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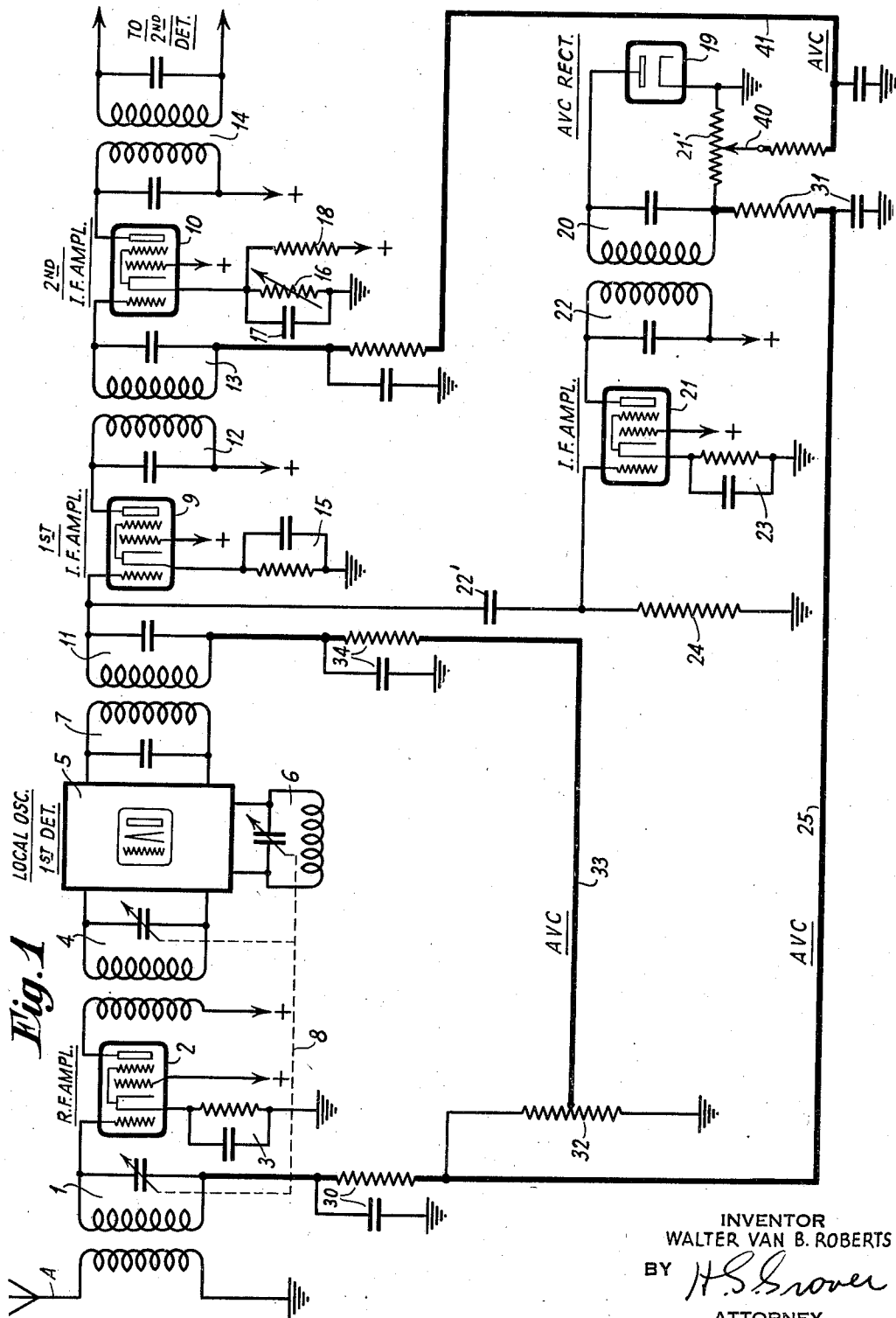
W. VAN B. ROBERTS

2,129,028

AUTOMATIC GAIN CONTROL CIRCUIT

Filed June 23, 1936

2 Sheets-Sheet 1



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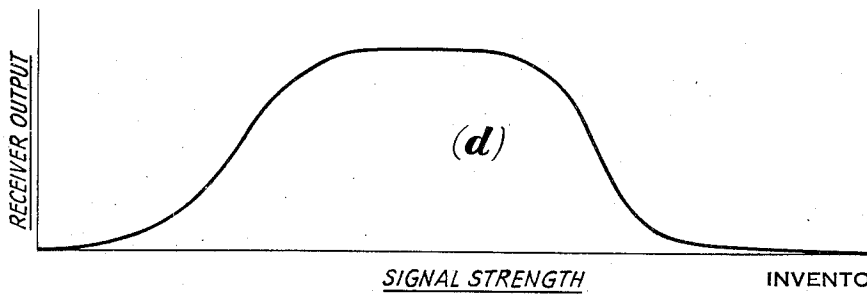
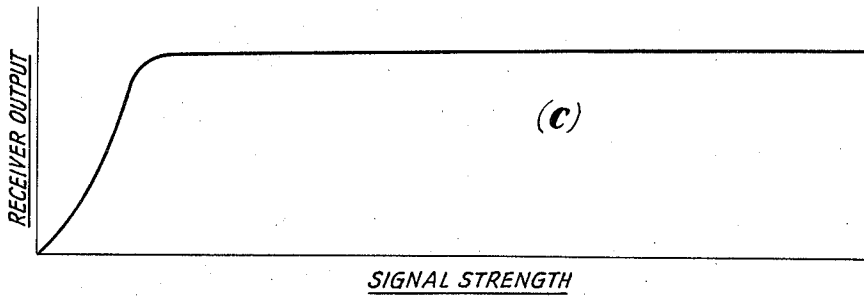
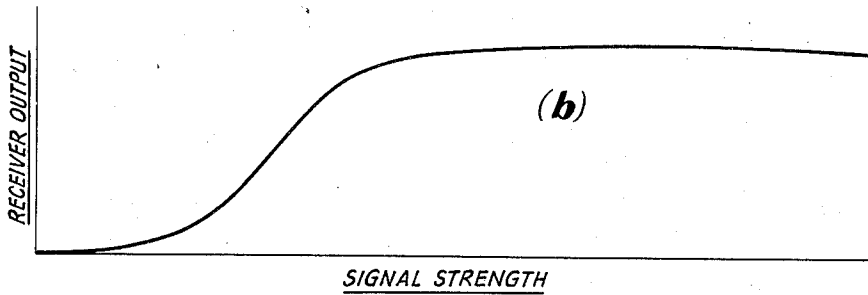
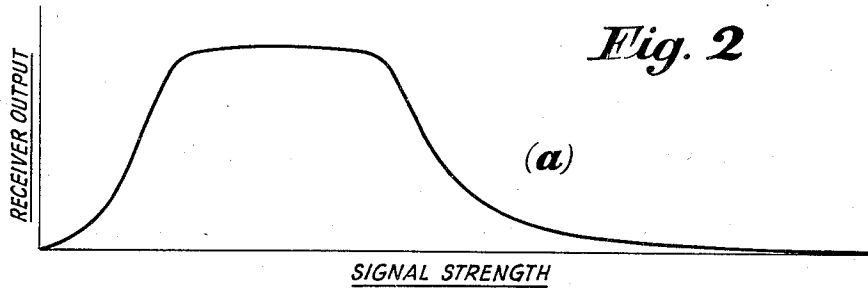
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Fig. 2



INVENTOR
WALTER VAN B. ROBERTS
BY *J. S. Grover*
ATTORNEY

UNITED STATES PATENT OFFICE

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AUTOMATIC GAIN CONTROL CIRCUIT

Walter van B. Roberts, Princeton, N. J., assignor
to Radio Corporation of America, a corporation
of Delaware

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1 Claim. (Cl. 250—20)

My present invention relates to gain control circuits for radio receivers, and more particularly to gain control arrangements for radio receivers which are adapted to produce predetermined relations between received signal amplitude and receiver output.

Automatic gain control arrangements, or automatic volume control circuits, are well known for use in connection with radio receivers, and such circuits function to maintain the signal amplitude at the receiver demodulator substantially uniform over a relatively wide range of signal amplitude variation at the receiver signal collector. An automatic gain control circuit may be arranged to control the signal transmission tubes preceding the point in the signal transmission channel from which the signal energy for control is taken, and the gain control may also be applied to transmission tubes following the point from which signal energy for control is derived. For example, such gain control arrangements have been disclosed by G. L. Beers in U. S. P. 1,960,723 of May 29, 1934.

It may be stated that it is one of the main objects of my present invention to apply gain control to a signal amplifier preceding the receiver demodulator, and which amplifier follows the point in the signal transmission channel from which signal energy for control purposes is derived, the signal input to the controlled amplifier being maintained substantially uniform by the automatic gain control arrangement, and there being provided a device for adjusting the sensitivity of the controlled amplifier feeding the demodulator independently of an auxiliary means which functions to vary the gain control applied to the last named amplifier, whereby different relations between received signal strength and receiver output may be secured.

Another important object of the invention may be stated to reside in the provision, in a radio receiver, of devices which may be adjusted to control the gain of an amplifier feeding into the receiver demodulator, such devices being adjustable to vary at will the receiver output for different conditions of received signal amplitude; and the receiver output adjustment devices essentially comprising a manually adjustable instrumentality for varying the gain of the amplifier feeding into the demodulator, and an automatic gain control arrangement which is constructed to apply different degrees of gain control to the amplifier, the amplifier additionally having the signal amplitude at its input circuit maintained substantially uniform.

Another object of the invention may be stated to reside in the provision of a superheterodyne receiver which includes an IF amplifier feeding into the second detector, an automatic volume control circuit being provided to control at least one of the stages preceding the IF amplifier in a sense such that the signal amplitude at the IF amplifier input circuit is maintained substantially uniform over a relatively wide range of signal amplitude variation at the receiver signal collector, and the control circuit, furthermore, being constructed so as to receive signal energy for control purposes from a point ahead of the IF amplifier to applying gain control to the IF amplifier tube, the IF amplifier including a manually adjustable device for controlling in a predetermined manner the amplitude of weak signals prior to demodulation by the second detector, and the automatic volume control circuit including a device for varying the degree of gain control on the IF amplifier in such a manner that the transmission of strong signals to the second detector is effectively predetermined.

Still other objects of the invention are to improve generally the efficiency of receivers employing automatic gain control arrangements, and more especially to provide a superheterodyne receiver adapted to be varied from local to distant reception in a simple and effective manner, and which receiver is moreover efficient in operation, and economically manufactured and assembled.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claim; 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 drawings in which I have indicated diagrammatically a circuit organization whereby my invention may be carried into effect.

In the drawings,

Fig. 1 schematically shows a superheterodyne receiver embodying the invention,

Fig. 2 shows four receiver output-signal strength characteristics of the receiving system shown in Fig. 1 for different adjustments of the device embodied in the invention.

Referring now to Fig. 1, there is shown in schematic manner a superheterodyne receiver of a conventional type. The receiver may comprise the usual signal collector A, and this may be of the customary grounded antenna type, or a radio frequency distribution line, or even the signal

collector employed on mobile structures such as automobiles. Regardless of the construction of the collector, the collected signals, which may be in the broadcast range of 500 to 1500 kc., are impressed on the tunable input circuit 1 of the radio frequency amplifier tube 2. The radio frequency amplifier is constructed in the usual manner and includes the signal grid biasing network 3 in its cathode circuit, the function of the network 3 being to provide the minimum signal grid bias, and the amplifier tube having its maximum gain at that normal bias value. The amplified signals are fed to the tunable input circuit 4 of the converter network 5. The latter network may comprise independent first detector and local oscillator tubes constructed in any well known manner, or it may comprise a tube, such as one of the 2A7 type, wherein the electrodes are connected by circuits to provide a combined local oscillator-first detector stage. The numeral 6 denotes the tunable local oscillator circuit, whatever the construction of network 5, and the numeral 7 signifies the IF output circuit of the converter network 5. The variable condensers of circuits 1, 4 and 6 are arranged to have their rotors mechanically controlled in uni-control fashion, and the dotted line 8 signifies such uni-control mechanism. As those skilled in the art will readily understand, the tuning of the circuit 6 is varied over a frequency range which differs from the frequency range of circuits 1 and 4 by an intermediate frequency to which the circuit 7 is resonated. This IF value may be chosen from a range of 75 to 465 kc., and where the receiver is of the multi-range type it will be understood that the operating IF may assume different values depending on the design of the transmission circuits. Furthermore, it will be understood that the customary devices may be used in the oscillator tank circuit 6 so as to maintain the energy in circuit 7 at a substantially constant IF value regardless of what frequency the tunable circuits are adjusted to.

The IF energy in circuit 7 is transmitted through the IF amplifier network, and the latter is shown as comprising at least two amplifiers 9 and 10. The amplifier 9 has its IF tuned circuit 11 coupled to the circuit 7, and the output circuit 12 on amplifier 9 is coupled to the input circuit 13 of amplifier 10. Circuits 12 and 13 are resonated to the operating IF value. The numeral 14 designates the IF transformer, having primary and secondary circuits each tuned to the operating IF, which transmits the amplified IF energy to the demodulator, or second detector. The demodulator, and its following audio amplifier network and reproducer, is not shown because those skilled in the art are fully aware of the constructional details of such stages. The IF amplifier 9 includes in its cathode circuit the signal grid biasing network 15, and the amplifier 10 includes in its connection to ground a resistor 16 which is adjustable in magnitude. The IF by-pass condenser 17 is connected across resistor 16, a source of direct current voltage (not shown) being connected in shunt across adjustable resistor 16, and the cathode side of resistor 16 being connected through the resistor 18 to the positive terminal of the voltage source shunting resistor 16. It will then be seen that by adjusting the magnitude of resistor 16 the signal input grid of tube 10 may be given a predetermined negative bias with respect to the cathode. The adjustable resistor 16 functions as the manual gain control mechanism or device

for IF amplifier 10, and its functional relation to the automatic gain control circuit will be described at a later point.

The automatic gain control arrangement comprises a diode 19 having connected in series between its anode and grounded cathode a path including the resonant input circuit 20 and the load resistor 21'. The IF energy is impressed on input circuit 20 through an amplification stage, and for this purpose the amplifier tube 21 has its resonant output circuit 22 coupled to input circuit 20. Circuits 20 and 22 are tuned to the operating IF, and the signal grid of tube 21 is connected to the high alternating potential side of circuit 11 through a coupling condenser 22'. The amplifier tube 21 includes the usual biasing network 23 in its grounded cathode lead, and the signal grid of tube 21 is connected to ground through a resistor 24 so that a desired operating bias may be applied to the signal grid of tube 21. The direct current voltage developed across resistor 21' by the rectified IF currents, is impressed upon the signal grid circuits of different signal transmission tubes of the receiver. Thus, the anode side of resistor 21' is connected to the low alternating potential side of input 1 through a path which includes the lead 25, and this lead is designated by the letters "AVC" to show that this is the automatic volume control connection for the radio frequency amplifier tube.

The AVC lead 25 may include appropriate filter elements 30 and 31, and the function of these filter elements is to suppress the pulsating voltage components developed across resistor 21'. The signal grid of the first detector may also be connected to the AVC lead 25 if desired. The first IF amplifier 9 has its signal grid circuit connected to the AVC rectifier 19 so that less AVC voltage is impressed on amplifier 9 than is applied to amplifier 2. This is accomplished by connecting the low alternating potential side of input circuit 11 to a voltage reducing resistor 32 through the AVC lead 33. The resistor 32 is connected from lead 25 to ground, and the filter elements 34 are inserted in the AVC connection 33 to suppress pulsating voltages.

The signal grid of amplifier 10 is connected to a desired point on resistor 21' through an adjustable tap element 40. The tap 40 may be adjusted to any point along resistor 21', and it is connected through the AVC lead 41 to the low alternating potential side of input circuit 13. The AVC lead 41 includes filter elements for suppressing pulsating voltages. It will therefore be seen that the automatic volume control network operates its signal energy for control purposes from the input circuit of IF amplifier 9, but it not only controls the gain of amplifier 2 which precedes input circuit 11, but also controls the gain of each of amplifiers 9 and 10 which follow the input circuit 11. Furthermore, while the grid circuits of amplifiers 2 and 9 are always connected to a common point on resistor 21', the AVC connection 41 to amplifier 10 may be made to any desired point of resistor 21', and for a purpose now to be described in detail.

Considering the amplifier 10 it will be seen that the gain control action of amplifiers 2 and 9 results in the maintenance of the signal amplitude at input circuit 13 substantially uniform over a wide variation of signal amplitude at collector A. The action that secures this result is well known and it is only necessary to state that the signal energy from input circuit 11 is amplified by amplifier 21, and then rectified by

diode 19. The signal grids of amplifiers 2 and 9 being connected to the point on resistor 21', which is negative with respect to ground, the gain of each of amplifiers 2 and 9 will be decreased as the received signal amplitude increases. Assume, now, that the tap 40 is adjusted to the point on resistor 21' to which lead 25 is connected. Further, let it be assumed that the resistor 16 has been adjusted so that in the absence of received signals the amplifier 10 has a normal negative bias impressed thereon such as to give maximum gain. In such case the characteristic *a* in Fig. 2 shows the receiver output-signal strength characteristic of the receiving system. It will be seen that with these adjustments of tap 40 and variable resistor 16 weak stations will only be heard whereas the response to stronger stations will be practically eliminated by virtue of the connection of AVC lead 41 to the most negative point on resistor 21'. It will therefore be seen that by adjusting the manual sensitivity control 16 for maximum sensitivity, and adjusting tap 40 for maximum gain control action on amplifier 10, response is limited practically to weak stations, as shown by characteristic *a* in Fig. 2.

If now tap 40 is shifted to the grounded side of resistor 21', and the manual sensitivity control 16 is adjusted to reduce the sensitivity of amplifier 10 from its previous maximum setting, then characteristic *b* is secured. From this characteristic it will be seen that the weak signal response is a minimum, whereas the strong signal response is a maximum. With these adjustments of tap 40 and manual sensitivity control 16, the weak signal response is practically eliminated. The automatic gain control action on amplifier 10 in this case is also eliminated, and gain regulation depends upon the regulation of amplifiers 2 and 9.

The characteristic *c* is secured by restoring maximum sensitivity control 16 to the maximum sensitivity setting, but with the tap 40 still at the grounded side of resistor 21'. In this case it is seen that the response to weak signals is increased, and this results because of the increase of the normal operating gain of amplifier 10. Here, again, the gain regulation depends upon the control applied to amplifiers 2 and 9.

The characteristic *d* is secured by adjusting the tap 40 to an intermediate point on resistor 21', and adjusting the sensitivity control 16 to a moderate setting. The characteristic secured by these adjustments is such that the receiver response is confined to an intermediate range of signal amplitude values. It will be seen that with characteristic *d* the response to weak signals and strong signals is practically eliminated. This

characteristic results because of the fact that the control device 16 has been adjusted so as to reduce the normal sensitivity of amplifier 10 to a value below maximum, and also because of the fact that the gain control applied to amplifier 10 is of an intermediate degree.

It will now be seen that by proper adjustment of the manual sensitivity control 16 and the automatic gain control tap 40 the different receiver output-signal strength characteristics shown in Fig. 2 may be secured. In other words, the receiver response to weak signals, signals of moderate amplitude, or strong signals may be varied at the will of the receiver operator. Clearly, for distant reception the characteristic *a* is desirable, whereas for local reception the characteristic *b* is desired. By means of the present invention the receiver output with respect to received signal amplitude becomes adjustable so as to satisfy varying reception conditions.

While I have indicated and described a system 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 claim.

What is claimed is:

In a receiving system provided with a plurality of signal transmission tubes arranged in a cascade network, manually adjustable means electrically associated with the last of said tubes for establishing the tube gain at a predetermined value related to a desired signal amplitude, automatic volume control means having a signal input circuit connected to an intermediate point in said cascaded tube network, an impedance electrically associated with said control means for developing thereacross a direct current voltage which varies in accordance with signal amplitude variation, a direct current voltage connection between a point on said impedance and a gain control electrode of at least one of the tubes preceding said intermediate point, a second direct current voltage connection between a gain control electrode of said last tube and a point on said impedance, and means for selecting at will the point of connection to the impedance of said second direct current voltage connection whereby there may be adjusted the rate of reduction of gain of said last tube with increase in signal amplitude, said manually adjustable means and said selecting means having gain control adjusting ranges such that the receiver response to signals of different amplitudes may be varied widely at the will of the receiver operator.

WALTER VAN B. ROBERTS.