one terminal connected to a resistor **26** grounded at **28**. From this it may readily be seen that the potential of the cathode **22** is considerably above ground when the amplifier **24** is functioning, in that the plate current of the amplifier **24** passes through the resistances **20** and **26**. Under normal operating conditions, with a strong signal, a grid **30** of the amplifier **24** is substantially at the same potential as the potential supplied to an anode **32** of a detector **34**, in that the grid **30** is connected to the anode **32** through a resistance **36** and through an inductance **38** including a condenser **40**. When the signal is weak, the rectifier takes current causing a drop through resistor **36**. In the modification disclosed in Fig. 1 the plate **32** is energized from a suitable potential E supplied to a voltage divider including resistances **42**, **44**, **26** and **48**. The potential supplied to anode **32**, however, is not equal to the terminal voltage supplied to terminal **50** as the plate current through the detector decreases by a voltage equal to the IR drop across the resistance **52**. When the incoming signal is strong a large current flows through the resistance **52** which causes the potential to the plate **32** to drop, thereby resulting in the grid **30** becoming more negative with respect to the cathode **22**.

A cathode **54** of a rectifier **56** is connected to a terminal **57** intermediate the resistances **26** and **44** in the voltage divider. An anode **58** of rectifier **56** is connected to the circuit of grid **30** so that the potential supplied to the anode **58** is at all times substantially the same as the grid potential supplied to the amplifier **24**. A grid or control electrode **60** of the rectifier **56** is connected to the anode **58** of that same tube. It is apparent to one skilled in the art that since the control electrode **60** is not used as such, a tube could be used which had no grid. It can be readily seen that when the potential of the cathode **54** is greater than the potential of the anode **58** no current flows through the rectifier. This is the condition that exists when the output of the amplifier follows the horizontal portion of the curve **15**, the potential of the grid **30** steadily increasing as the input decreases from C to B. When the input decreases substantially to B the potential supplied to the anode **32** is substantially the same as the potential of the cathode **54**. Whenever the input falls below the abscissa of B the current flows from the anode **58** to the cathode **54** in the rectifier **56**, because the voltage supplied to the anode **32** of the detector **34** exceeds the potential supplied to the anode **58**. As soon as current begins to flow in the rectifier **56** the potential of the grid **30** will be less than the potential of the anode **32** of the detector **34**, in that the rectifier current causes a voltage drop across the resistance **36**. By properly selecting the values of the resistances **26**, **36**, **42**, **44**, **48**, **52** and **20**, it is possible to maintain the potentials supplied to the grid **30**, when the input signal is less than B, that is substantially the proper value with respect to the cathode **22**. Instead of using a voltage divider including the resistances **42**, **44**, **26** and **48**, a suitable potential can be supplied to the terminals **50**, **57** by any other suitable means such as, for example, batteries or terminals on the AC source of rectified current.

While the form of embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In combination with a high frequency amplifier and detector, a control network for automatically regulating the gain of the amplifier, said network comprising a direct current biasing path connected between an input electrode of the amplifier and the anode of said detector, and a space discharge device, connected between said path and the cathodes of said amplifier and detector, for maintaining said amplifier input electrode independent of the biasing action of said path until a predetermined amplifier energy input value is reached.

2. In combination with a high frequency amplifier and a detector, a control network for automatically regulating the gain of the amplifier, said network comprising a direct current biasing path connected between an input electrode of the amplifier and the anode of said detector, and a space discharge device including at least a cold electrode and an electron emission electrode, connected between said path and the cathodes of said amplifier and detector, for maintaining said amplifier input electrode independent of the biasing action of said path until a predetermined amplifier energy input value is reached.

3. In combination with a high frequency amplifier and a detector, a control network for automatically regulating the gain of the amplifier, said network comprising a direct current biasing path connected between an input electrode of the amplifier and the anode of said detector, and a space discharge diode, connected between said path and the cathodes of said amplifier and detector, for maintaining said amplifier input electrode independent of the biasing action of said path until a predetermined amplifier energy input value is reached.

4. In combination with a high frequency amplifier and a detector, a control network for automatically regulating the gain of the amplifier, said network comprising a direct current biasing path connected between an input electrode of the amplifier and the anode of said detector, a conductive connection between the cathodes of the detector and amplifier, and a space discharge device, connected between said path and the cathodes of said amplifier and detector, for maintaining said amplifier input electrode independent of the biasing action of said path until a predetermined amplifier energy input value is reached.

5. An automatic volume control arrangement in combination with a radio receiver comprising a radio frequency amplifier and a detector, said arrangement including a direct current connection between the amplifier and detector cathodes, a second direct current connection between the amplifier grid and the anode of said detector,

and a diode connected between said two connections.

6. An automatic volume control arrangement in combination with a radio receiver comprising a radio frequency amplifier and a detector, said arrangement including a direct current connection between the amplifier and detector cathodes, a second direct current connection between the amplifier grid and the anode of said detector, and a diode connected between said two connections, the diode cathode being at a less positive potential than the amplifier cathode when weak signals are impressed on the amplifier.

7. An automatic volume control arrangement in combination with a radio receiver comprising a radio frequency amplifier and a detector, said arrangement including a direct current connection between the amplifier and detector cathodes, a second direct current connection between the amplifier grid and the anode of said dectector, and a diode connected between said two connections, the anode of said diode being negative with respect to the cathode thereof to cause the diode to become non-conductive when the signals impressed on said detector increase beyond a desired intensity.

8. In a radio receiver, a high frequency amplifier, a detector, a network for automatically controlling the gain of said amplifier so that the detector output is maintained substantially constant regardless of variations of collected signal intensity, said network including a direct current biasing path between the anode of the detector and the grid of said amplifier, and means for delaying the action of said control network until a predetermined signal intensity is attained, said delay means comprising a diode connected to said biasing path and the cathodes of said amplifier and detector in such a manner that said grid is maintained at a constant bias until said predetermined intensity is reached.

9. In an automatic volume control system for a radio receiver, which receiver comprises a radio frequency amplifier and a detector, said system including a variable biasing impedance for said radio frequency amplifier, said impedance being operatively associated with the amplifier and detector varying with the intensity of current flow in the detector output, the value of said biasing impedance being infinite when said detector output current exceeds a predetermined value, and additional means, when said biasing impedance becomes infinite, for imparting a biasing potential to the grid of the radio frequency amplifier which varies directly with variation of the detector anode potential.

10. In a radio receiver, a high frequency amplifier, a detector, and a diode, a potential supply resistor, a direct current path between the detector anode and a positive potential point on said resistor, a second path including a resistor connecting the detector anode to the diode anode and amplifier grid, a connection between the diode cathode and a less positive potential point on the supply resistor, a resistor connecting the amplifier cathode to said last connection, and a connection between the detector cathode and a point on said supply resistor which is less positive than the other two points.

11. In a radio receiver, a high frequency amplifier, a detector, and a diode, a potential supply resistor, a direct current path between the detector anode and a positive potential point on said resistor, a second path including a resistor connecting the detector anode to the diode anode and amplifier grid, a connection between the diode cathode and a less positive potential point on the supply resistor, a resistor connecting the amplifier cathode to said last connection, a connection between the detector cathode and a point on said supply resistor which is less positive than the other two points, and an audio frequency amplifier having its grid circuit coupled to the said second resistor.

12. In a radio receiver, a high frequency amplifier, a detector, and a diode, a potential supply resistor, a direct current path between the detector anode and a positive potential point on said resistor, a second path including a resistor connecting the detector anode to the diode anode and amplifier grid, a connection between the diode cathode and a less positive potential point on the supply resistor, a resistor connecting the amplifier cathode to said last connection, a connection between the detector cathode and a point on said supply resistor which is less positive than the other two points, said first named path including a resistor.

13. In combination, in a radio receiver, a signal transmission tube, an electron discharge tube following the first tube, a signal transmission network coupling the output electrodes of the first tube to the input electrodes of the second tube, a diode having its electrodes connected to points in the space current path of said second tube such that the diode anode is negative with respect to the diode cathode in the absence of received signals, a gain control connection between the diode anode and the input grid of the first tube, and means for reversing the polarity of the diode anode with respect to the diode cathode when signals above a predetermined amplitude are impressed on said receiver.

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