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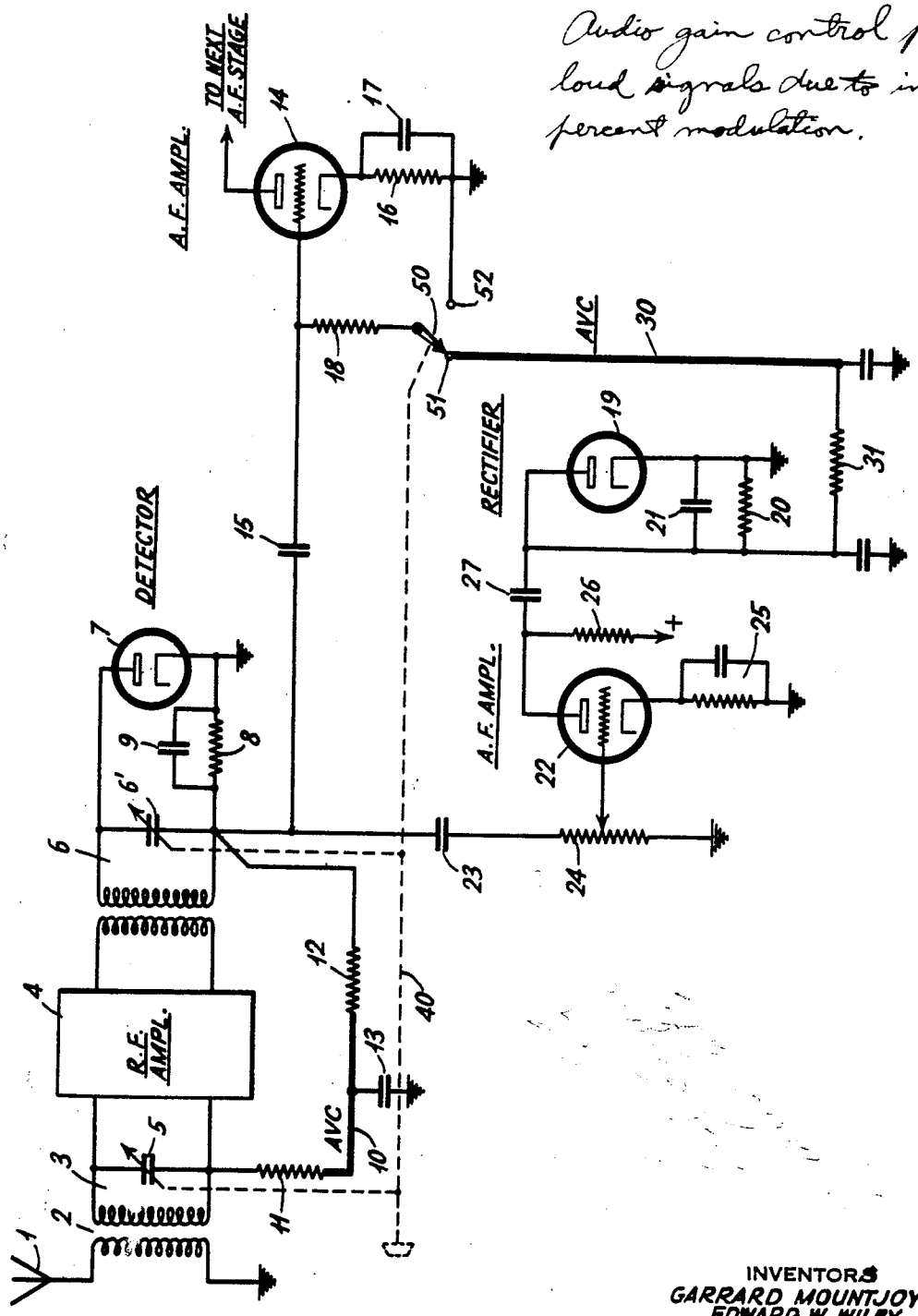
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AUTOMATIC VOLUME CONTROL CIRCUIT

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Audio gain control prevents loud signals due to increased percent modulation.



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AUTOMATIC VOLUME CONTROL CIRCUIT

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Our present invention relates to gain control circuits for radio receiving systems, and more particularly to an improved type of automatic volume control, for a radio receiver, which utilizes both the carrier and modulation signal for the gain control action.

One of the main objects of our present invention is to provide a method of tuning a radio receiving system through a relatively wide range of signal frequencies, and during the tuning process controlling the transmission efficiency of the receiver in such a manner that the volume of the receiver is substantially uniform, whereby blasting, or, in general, excessive sound production. is avoided at strong signal settings of the tuning mechanism.

Another important object of our invention may be stated to reside in the provision of a radio receiver equipped with automatic volume control (AVC hereinafter) which functions to maintain the carrier amplitude at the demodulator input circuit substantially uniform in spite of a wide range of carrier amplitude variation at the signal collector; an auxiliary gain control mechanism being utilized for the purpose of regulating the transmission efficiency subsequent to the demodulator in a sense such that the volume output of the receiver is substantially uniform regardless of relatively wide changes in the modulation intensity of received signals.

Another object of the invention is to provide in a radio receiver an AVC arrangement operating on a high frequency amplifier preceding the demodulator; and a second AVC circuit which utilizes the modulation component of the demodulated signals to control the gain of an audio frequency amplifier subsequent to the demodulator.

Still other objects of the invention are to improve generally the simplicity and efficiency of automatic gain control circuits for radio receivers, and more especially to provide an AVC circuit, for a radio receiver, which is not only reliable in operation, but is economically manufactured and assembled in radio receivers.

The novel features which we believe to be characteristic of our 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 we have indicated diagrammatically a circuit organization whereby our invention may be carried into effect.

Referring now to the accompanying drawing, wherein there is shown a radio receiving system embodying the invention, it will be observed that the receiving system generally embodies a signal collector 1 which may be of any well known type. For example, the collector may be a grounded antenna circuit; a radio frequency distribution line; a loop collector; or even an antenna used on a mobile structure such as an automobile. The collector 1 is coupled, as at 2, to the signal selector circuit 3 of the high frequency amplifier. The amplifier is generally denoted by the reference numeral 4, but it is to be understood that it may comprise one or more stages of tunable radio frequency amplification.

In other words, each of the radio frequency amplifier tubes embodied in the network 4 will be provided with its individual tunable signal selector circuit. Hence the numeral 3 will be understood as denoting the various cascaded signal selector circuits employed prior to the demodulator input circuit. The selector circuit 3 includes a variable condenser 5 whose rotors can be adjusted to vary the tuning of the selector circuit. The signal output of amplifier 4 is impressed upon the signal selector circuit of the demodulator, or detector, 7.

The demodulator is shown as of the diode type, and in that case the anode is connected to the grounded cathode through a path which includes the selector circuit 6 in series with the load resistor 8, the latter being shunted by the high frequency by-pass condenser 9. The direct current voltage component of the voltage developed across resistor 8 is utilized for the gain control of the high frequency amplifiers 4. This is accomplished by connecting the anode terminal of resistor 8 to the low potential sides of the various selector circuits. It will be understood that each of the radio frequency amplifiers includes a tube which has its control grid connected to the high potential side of the the tunable signal input circuit.

As shown in the drawing, the signal input grid circuit 3 of the first amplifier 4 has its low potential side connected to the anode side of resistor 8 through a path which includes lead 10; the lead is designated by the letters "AVC" to show that this is the usual AVC connection. Resistor 11 functions to suppress pulsating components in the AVC voltage fed to the grid circuits of the amplifiers, while the resistor-condenser network 12, 13 is a time constant circuit which is disposed in the AVC connection in order to have the gain control of the radio frequency

amplifiers respond solely to the carrier amplitude variation, and not to the modulation intensity changes. The time constant for network 12—13 may be 1/30 of a second.

The modulation, or audio, component of the voltage developed across resistor 8 is impressed upon the audio frequency amplifier 14, the latter having its control grid connected to any desired point on the load resistor 8 through a condenser 15. The grounded cathode lead of amplifier 14 includes the usual self-bias resistor 16, and the latter is shunted by an audio frequency by-pass condenser 17. The control grid of the amplifier 14 derives its normal operating negative bias by virtue of its connection, through grid leak resistor 18, to the grounded side of bias resistor 16. The plate of the audio amplifier 14 may be connected to additional audio frequency amplifiers, and the amplified audio voltage will be utilized by any desired type of reproducer, such as a loud speaker. An auxiliary AVC circuit is provided to control the transmission efficiency of the receiver in response to changes in the modulation intensity. More specifically, the modulation component of the voltage developed across resistor 8 is rectified, and the rectified voltage is utilized to control the gain of the audio frequency amplifier 14 in a sense such that the gain is reduced when the modulation intensity increases. It is to be understood that by the term "modulation" is meant the modulation signal which is impressed on the carrier. In other words the auxiliary AVC circuit functions to decrease the gain of audio amplifier 14 as the percentage modulation of received signals increases.

This increase in percentage modulation may be due to various causes. In the first place when tuning over a wide range of signal frequencies, stations of varying signal intensity will be received. Differences in carrier intensity will be compensated for by the main AVC circuit. However, some of the stations will employ a greater percentage modulation on the carrier than others. Again, the apparent percentage modulation of a received signal may vary greatly during reception by virtue of "selective fading"; that is a phenomenon which occurs when the carrier fades to an excessive extent with respect to its side bands. By employing the auxiliary AVC circuit of the present invention it is possible greatly to minimize the annoying sound output due to an increase in percentage modulation of received signals.

The auxiliary AVC circuit comprises a rectifier 19, as of the diode type, which has a load resistor 20 connected between its anode and its grounded cathode; an audio frequency by-pass condenser 21 is connected in shunt with the load resistor 20. The audio component of the voltage developed across load resistor 8 is amplified by an audio frequency amplifier 22. The anode side of load resistor 8 is connected to ground through a path including condenser 23 and resistor 24. The control grid of audio amplifier 22 may be adjustably connected to resistor 24 in order to adjust the portion of the modulation voltage diverted for gain control action. The effect of the auxiliary AVC will be more pronounced as the slider on resistor 24 is raised. In the grounded cathode lead of tube 22 is disposed the usual self-bias network 25, and the plate of amplifier 22 may be connected to a source of positive potential through a resistor 26. The anode of diode 19 is coupled to the plate of amplifier 22 through a condenser 27, and the amplified voltage output of amplifier 22 is impressed upon diode 19.

The voltage developed across resistor 20 by the rectification action of diode 19 is transmitted through lead 30 to the control grid of audio amplifier 14. The lead 30 includes a resistor-condenser network 31 which functions to suppress pulsating components in the rectified voltage output of diode 19. The network 31 has a time constant which may be relatively long compared to the time constant of network 12—13. The time constant value of network 31 is chosen so that the gain of audio amplifier 14 is readily controlled by the changes in average modulation intensity. For example, the time constant may have a value of 1/2 second or longer.

The tuning mechanism of the receiver is designated by the dotted lines 40, and it will be understood that this mechanism includes the usual uni-control device which adjusts the rotors of the variable condensers 5 and 6'. The uni-control mechanism 40 may be mechanically coupled with the adjustable element 50 of a switch device. This switch device may have a contact point 51 connected to lead 30, and a second contact 52 connected to the grounded side of bias resistor 16. When the adjustable element 50 is connected with contact 52, then the AVC lead 30 has no effect on the audio amplifier 19. However, when the element 50 is adjusted to connect with contact 51, then the amplifier 14 will be under the control of the voltage developed across load resistor 20. The mechanical coupling between the adjustable element 50 and the uni-control mechanism 40 may be such that the element 50 connects with contact 51 solely during tuning adjustment of the tuning mechanism 40.

For example, the tuning knob of the mechanism 40 could be arranged to be pushed towards the operating panel and thereby close switch 50—51 during the tuning process. As soon as the tuning were finished, release of the tuning knob would permit any well known form of spring device to restore element 50 to connection with contact 52 and thus provide the normal bias for the audio amplifier 14. Of course, such an arrangement will be employed only in such case when it is desired to utilize the auxiliary AVC circuit during the tuning operation in order to maintain a substantially constant volume output from the loud speaker of the set thereby to prevent blasting at strong signal settings of the tuning mechanism 40.

However, it is not necessary to employ such a switch device as 50—51. The auxiliary AVC circuit may be permitted to remain permanently connected; and, in this case, an increase in the apparent percentage modulation of received signals would cause the gain of audio amplifier 14 to be reduced. Furthermore, it is to be clearly understood that the radio receiving system may be of the superheterodyne type. In that case, the detector 7 would be the second detector, and its input circuit 6 would be fixedly tuned to the operating intermediate frequency. In the superheterodyne receiver arrangement, the numeral 3 will represent the signal selector circuits and the local oscillator tank circuit; it will be understood that the output of the first detector, which will be at I. F., will be fed to the second detector input circuit.

It is believed that the operation of the receiving system shown in the drawing will be clear from the foregoing description. As the tuning

mechanism 40 is adjusted from one point in the tuning spectrum to another point, and assuming the existence of intervening stations of varying signal intensity, the auxiliary AVC circuit will function to maintain a constant volume output from the loud speaker. This will happen because the audio component developed across resistor 8 will tend to increase the negative bias impressed on the control grid of amplifier 14 whenever the modulation intensity increases above the predetermined operating level. This decrease in gain of audio amplifier 14 follows from the fact that the control grid is connected to the negative side of load resistor 20, and any increase in current flow through resistor 20 will result in an increased bias on the control grid of amplifier 14. Of course, if the carrier amplitude varies, then the AVC lead 10 will function to increase the bias on the signal control grids of the amplifiers 4 and thus decrease the gain of these amplifiers. Should the percentage modulation of received signals increase during reception, as when the carrier fades with respect to the side bands, then the gain of audio amplifier 14 will be reduced and thereby minimizing the effect of the percentage modulation increase. By lengthening the time constant of network 31 the average percent modulation will operate the device, and sudden "ups and downs" in volume will not change the gain of tube 14. For example, if variations in music occurred every two seconds, and the time constant were 4 seconds, then the device would only average the pianissimo and fortissimo to produce constant gain for tube 14.

While we have indicated and described one system for carrying our invention into effect, it will be apparent to one skilled in the art that our invention is by no means limited to the particular organization shown and described; many modifications may be made without departing from the scope of our invention as set forth in the appended claims.

What we claim is:

1. In a radio receiving system of the type employing a high frequency amplifier feeding a detector, and an automatic volume control circuit which reduces the gain of the amplifier in response to the direct current voltage output of said detector, said amplifier including a tuning means, an auxiliary automatic volume control circuit adapted to derive a second direct current voltage from the modulation component of the detector output, a modulation component utilization network fed by said detector, and means responsive to actuation of the tuning means for decreasing the transmission efficiency of said utilization network with said second direct current voltage.

2. In a radio receiver of the type employing a high frequency amplifier having at least one tunable signal selector network which includes means for tuning it over a wide range of signal frequencies, a demodulator coupled to the amplifier output, an audio frequency amplifier network connected to utilize the audio component of the demodulated signals, an automatic volume control circuit arranged to reduce the gain of the high frequency amplifier in response to an increase in the carrier amplitude, a second automatic volume control circuit arranged to decrease the gain of said audio amplifier in response to an increase in the modulation intensity of received signals thereby to maintain a constant volume output for the receiver over said tuning range and means responsive to said tuning means for rendering said second volume control circuit operative to decrease said audio amplifier gain.

3. In a radio receiver of the type including a tuning device, a demodulator, an audio transmission network coupled to said demodulator, and audio signal-actuated means for regulating the transmission efficiency of said audio network in response to actuation of said tuning device.

4. In a modulated wave transmission system, a high frequency amplifier, a detector, a low frequency amplifier, means responsive to an increase in modulation intensity of received waves for decreasing the gain of the low frequency amplifier, means for tuning the high frequency amplifier over a desired wave frequency range, and means responsive to adjustment of the tuning means for rendering said gain decreasing means effective.

5. In a modulated wave transmission system, a high frequency amplifier, a detector, a low frequency amplifier, means responsive to an increase in modulation intensity of received waves for decreasing the gain of the low frequency amplifier, means for tuning the high frequency amplifier over a desired wave frequency range, and means responsive to adjustment of the tuning means for rendering said gain decreasing means effective, and additional means, responsive to wave amplitude variation, for controlling the high frequency amplifier gain.

6. In a radio receiver of the type comprising a high frequency amplifier provided with tuning means, a detector, an audio amplifier and automatic volume control means for said high frequency amplifier; an auxiliary automatic volume control including means for deriving a direct current voltage from detected signals, means for applying the voltage to said audio amplifier in a gain-reduction sense, and means responsive to adjustment of the tuning means for rendering said applying means effective to reduce the audio amplifier gain.

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