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RECEIVER NOISE SUPPRESSOR ARRANGEMENT

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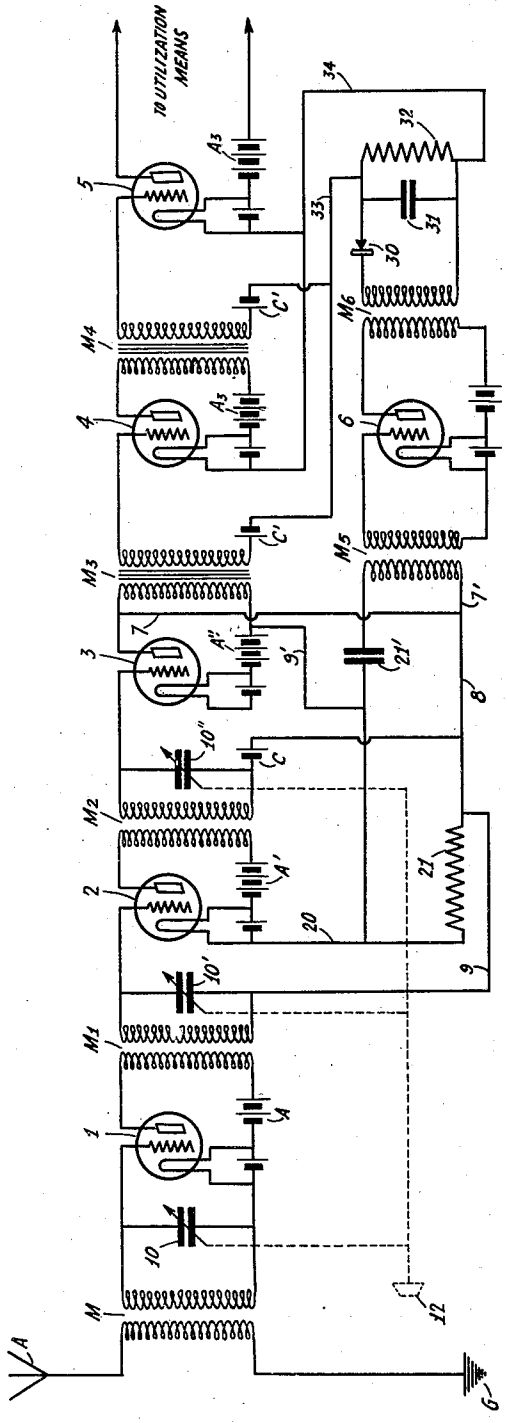

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RECEIVER NOISE SUPPRESSOR ARRANGEMENT

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My present invention relates to automatic gain control devices adapted for use in radio receivers, and more particularly to a novel, and improved means for suppressing background noises in receivers of the aforementioned type.

One of the main objects of the present invention is to provide an improved device for eliminating amplification of noises in a radio receiver, whenever the ratio between the background noise level and the carrier intensity level becomes such as to permit the receiver to amplify the noises to a great extent, the noise suppressor device essentially comprising an arrangement for correcting, in a predetermined manner, the bias of the audio frequency amplifier tubes from the normal cut-off bias with which they are supplied.

Another object of the present invention is to provide a radio receiver with an automatic volume control device, and to control the bias of one, or more, audio amplifier tubes to suppress the further amplification of the background noises whenever the ratio of carrier intensity level to background noise level, as amplified by the volume controlled amplifier, drops below a predetermined value, the said audio frequency tubes being normally maintained at cut-off bias.

Still other objects of the invention are to improve generally the simplicity and efficiency of radio receivers employing automatic volume control devices, and to provide more particularly a radio receiver of the aforementioned type which is not only reliable in operation but economically assembled for the purpose of suppressing background noises whenever the receiver is tuned from station to station with no signals present between such stations.

In accomplishing the objects of the present invention I utilize the rectified constant high frequency component in the output of the detector stage of a radio receiver employing an automatic gain control device, to correct the bias of the audio frequency amplifier tubes from the normal cut-off bias with which they are supplied. Thus whereas, in the absence of a carrier, as in tuning from station to station, a cut-off bias will obtain in the audio frequency amplifier stages, which will prevent, in a highly effective manner, any background noises from passing to the reproducer device, the presence of a carrier will correct the bias and the signals will be amplified in the audio stages and supplied to the output circuit.

The novel features which I believe to be characteristic of my invention are set forth with 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 arrangement whereby my invention may be carried into effect.

Referring to the accompanying drawing there is shown diagrammatically, a radio receiver of the tuned radio frequency type, comprising a grounded signal collecting circuit, as antenna A and ground G. The collecting circuit is coupled as at M, to the resonant input circuit of a first stage of a tuned radio frequency amplifier. This input circuit is rendered tunable by means of the usual variable condenser **10**. The first stage includes an electron discharge tube **1**, whose anode is maintained at a positive potential by means of the usual high potential source A.

The output of the first tuned radio frequency stage is impressed, through a coupling M_1, upon the resonant input circuit of the second stage of the tuned radio frequency amplifier, which stage includes an electron discharge tube **2**. A variable condenser **10'** is adapted to tune the second radio frequency stage to the same desired signal to which the input of the first stage is tuned. A source A' is employed for maintaining a high potential on the anode of the tube **2**.

The resonant input circuit of the detector stage, which stage includes electron discharge tube **3**, has the output of the second radio frequency stage impressed upon it, through a coupling M_2. A variable condenser **10''** is provided to tune the input circuit of the detector to the desired signal frequency.

As is well known to those skilled in the art, any well known type of mechanical uni-control, designated by the dotted lines **12**, may be employed for operating the variable condensers **10**, **10'** and **10''**, so as to tune the first three stages of the receiver simultaneously to the same signal frequency.

A biasing potential source C is employed in the detector stage to cause the device **3** to act as a detector, while the high potential source A'' is employed in the anode circuit of the detector to apply a positive potential to the anode of the tube **3**.

The detector stage is followed, in a manner well known to those skilled in the art, by two stages of audio frequency amplification. The first audio stage includes an electron discharge tube **4**, having its input circuit coupled to the output circuit of the detector stage through an audio frequency coupling device M_3. The output of the

first audio frequency amplifier stage is impressed upon the input of the second audio frequency stage, through a second audio frequency coupling device M_4.

The anodes of tubes **4** and **5** of the audio frequency amplifier are maintained at positive potentials by means of sources A_3. Biasing sources C' are provided in the grid circuits of the audio frequency amplifier devices **4** and **5**, of such potential that these devices are normally biased to cut off as will be explained later. The output circuit of the second audio stage may have associated with it, in any manner well known to those skilled in the art, any type of utilization means, as for example a loud speaker, head phones, or other signal reproducer.

The automatic gain control arrangement employed in the receiver comprises a circuit disposed between the output circuit of the detector tube **3** and the input circuit of the tube **2** of the second radio frequency amplifier stage. The automatic gain control comprises conductors **7**, **8** and **9** connecting the high potential side of the detector output circuit and the grid return side of the input circuit of the tube **2**. Conductors **9'** and **20** are connected between the postive terminal of the source A'' and the negative side of the cathode of tube **2**. A biasing resistor **21** is connected between conductor **20** and the junction of conductors **8** and **9**. The operation of this type of automatic gain control is well understood in the art, and need not be described in any detail, as it does not form the subject matter of the present invention. It will be sufficient to point out that when the carrier intensity drops the output circuit of the detector tube **3** induces less radio frequency energy across the bias resistor **21**, with the result that the bias impressed upon the grid of the tube **2** is reduced, thereby increasing the amplification of the energy received and raising the carrier intensity level in the output circuit of the detector tube. The reverse of this action occurs whenever the carrier intensity level increases.

The audio frequency bias control arrangement comprises one or more stages of amplification including for illustration an electron discharge tube **6**, which has its input circuit coupled, through a coupling arrangement M_5 to the terminals of the conductors **7** and **9'**. One terminal of the primary coil of the coupling device M_5 is connected to the conductor **9'** through a blocking capacity **21'** to prevent the flow of direct current through the said primary coil, and the other terminal of the coil is connected by a conductor **7'** to the conductor **7**.

The amplified radio frequency output of the stage including the tube **6**, is impressed, through a coupling M_6, upon a circuit including a rectifier element **30**. A radio frequency by-pass capacity **31** is connected in shunt with the coupling M_6, and in series with the rectifier **30**, while a resistor **32** is connected in shunt with the capacity **31**.

The grid returns of both audio amplifier tubes **4** and **5** are connected through biasing sources C' by conductor **33** to one side of the resistor **32**, while the negative sides of both cathodes of the tubes are connected by lead **34** to the opposite side of the resistor **32**. It is, of course, to be clearly understood that the rectifier device **30** can be of any type well known in the art, such as a crystal rectifier, diode, or any similar instrumentality.

It is believed that the operation of the noise suppressor arrangement will now be clear from the accompanying drawing and the above description. When no carrier energy is being received, there exists, in such a case, no carrier frequency component in the output circuit of the detector stage; the cut-off bias of the grids of the audio amplifier tubes **4** and **5** would prevent any current from passing to the utilization means, it being clearly understood that the grid circuits of tubes **4** and **5** are normally biased to cut-off.

As the uni-control device **12** is varied to a point corresponding to a desired station setting, carrier frequency energy is collected, with the result that the amplification of the input stages will decrease. Radio frequency component is produced in the detector output circuit, which component is of constant intensity as long as carrier frequency energy is being collected. This radio frequency component is amplified by the stage which includes the tube **6**, is rectified in the circuit including the device **30**, and is then utilized to correct the bias of the tubes **4** and **5**, this being accomplished by an increasing drop of potential being produced across the resistor **32**, to counteract the novel cut-off biasing potential of source C', as the radio frequency component appears in the detector output circuit.

It will therefore be seen that in the radio receiver diagrammatically represented herein, the tubes **2** and **3**, radio frequency amplifier and detector tubes respectively, are normally biased to maximum amplification and detection, while the tubes **4** and **5**, the audio amplifier tubes, are normally biased to minimum amplification, the rectified radio frequency component of the detector output decreasing the negative bias on the grids of the tubes **4** and **5**, and thus amplification is had only in the presence of an amplified carrier. It is again pointed out that the principle underlying the present invention involves the fact that the output circuit of the detector tube of a radio receiver employing an automatic volume control arrangement, includes a constant main audio frequency component, as well as a constant radio frequency component. The controlling carrier frequency component, which it is to be noted is obtained after the automatic volume control, is at all times constant if it exists at all.

In other words, the controlling current which regulates the reproducer cut-off is part of the current which has been controlled by the automatic volume control arrangement, so that if any such carried current exists, it will have a predetermined amplitude, which fact permits proportioning of resistor **32** and sources C' to permit undistorted amplification of the desired signals. Considering these facts, then, it will be readily appreciated by those skilled in the art that the characteristics of the biasing circuit for the cut-off audio amplifier tubes can be readily designed to either completely cut-off, or amplify, at the proper point of the characteristic curve to prevent distortion.

While I have indicated and described one arrangement 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. A method of controlling the gain of a radio receiver which consists in collecting modulated carrier energy, amplifying the collected energy, detecting the amplified energy, amplifying the

detected energy, regulating the amplification of the collected carrier energy to maintain the radio frequency component of the detected carrier energy constant, amplifying the said radio frequency component, rectifying the amplified component, and controlling the amplification of the detected carrier energy with the rectified radio frequency component.

2. A method of controlling the gain of a radio receiver which consists in collecting modulated carrier energy, amplifying the collected energy, detecting the amplified energy, amplifying the detected energy, amplifying the radio frequency component of said energy, rectifying the amplified component, and controlling the amplification of the detected carrier energy with the rectified radio frequency component in such a manner that no amplification of the detected carrier energy takes place in the absence of carrier energy.

3. A method of controlling the gain of a radio receiver which consists in collecting modulated carrier energy, amplifying the collected energy, detecting the amplified energy, amplifying the detected energy, regulating the amplification of the collected carrier energy to maintain the radio frequency component of the detected carrier energy constant, rectifying the component, and controlling the amplification of the detected carrier energy with the rectified radio frequency component.

4. A method of controlling the gain of a radio receiver which consists in collecting modulated carrier energy, amplifying the collected energy, detecting the amplified energy, amplifying the detected energy, regulating the amplification of the collected carrier energy to maintain the radio frequency component of the detected carrier energy constant, amplifying the said radio frequency component, rectifying the amplified component, and controlling the amplification of the detected carrier energy with the rectified radio frequency component in such a manner as to automatically prevent amplification of detected energy when no carrier energy is being collected.

5. A method of controlling the gain of a radio receiver which consists in collecting modulated carrier energy, amplifying the collected energy, detecting the amplified energy, amplifying the detected energy, regulating the amplification of the collected carrier energy to maintain the radio frequency component of the detected carrier energy constant, amplifying said radio frequency component, rectifying the amplified component, and controlling the amplification of the detected carrier energy with the rectified radio frequency component in such a manner as to prevent amplification of background noises when no carrier energy is collected.

6. A method of suppressing background noises in a radio receiver utilizing automatic gain control, which consists in detecting collected modulated carrier energy, maintaining the radio frequency component of the detected carrier energy constant as long as carrier energy is being detected, amplifying the audio frequency component of the detected carrier energy, rectifying the said radio frequency, and controlling the amplification of said audio frequency component with the rectified radio frequency component.

7. In combination, in a radio receiver provided with a radio frequency amplifier, a detector and an audio frequency amplifier, an automatic gain control arrangement between the detector output and the radio frequency input, a rectifier device, means associated with the detector output for impressing a radio frequency component of the detector output upon the input of the said rectifier device, and a bias control means between the said rectifier device and the input of said audio amplifier.

8. In combination, in a radio receiver provided with a radio frequency amplifier, a detector and an audio frequency amplifier, an automatic gain control arrangement between the detector output and the radio frequency input, a rectifier device, means associated with the detector output for impressing a radio frequency component of the detector output upon the input of the said rectifier device, and a bias resistor between the said rectifier device and the input of said audio amplifier.

9. In combination, in a radio receiver provided with a radio frequency amplifier, a detector and an audio frequency amplifier, an automatic gain control arrangement between the detector output and the radio frequency input, a rectifier device, means associated with the detector output for impressing a radio frequency component of the detector output upon the input of the said rectifier device, and a bias control means between the said rectifier device and the input of said audio amplifier, and an amplifier between said rectifier device and the detector output.

10. In combination, in a radio receiver provided with a radio frequency amplifier, a detector and an audio frequency amplifier, an automatic gain control arrangement between the detector output and the radio frequency input, a rectifier device, means associated with the detector output for impressing a radio frequency component of the detector output upon the input of the said rectifier device, and a bias control means between the said rectifier device and the input of said audio amplifier and an amplifier between said rectifier device and said automatic gain control arrangement.

11. In combination, in a radio receiver provided with a radio frequency amplifier, a detector and an audio frequency amplifier, a rectifier device, means associated with the detector output for impressing a radio frequency component of the detector output upon the input of the said rectifier device, means for adjusting the audio frequency amplifier so that the amplifier will normally function at its minimum amplification value, and a bias control means between the said rectifier device and the input of said audio amplifier.

12. In combination, in a receiver, radio frequency amplifier and detector stages, means for normally biasing said stages for maximum amplification and detection, an audio frequency amplifier, constant magnitude potential means for normally biasing the latter for minimum amplification, means for automatically maintaining the output of said radio frequency amplifier substantially uniform throughout signal reception periods, and additional means for opposing said audio frequency amplifier biasing means during said periods.

13. In combination, in a receiver, radio frequency amplifier and detector stages, means for normally biasing said stages for maximum amplification and detection, an audio frequency amplifier, means for normally biasing the latter for minimum amplification, means for automatically maintaining the output of said radio frequency amplifier substantially uniform throughout signal reception periods, and additional means responsive to the detector output

for opposing said audio frequency amplifier biasing means during said periods.

14. In combination, in a receiver, radio frequency amplifier and detector stages, means for normally biasing said stages for maximum amplification and detection, an audio frequency amplifier, constant magnitude potential means for normally biasing the latter for minimum amplification, means responsive to the detector output for automatically maintaining the output of said radio frequency amplifier substantially uniform throughout signal reception periods, and additional means for opposing said audio frequency amplifier biasing means during said periods.

15. In combination, in a receiver, radio frequency amplifier and detector stages, means for normally biasing said stages for maximum amplification and detection, an audio frequency amplifier, means for normally biasing the latter for minimum amplification, means for automatically maintaining the output of said radio frequency amplifier substantially uniform throughout signal reception periods, and additional means including a rectifier coupled to the detector output for opposing said audio frequency amplifier biasing means during said periods.

16. In combination, in a receiver, radio frequency amplifier and detector stages, means for normally biasing said stages for maximum amplification and detection, an audio frequency amplifier, means for normally biasing the latter for minimum amplification, means for automatically maintaining the output of said radio frequency amplifier substantially uniform throughout signal reception periods, and additional means including an amplifier and rectifier coupled to the detector output for opposing said audio frequency amplifier biasing means during said periods.

17. A radio receiver, including a high frequency amplifier and a low frequency amplifier, means for normally biasing said amplifiers in opposite directions, an automatic high frequency amplifier gain control device connected from a point between the two amplifiers to the input of the high frequency amplifier, and a background noise suppressor device connected from said point between the two amplifiers to the input of the low frequency amplifier, said suppressor device including a signal carrier rectifier which is independent of said gain control device.

18. A radio receiver, including a high frequency amplifier and a low frequency amplifier, means for normally biasing said amplifiers in opposite directions, said low frequency amplifier being normally biased substantially to cut-off on its plate current-grid voltage characteristic, an automatic high frequency amplifier gain control device connected from a point between the two amplifiers to the input of the high frequency amplifier, and a back-ground noise suppressor device connected from said point between the two amplifiers to the input of the low frequency amplifier, said suppressor device including a signal carrier rectifier which is independent of said gain control device.

19. A radio receiver, including a high frequency amplifier and a low frequency amplifier, means for normally biasing said amplifiers in opposite directions, an automatic high frequency amplifier gain control device connected from a point between the two amplifiers to the input of the high frequency amplifier, and a background noise suppressor device including a rectifier independent of said gain control device connected from said point between the two amplifiers to the input of the low frequency amplifier.

20. A radio receiver, including a high frequency amplifier and a low frequency amplifier, means for normally biasing said amplifiers in opposite directions, an automatic high frequency amplifier gain control device connected from a point between the two amplifiers to the input of the high frequency amplifier, and a background noise suppressor device connected from said point between the two amplifiers to the input of the low frequency amplifier for offsetting the normal bias of said low frequency amplifier when sufficient signal energy is impressed upon the input of the high frequency amplifier, said suppressor device including a signal carrier rectifier which is independent of said gain control device.

21. In combination with a radio receiver which includes a radio frequency amplifier, a detector, a lower frequency amplifier, and means, responsive to variations in the signal energy impressed on said detector, for automatically regulating the gain of said radio frequency amplifier, an arrangement for automatically controlling the reproduction of undesired background noises during periods when substantially no signal energy is impressed upon said detector, said arrangement including means for maintaining the transmission efficiency of said lower frequency amplifier relatively poor during said periods, and additional means, responsive to signal energy impressed on said detector, for opposing the last named means and thereby increasing the said efficiency.

22. In combination, in a radio receiver, a radio frequency amplifier provided with a tunable input circuit, a detector, an automatic volume control arrangement, responsive to signal energy fluctuations in the detector input, for regulating the amplifier gain in such a manner that the signal input to the detector is substantially constant, an audio frequency amplifier, means for normally biasing said amplifier substantially to cut-off whereby, in the absence of received signal energy, the audio amplifier is substantially inoperative, and a network, including a rectifier responsive to signal energy impressed on the detector, for applying a neutralizing bias to said audio amplifier when the radio frequency amplifier is tuned to receive signal energy.

23. In a radio receiver, the combination with a radio frequency amplifier, a demodulator stage, and a stage of audio frequency amplification, means normally impressing a bias voltage on said amplifier to produce maximum gain, and means normally impressing upon said audio amplification stage a bias voltage of a constant magnitude effective to prevent transmission therethrough, of control means operating automatically, when the receiver input exceeds a predetermined value to maintain the amplified voltage level at a point in said amplifier at a substantially fixed value over a wide range of received signal voltages, and control means operable automatically when the received radio frequency voltage rises to a critical value to remove said transmission-preventing bias voltage.

24. In an electrical wave transmission system, the combination with a plurality of cascaded stages for transmitting impressed electrical waves, means normally biasing a first of said stages to facilitate transmission, and means normally biasing a second of said stages to block transmission therethrough, said second stage being an audio amplifier, and means operative auto-

matically with increasing magnitudes of impressed waves to impress additional bias voltage on said first stage in the polarity which decreases the transmission therethrough, and additional bias voltage on said second stage in the polarity which facilitates transmission therethrough.

25. In a radio receiver, the combination of an audio frequency amplifier, a network resonant to a desired operating frequency preceding the amplifier input, and coupled thereto, for providing an audio frequency signal to be amplified, means providing a potential of constant magnitude for normally maintaining an input electrode of the amplifier biased to cut-off, and a control circuit connected between said electrode and a desired point in said network for sufficiently reducing the bias to render the amplifier conductive only when said signal is provided.

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