April 20, 1937. W. L. CARLSON ET AL 2,078,055

AUTOMATIC VOLUME CONTROL WITH NOISE SUPPRESSOR

Filed Dec. 22, 1932 2 Sheets-Sheet 1

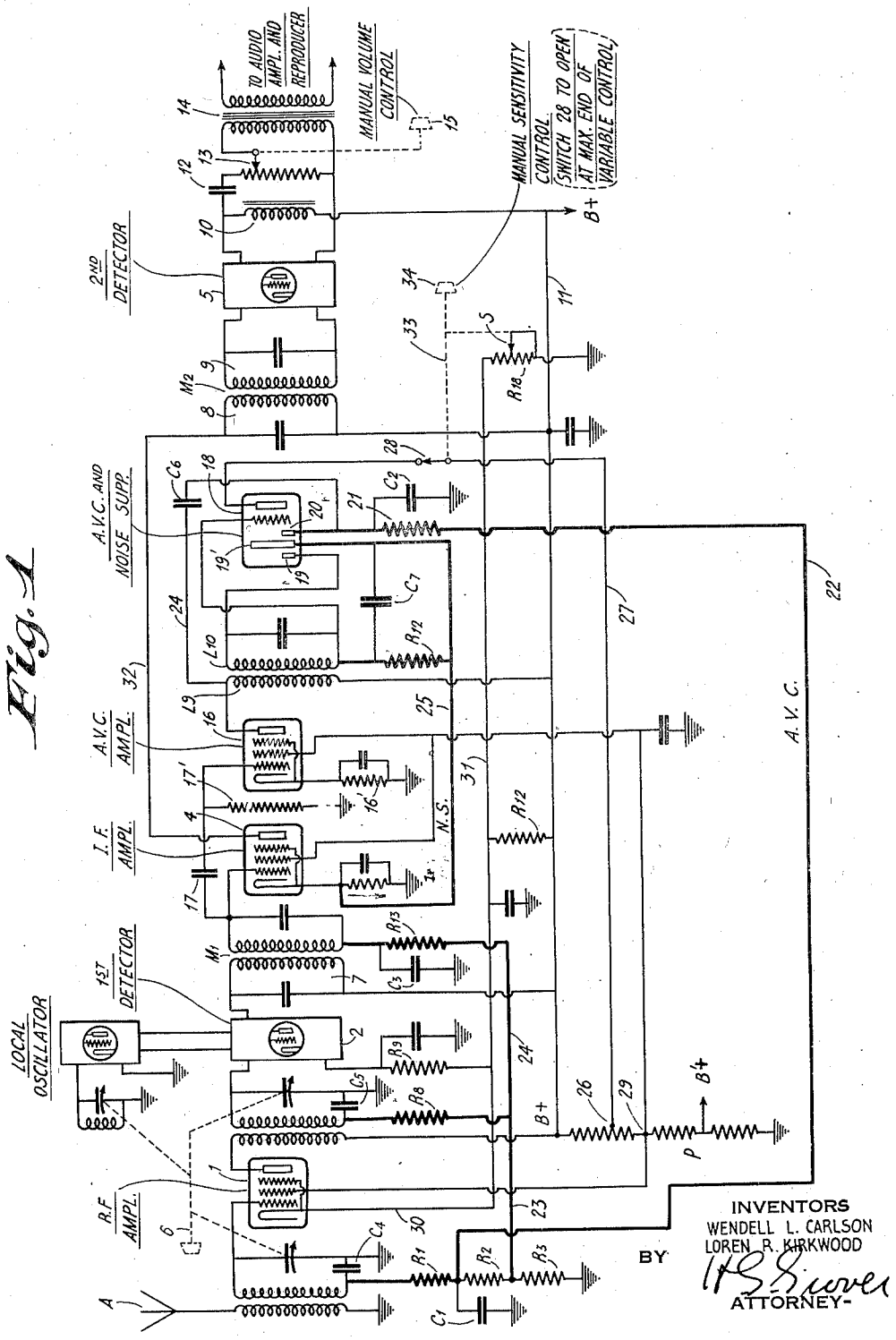


Fig. 1

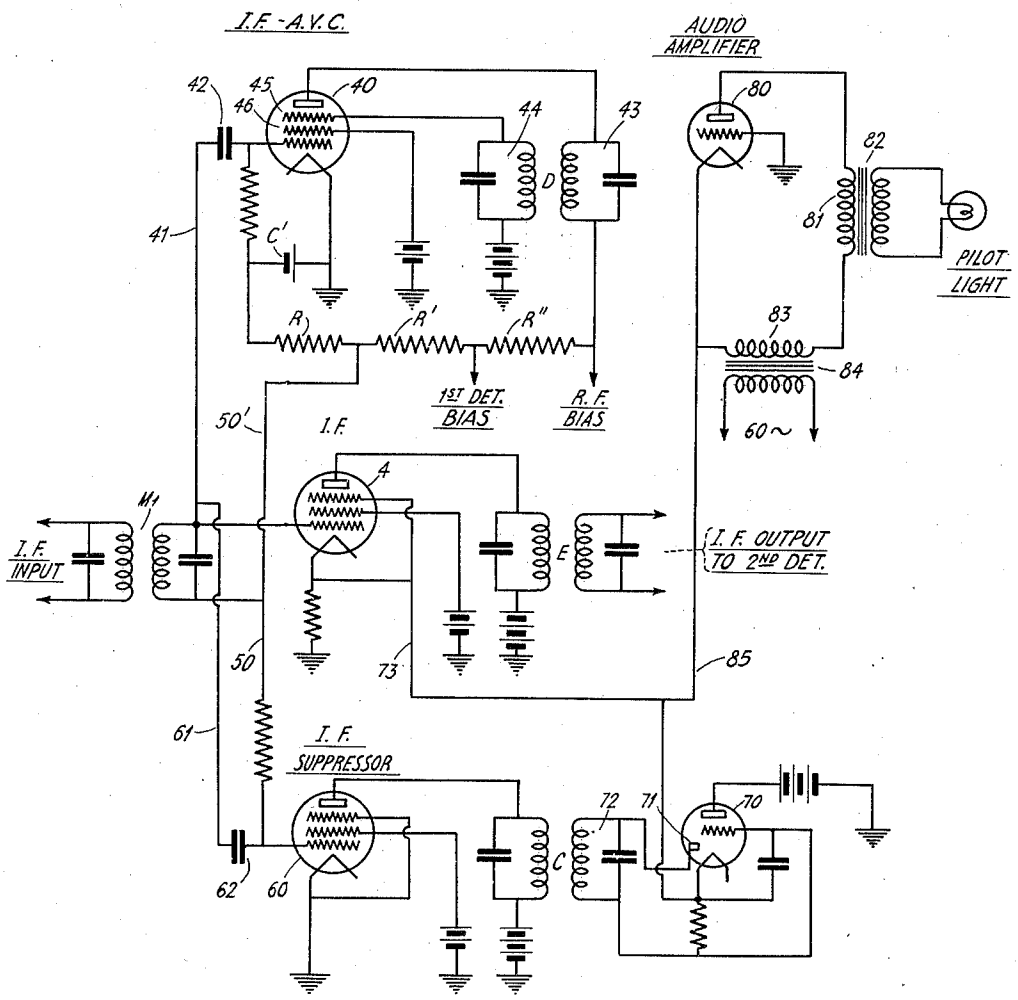
INVENTORS
WENDELL L. CARLSON
LOREN R. KIRKWOOD
BY
ATTORNEY

April 20, 1937. W. L. CARLSON ET AL 2,078,055

AUTOMATIC VOLUME CONTROL WITH NOISE SUPPRESSOR

Filed Dec. 22, 1932 2 Sheets-Sheet 2

Fig. 2



INVENTORS
WENDELL . L. CARLSON
LOREN R. KIRKWOOD

BY H. G. Storer
ATTORNEY

Patented Apr. 20, 1937 2,078,055

UNITED STATES PATENT OFFICE

2,078,055

AUTOMATIC VOLUME CONTROL WITH NOISE SUPPRESSOR

Wendell L. Carlson, Haddonfield, and Loren R. Kirkwood, Merchantville, N. J., assignors to Radio Corporation of America, a corporation of Delaware

Application December 22, 1932, Serial No. 648,422

35 Claims. (Cl. 250—20)

The present invention relates to radio receivers employing automatic volume control circuits, and more particularly to receivers embodying inter-channel noise suppressor arrangements.

In a co-pending application of K. A. Chittick and W. L. Carlson, Serial No. 642,544, filed November 14, 1932, there have been disclosed automatic volume control circuits for use in radio receivers. The characteristic feature of the circuits disclosed in the said application comprised an automatic volume control circuit which divided from the sound channel at the grid of the last intermediate frequency amplifier stage, the volume control circuit consisting of an intermediate frequency amplifier and a rectifier, the output electrode of the rectifier being connected by a direct current path to the radio frequency, first detector and intermediate frequency stages for gain control of these stages. It was pointed out in the aforesaid application that one of the advantages resulting from the arrangement shown therein was the reduction of overloading on the side of strong carriers due to the fact that there was less selectivity to the volume control circuit than to the audio detector. In other words, unlike the old volume control systems which required a slight increase in signal potential to operate the volume control tube, the system of the aforesaid application operated to control the signal channel to a greater extent than the channel supplying the volume control tube.

Now, it is often desirable to embody in a receiver of the type disclosed in the aforementioned application, an arrangement capable of providing inter-channel noise suppression. The function of a noise suppressor circuit is to reduce receiver noises, by greatly decreasing the sensitivity of the receiver when no signal modulated carrier waves are being received. Furthermore, it is highly desirable to achieve the function of noise suppression without introducing distortion of the signals transmitted through the receiving system.

Accordingly, it may be stated that it is one of the main objects of the present invention to provide in a radio receiver, equipped with an automatic volume control circuit, a noise suppressor system whose circuits are confined entirely to the intermediate frequency circuits, and are not associated with the audio detector or audio circuits, thus resulting in smoother operation and no distortion at the threshold operating point.

Another important object of the present invention is to provide a circuit, for use in connection with the superheterodyne type of radio receiver, which not only possesses the desirable features of an automatic volume control system, but in addition thereto, includes inter-channel noise suppression, auxiliary means being provided for adjusting the degree of the suppression. The suppressor control is further characterized in that it is capable of functioning as a manually operable sensitivity control to regulate the overall sensitivity of the receiver, thereby eliminating the reception of signals having too great a noise level, and the suppressor control, additionally may include a switch which is adapted to control the conductivity of the suppressor tube whereby the suppressor action may be rendered effective or ineffective at will.

Another object of the present invention may be said to consist in the provision of an automatic volume control circuit for a radio receiver, which control circuit includes one network adapted to regulate the gain of at least one radio frequency stage in a manner such that the output of the stage is substantially uniform regardless of variations in signal intensity in the input circuit of the stage, and an additional network for regulating the operation of the said radio frequency stage in such a manner that the stage is rendered inoperative to transmit electrical impulses when the signal level in the input circuit of the stage decreases below a predetermined intensity level.

Still another object of the present invention is to provide a radio receiver provided with means for automatically controlling the volume of the signal output therefrom, a manual volume control device being disposed in the audio frequency section of the receiver, and a manual sensitivity control device being disposed in a radio frequency section of the receiver, the sensitivity control being so arranged and connected that it is capable of regulating the suppression of noise or undesired electrical disturbances, the receiver being characterized by its freedom from noises between desired settings of the tuning device of the receiver, said sensitivity control, additionally, including means for eliminating the aforesaid noise suppression function.

Still other objects of the invention are to improve generally the simplicity and efficiency of radio receivers equipped with automatic volume control circuits, and particularly to provide a superheterodyne receiver provided with automatic volume control, accompanied by an inter-channel noise suppressor means, which is not only durable and reliable in operation, but which

may economically be manufactured and assembled in a radio receiver.

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 accompanying drawings in which we have indicated diagrammatically several circuit organizations whereby our invention may be carried into effect.

In the drawings,

Fig. 1 shows diagrammatically the circuit of a radio receiver embodying the present invention,

Fig. 2 is a similar diagram showing a modified form of the invention.

Referring now to the accompanying drawings wherein like reference characters designate similar elements in the two figures, the radio receiver shown in Fig. 1 is of the well known superheterodyne type. The receiver includes a usual grounded antenna circuit A coupled to the tunable input circuit of a radio frequency amplifier tube 1, the latter in turn having its output circuit coupled to the tunable input circuit of a first detector means or tube 2. The usual local oscillator circuit is shown connected to the first detector 2 for the impression of the heterodyne frequency upon the first detector. This may be accomplished in any suitable manner. Each of these three aforesaid tunable circuits includes a variable tuning condenser, and the rotors of these condensers are grounded. Any desired type of uni-control tuning mechanism 6 may be utilized, the same being shown in dotted lines, for simultaneously varying the rotors of the tuning condensers.

The output circuit 7 of the first detector is fixedly resonant to the desired operating intermediate frequency. The latter may have a value of 175 kilocycles, for example, and the tunable circuits preceding this circuit may include any desired means for positively maintaining the intermediate frequency constant. Such a means is not shown, but reference is made to U. S. Patent 1,740,331 to W. L. Carlson, issued on December 17, 1929 to show such a means for maintaining the intermediate frequency constant throughout the tuning range of the receiver. The resonant circuit 7 is coupled, as by a transformer M_1, to the resonant input circuit of the intermediate frequency amplifier tube 4, this input circuit being fixedly tuned to the aforesaid operating intermediate frequency.

The output circuit of the tube 4 includes the resonant circuit 8, fixedly tuned to the intermediate frequency, which is coupled, as by means of a transformer M_2, to the resonant input circuit 9 of the second detector 5, the circuit 9 also being fixedly tuned to the intermediate frequency. The output of the second detector is transmitted to one, or more, succeeding stages of audio frequency amplification, and a final reproducer, through an impedance-transformer coupling network which includes the coupling reactor 10. The plate supply to the detector is fed to the coupling reactor through a lead 11 which is connected to the high potential side of the voltage divider P.

The audio frequency component of the second detector output passes through the 0.5 mfd. coupling capacitor 12, the manual volume control 13 being located between the capacitor 12 and the audio frequency coupling transformer 14. The manual volume control functions to reduce the voltage applied to the primary of the transformer 14, the numeral 15 designating the well known manual volume control knob usually disposed on the control panel of the receiver adjacent the tuning control mechanism 6.

The input signal voltage for the intermediate frequency amplifier tube 4 is also applied to an automatic volume control amplifier tube 16 due to the grids of both tubes being coupled together as by means of a capacitor 17, the capacitor being shunted to ground on the grid side through a resistor 17' which may have a value of 2 megohms. The resistor 17' functions to provide a grid leak for the tube 16 to supply bias to the grid from the self-bias source 16' indicated. The output voltage of the intermediate frequency amplifier tube 4 is applied to the second detector 5 through the transformer M_2, the latter being sharply tuned to the intermediate frequency. However, the output of the amplifier tube 16 is coupled to the combined volume control and noise suppressor tube 18 through a specially designed coupling network.

This coupling network includes a natural period plate coil L_9, which coil is connected at one end to the anode of tube 16 and at its other end to the lead 11. Coil L_9 is resonant to the intermediate frequency and broadly so by means of relatively large inductance and small capacity. The coil L_9 is inductively coupled to a secondary coil L_{10} which is sharply tuned to the operating intermediate frequency. The coil L_9 supplies the voltage to operate the automatic volume control circuit, and possesses a natural period in order to provide the advantage described in the said Chittick and Carlson application referred to above. That is, to provide less selectivity to the automatic volume control circuit than to the second detector circuit. A natural period coil of this type has very broad selectivity in itself due to its inherent loss. The coil L_{10} supplies the voltage used to operate the noise suppressor network.

The tubes 1, 4 and 16 are shown as of the type known by the trade symbol 58, and it will be observed that each includes a suppressor grid at cathode potential. The tube 18 is of the type bearing the trade symbol 55, and, while conventionally shown, is to be understood as including the usual heater type cathode, a control grid and an anode, and two auxiliary cold electrodes, or anodes, 19, 20. The 55 tube, or duplex-diode triode as it may be aptly termed, is an alternating current heater type of tube consisting of two diodes and a triode in a single bulb. In operation, the two diodes and the triode are independent of each other except for the common cathode sleeve, which has one emitting surface for the diodes, and another for the triode. This independence of operation permits of unusual flexibility in circuit arrangement and design.

For example, in the present arrangement, the electrode 20 controls the function of automatic volume control, while the electrode 19 controls the noise suppressor action. It is not believed necessary to describe the construction of the tube 18 in detail, since the construction thereof is not a part of the present invention. It is believed sufficient to point out that the two plates 19 and 20 are disposed around one end of the common cathode sleeve 19', and that the control grid and main anode are concentrically disposed around the cathode sleeve, the anodes 19 and 20

therefore being out of the main electron stream to the usual control grid and main anode.

The automatic volume control network includes a direct current connection between the grid circuit of each of tubes 1, 2 and 4 and the auxiliary electrode 20. Thus, the electrode 20 is connected to the low potential side of the grid circuit of tube 1 through a path which includes the resistor 21, having a magnitude of about 200,000 ohms, the lead 22, and the resistor R_1, having a value of about 500,000 ohms. The low potential side of the grid circuit of the first detector 2 is connected to the lead 22 through a path which includes the resistor R_8, having a value of about 100,000 ohms, the lead 23, and the resistor R_2, having a value of about 400,000 ohms. The low potential side of the grid circuit of tube 4 is connected to the lead 22 through a resistor R_{13}, having a value of about 100,000 ohms, the lead 24, the lead 23, and the resistor R_2, one side of the resistor R_2 being connected to ground through a resistor R_3, having a value of about 600,000 ohms.

The resistors R_1, R_2 and R_3 are by-passed to ground not only for radio frequency currents but for all signal frequencies through a capacitor C_1, the resistor 21 being similarly by-passed for signal and radio frequency currents by means of a capacitor C_2, and the resistors R_{13} and R_9 being by-passed to ground for signal and radio frequency currents by means of the capacitor C_3. Direct current blocking condensers C_4 and C_5 are disposed respectively in the low potential sides of the grid circuits of tubes 1 and 2. The electrode 20 has signal voltage applied to it from the high potential side of the coil L_9 through a path which includes the lead 24, and the condenser C_6, the latter having a magnitude of about 300 mmfd. It is to be clearly understood that magnitudes recited herein are purely illustrative, and may be freely varied to suit the exigencies of a given receiver design.

The noise suppressor network is confined to the intermediate frequency circuits, and is not associated with the audio detector or audio circuits, thus not only distinguishing the arrangement from systems employed in the prior art, but providing an arrangement which results in smoother operation and no distortion at the threshold operating point. This network includes a direct connection 25 between the cathode 19′ of tube 18 and the grounded leg of the cathode of tube 4, it being observed that the grounded leg includes the conventional resistor-shunt condenser grid biasing arrangement, a similar biasing arrangement being employed in the grounded leg of the cathode of tube 16. The low potential side of the sharply tuned coil L_{10} is connected to the lead 25 through a resistor R_{12} having a magnitude of about 2 megohms, a condenser C_7 being connected between one side of the resistor R_{12} and the lead 25, the condenser C_7 having a value of 0.005 mfd. The lead 25 functions to connect the cathode of the suppressor tube 18 to the cathode of tube 4, establishing the suppressor action due to the cathode current of suppressor tube 18 flowing through the cathode resistor of the intermediate frequency tube 4 and biasing said intermediate frequency tube to cut-off when no signal is received. The electrode 19 is connected to the high potential side of the sharply resonant coil L_{10}, while the control grid of tube 18 is connected to the low potential side of the said coil. The triode anode of tube 18 is connected to a point 26 on the divider P through a path which includes the lead 27 and the "on-off" switch 28.

The connections to the divider P of certain of the electrode circuits necessary to a proper understanding of the invention have only been shown. Thus, the connections from the screen grids of tubes 1 and 4 to the point 29 on the divider P have been shown. Again, the connections from the anodes of tubes 1, 2, 4, 16 and 5 to the high potential side of divider P, through lead 11, have been shown. The cathode of tube 1 is connected to ground through a path which includes the lead 30, the lead 31, and the sensitivity control resistor R_{18}, the latter having a magnitude of about 4500 ohms, an adjustable tap S being arranged to vary the value of the resistor R_{18}. The cathode circuit of the first detector 2 is, also, connected to the lead 31 through a resistor R_9, having a value of about 2500 ohms, this resistor R_9 functioning to bias the first detector to the proper operating point. A resistor R_{12}, of a value of about 100,000 ohms, is connected between leads 31 and 11, and functions to provide some bleeder current through the sensitivity control.

For the purposes of illustration it is pointed out that the resistor portion between the high potential side of the divider P and point 26 may have a value of about 3000 ohms; the portion between 26 and 29 may have a value of about 600 ohms; the section between point 29 and point +B′ may have a value of about 1300 ohms; and, the remaining section to ground may have a value of about 2900 ohms. It is to be clearly understood that these values, as well as all other values stated heretofore or hereafter, are merely examples of an actual embodiment. It is believed that the diagrammatic showing of Fig. 1, and the aforegoing description, will now render the following explanation of the operation of the invention clearly understandable.

From the secondary of the first intermediate frequency transformer M_1 the signal voltage is fed to parallel paths. The normal signal path passes through the intermediate frequency amplifier tube 4, through the lead 32, to the intermediate frequency output transformer M_2. The cathode of the tube 18 is tied to the cathode of tube 4. The plate current through the tube 18 and the grid bias resistor of tube 4 is of the order of five to ten M. A. before the signal voltage has reached the threshold operating value. About 45 volts drop exists in the grid bias resistor of tube 4 at this time, which practically cuts off the tube 4, and prevents signals from passing through to the transformer M_2. Voltage is also transferred from the secondary of the transformer M_1 on tube 16, and is amplified and impressed on the two diode anode electrodes of tube 18.

Coil L_9 supplies the voltage to operate the volume control circuit, while coil L_{10} supplies that used to operate the suppressor network. An examination of this circuit will show that with no signal voltage impressed on coil L_{10}, no current is rectified in the diode plate 19, and hence the grid of the tube 18 operates at zero bias. The plate current is then at a maximum value, approximately 10 M. A., and since the cathodes of the tube 18 and the signal channel intermediate frequency tube 4 are common, the intermediate frequency tube is biased to cut-off. This, therefore, prevents signal voltage from reaching the second detector through the path including lead 32.

When the tuning device 6 is, however, adjusted to tune in a desired signal, the signal voltage is amplified in the automatic volume control amplifier 16, and impressed on coils L_9 and L_{10}. On the positive half of the signal voltage, the signal is rectified in the suppressor circuit which generates a negative potential on the grid of the tube 18. The plate current is thereby reduced to approximately zero, and this releases the high bias potential on the signal channel amplifier tube 4. Signal voltage will then be impressed on the second detector.

Automatic volume control bias for the radio frequency, first detector and intermediate frequency tubes will be generated when the intermediate frequency voltage on the automatic volume control diode anode 20 overcomes and exceeds the positive potential on the cathode of tube 18. This bias is approximately 10 volts when the receiver is tuned to a signal. The transformer M_2 feeding the second detector includes two high impedance circuits in order to provide the proper amplification with the increased bias resistor in the intermediate frequency cathode circuit. The suppressor circuit including coil L_{10} is designed to be a sharp circuit so that the action of the suppressor network comes as near the center of the carrier as possible. It is important, therefore, that this last named circuit be aligned exactly on the center of the intermediate frequency resonance curve so that the operator of the receiver may hear a signal when it is exactly in tune.

The drop across resistors R_2 and R_3 gives the bias for the radio frequency stage. The drop across resistor R_2 comprises the grid voltage for the first detector, and intermediate frequency amplifier. As the drop in these resistors is due to the signal voltage applied to the automatic volume control tube and this voltage is in turn dependent on the bias of the radio frequency, first detector and intermediate frequency amplifier stages, an automatic action is obtained. The reason for the greater voltage applied to the radio frequency stage than that applied to the first detector and intermediate frequency stages is to prevent overloading of these tubes on the side of a strong carrier.

With the automatic volume control arrangement shown there is no danger of overloading the second detector, and, accordingly, the manual volume control means may be placed in the audio frequency circuit. The automatic volume control plus the special amplifier 16 provides a radio frequency voltage on the second detector which is substantially constant between 9 and 12 volts for a signal of from 10 microvolts to several volts. The function of the noise suppressor circuit is to reduce noise, by greatly decreasing the sensitivity of the receiver, when no carrier waves are being received. The manually operated sensitivity control S is provided so that the over-all sensitivity of the receiver may be adjusted, thereby eliminating the reception of signals having too great a noise level. This feature operates without introducing distortion, a quality not present in other types of noise suppressor circuits. The manual sensitivity control S is in the cathode circuit of the radio frequency and first detector stages, and reduces the sensitivity of the receiver by increasing the residual bias on the tube 1 and the first detector 2. One end of the sensitivity control S has a switch 28 which is provided so that the noise suppression circuit may be cut out at will. Under this condition, the full sensitivity of the receiver is obtained.

In other words, the numeral 33 will be understood to designate a common control mechanism, having a control knob 34 disposed on the receiver control panel adjacent knobs 15 and 6, which mechanically couples the variable tap S and the movable switch arm 28 in such a manner that the switch 28 is opened at the maximum end of the variable control S. To the operator's ear movement of the knob 34 will sound as if the volume control knob is being actuated to increase the sensitivity of the receiver. Of course, if the knob 34 is moved towards its maximum, the reproduced noise increases. Hence, it will be observed that the function of the control 15 is to vary the sound output of the receiver, without regard to reproduced noise; while the function of the control S is to vary the sound output of the receiver with regard to the level of reproduced noise, and, also, to render the noise suppressor circuit effective or ineffective at will. The variable resistance R_{18} controls the noise suppression level in that it controls normally negative bias on the grid of the radio frequency amplifier and first detector, and, naturally, the greater the normal negative bias on those grids the less noise suppression current through tube 18 is necessary to prevent the set from being triggered into operation by the incoming signal. This is more apparent when it is considered that the radio frequency tube and first detector are immediately effective on the incoming signal, which must come to a certain level in order to overcome the noise suppression action and cause signals to be received.

Fig. 2 shows a modified form of the invention which is diagrammatically shown in a highly conventional manner, the circuit energizing sources, for example, being conventionally shown to preserve simplicity of disclosure.

The intermediate frequency amplifier tube 4 has its resonant input circuit coupled to the source of intermediate frequency energy through the coupling transformer M_1, while the transformer E designates the coupling between the output of the tube 4 and the resonant input circuit of the second detector. In this modification the automatic volume control and suppressor circuits are separated. The automatic volume control arrangement is similar to that shown in the aforementioned co-pending application. That is, the automatic volume control amplifier and automatic volume control tube functions are derived from a single tube 40, the control grid of the tube 40 being connected to the high potential side of the grid circuit of tube 4 through a path which includes the lead 41, and the coupling capacitor 42. The anode of tube 40 includes a circuit 43, resonant to the intermediate frequency, the circuit 43 being coupled, as at D, to a similarly resonant circuit 44 disposed in the circuit of the positive electrode 45 of tube 40. Between electrode 45 and the control electrode of tube 40 is disposed a less positive electrode 46.

The volume control bias resistors include the resistor R, R' and R''. One side of the resistor R is connected to the negative side of the grid bias source C' of the tube 40, the junction of resistors R and R' being connected by a lead 50 to the low potential side of the grid circuit of tube 4, as well as to the control grid of tube 60. The anode side of resistor R'' is connected to the radio frequency amplifier grid (not shown) to furnish control bias therefor, and the junc-

tion of resistors R' and R'' is connected to the first detector grid to furnish control bias for the latter, the lead 50 furnishing the control bias for the intermediate frequency amplifier tube 4. The noise suppressor circuit in this modification includes the amplifier tube 60 which is coupled, as at C, to the tube 70. This tube 60 is of a type known as the RCA 58.

The auxiliary electrode 71 of tube 70 is connected to the high potential side of the resonant input circuit 72, while the cathode of tube 70 is connected to the low potential side. The cathode of tube 70 is, additionally, connected through a lead 73 to the cathode of tube 4, and functions as the noise suppressor network, and in a manner described heretofore in connection with Fig. 1. Not only is the function of the suppressor 70 the same as in Fig. 1, but in addition thereto it operates a power audio amplifier tube 80 which has a 60 cycle current source in the plate circuit thereof. The plate circuit of the tube 80 includes the primary winding 81 of a step-down transformer 82, the latter coupling a pilot light to the plate circuit of tube 80. The secondary winding 83 of the 60 cycle current transformer 84 is also included in the plate circuit of tube 80. The lead 85 connects the cathode side of winding 83 to the cathodes of tubes 4 and 70. The negative voltage on the grid of tube 80 reduces the alternating current in the plate which operates through the step-down transformer 82 to light the pilot light, the latter being an ordinary tuning dial light.

The automatic volume control operates on the suppressor intermediate frequency tube 60 so as to hold the voltage to the suppressor control level with wide changes of field strength. The suppressor intermediate frequency transformer C is made very sharply resonant so that when tuning the receiver the suppression will be retained until almost center resonance. The volume control transformer D is very broad, and the signal transformer E has medium selectivity. Of course, the connections between the second detector and the input to tube 80 have been omitted to preserve simplicity of description.

It is believed that the operation of the modification shown in Fig. 2 will be clearly understood from the aforegoing description. Briefly, when no signal is impressed on the input circuit of the amplifier tube 4, the volume control tube 40 tends to increase the amplification not only of the intermediate frequency amplifier tube 4, but also the amplification of the first detector and radio frequency tubes. However, in virtue of the signal path 61, 62 to the control grid of the suppressor amplifier tube 60, and the action of the suppressor tube 70, the amplifier tube 4 will be biased to cut-off so that undesired electric impulses, which evidence themselves to the ear as noise, will not be transmitted through the transformer E to the audio amplifier tube 80.

However, as soon as a signal is tuned in, the noise suppressor tube 70, as explained heretofore, releases the cut-off bias on the amplifier tube 4, thus rendering the tube operative to transmit signal energy through the transformer E. Simultaneously, the negative voltage on the grid of tube 80 is decreased so that the pilot light becomes brighter, thus visually signaling that a signal has been tuned in. Obviously, when the pilot light is brightest, it signifies that the maximum signal is being impressed on the input circuit of tube 4.

While we have indicated and described several systems 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 organizations shown and described, but that many modifications may be made without departing from the scope of the invention as set forth in the appended claims.

What we claim is:

1. In combination with an amplifier having a signal input circuit and an output circuit, a rectifier coupled to said signal input circuit, a control tube having its grid connected to said rectifier and its cathode connected to the amplifier cathode whereby said amplifier is biased to cut-off in the absence of signals, and an additional rectifier, coupled to said signal input circuit to receive signals therefrom, including a direct current connection to a gain control electrode of said amplifier for automatically regulating the gain of the amplifier when signals impressed on the amplifier input vary from a desired level.

2. In combination with an amplifier having a signal input circuit and an output circuit, a rectifier coupled to said signal input circuit, a control tube having its grid connected to said rectifier and its cathode connected to the amplifier cathode whereby said amplifier is biased to cut-off in the absence of signals, and an additional rectifier, coupled to said signal input circuit to receive signals therefrom, including a direct current connection to a gain control electrode of said amplifier for automatically regulating the gain of the amplifier when signals impressed on the amplifier input vary from a desired level, said rectifiers being disposed within said control tube.

3. In combination with an amplifier having a signal input circuit and an output circuit, a diode rectifier coupled to said signal input circuit, a control tube having its grid connected to said rectifier and its cathode connected to the amplifier cathode whereby said amplifier is biased to cut-off in the absence of signals, and an additional diode rectifier, coupled to said signal input circuit to receive signals therefrom, including a direct current connection to a gain control electrode of said amplifier for automatically regulating the gain of the amplifier when signals impressed on the amplifier input vary from a desired level.

4. In combination with an amplifier having a signal input circuit and an output circuit, a diode rectifier coupled to said signal input circuit, a control tube having its grid connected to said rectifier and its cathode connected to the amplifier cathode whereby said amplifier is biased to cut-off in the absence of signals, and an additional diode rectifier coupled, to said signal input circuit to receive signals therefrom, including a direct current connection to a gain control electrode of said amplifier for automatically regulating the gain of the amplifier when signals impressed on the amplifier input vary from a desired level, said rectifiers being disposed within said control tube.

5. In combination with an amplifier having a signal input circuit and an output circuit, a rectifier coupled to said signal input circuit, a control tube having its grid connected to said rectifier and its cathode connected to the amplifier cathode whereby said amplifier is biased to cut-off in the absence of signals, and an additional rectifier, coupled to said signal input circuit to receive signals therefrom including a direct current connection to a gain control electrode of said amplifier for automatically regulating the gain of the amplifier when signals impressed on

the amplifier input vary from a desired level, said rectifiers being diodes and being disposed within said control tube, the cathode of the latter being common to both diodes.

6. In combination with an amplifier having a signal input circuit and a load circuit coupled to the output electrodes of the amplifier, a control network for preventing transmission of undesired electric impulses in said input circuit to said load circuit, said network comprising a diode coupled to said signal circuit to provide a rectified signal output varying directly with the signal intensity in said input circuit, an electron discharge device having a control electrode connected to the diode and output electrodes connected to the said input circuit to bias said amplifier to cut off, whereby the amplifier transmission is rendered highly inefficient, when said signal intensity decreases below a desired level.

7. In combination with an amplifier having a signal input circuit and a load circuit coupled to the output electrodes of the amplifier, a control network for preventing transmission of undesired electric impulses in said input circuit to said load circuit, said network comprising a diode coupled to said signal circuit to provide a rectified signal output varying directly with the signal intensity in said input circuit, an electron discharge device having a control electrode connected to the diode and output electrodes connected to the said input circuit to bias said amplifier to cut off, whereby the amplifier transmission is rendered highly inefficient, when said signal intensity decreases below a desired level and a volume control diode, comprising the cathode of said device and an auxiliary cold electrode, having its cold electrode connected through independent signal and direct current paths to said signal input circuit.

8. In combination with an amplifier having a signal input circuit and a load circuit coupled to the output electrodes of the amplifier, a control network for preventing transmission of undesired electric impulses in said input circuit to said load circuit, said network comprising a tube having disposed therein a diode coupled to said signal circuit to provide a rectified signal output varying directly with the signal intensity in said input circuit, an electron discharge device having a control electrode connected to the diode and output electrodes connected to the said input circuit to bias said amplifier to cut off, whereby the amplifier transmission is rendered highly inefficient, when said signal intensity decreases below a desired level.

9. In combination with an intermediate frequency amplifier having a signal input circuit and a load circuit coupled to the output electrodes of the amplifier, a control network for preventing transmission of undesired electric impulses in said input circuit to said load circuit, said network comprising a diode coupled to said signal circuit to provide a rectified signal output varying directly with the signal intensity in said input circuit, an electron discharge device having a control electrode connected to the diode and output electrodes connected to the said input circuit to bias said amplifier to cut off, whereby the amplifier transmission is rendered highly inefficient, when said signal intensity decreases below a desired level.

10. In combination with an amplifier having a signal input circuit and a load circuit including a detector coupled to the output electrodes of the amplifier, a control network for preventing transmission of undesired electric impulses in said input circuit to said load circuit, said network comprising a diode coupled to said signal circuit to provide a rectified signal output varying directly with the signal intensity in said input circuit, an electron discharge device having a control electrode connected to the diode and output electrodes connected to the said input circuit to bias said amplifier to cut off, whereby the amplifier transmission is rendered highly inefficient, when said signal intensity decreases below a desired level.

11. A receiver including at least an amplifier and a detector, a resonant signal input circuit connected to the amplifier, a similarly resonant network coupling the amplifier output electrodes to the detector input electrodes, a second amplifier having a signal electrode coupled to said amplifier input circuit, a control tube of the type provided with at least two independent diode systems and a triode system all having a common cathode, a direct current connection between the common cathode and the first amplifier input circuit, a sharply resonant circuit connected to one of said diode systems and adapted to receive amplified energy from the second amplifier, means for connecting a cold electrode of said triode to said one diode, means for connecting the cold electrode of the other diode to said second amplifier output to receive signals therefrom, and a direct current connection between said last cold electrode and the input circuit of the first amplifier.

12. A receiver including at least an amplifier and a detector, a resonant signal input circuit connected to the amplifier, a similarly resonant network coupling the amplifier output electrodes to the detector input electrodes, a second amplifier having a signal electrode coupled to said amplifier input circuit, a control tube of the type provided with at least two independent diode systems and a multi-electrode system all having a common cathode, a direct current connection between the common cathode and the first amplifier input circuit, a sharply resonant circuit connected to one of said diode systems and adapted to receive amplified energy from the second amplifier, means for connecting a cold electrode of said multi-electrode system to said one diode, means for connecting the cold electrode of the other diode to said second amplifier output to receive signals therefrom, and a direct current connection between said last cold electrode and the input circuit of the first amplifier, said common cathode being maintained at a positive potential with respect to said last cold electrode until signals impressed on the first amplifier reach a predetermined intensity level.

13. A receiver including at least an amplifier and a detector, a resonant signal input circuit connected to the amplifier, a similarly resonant network coupling the amplifier output electrodes to the detector input electrodes, a second amplifier having a signal electrode coupled to said amplifier input circuit, a coil having a natural period in the output circuit of the second amplifier, a control tube of the type provided with at least two independent diode systems and a triode system all having a common cathode, a direct current connection between the common cathode and the first amplifier input circuit, a sharply resonant circuit connected to one of said diode systems, and adapted to receive amplified energy from the second amplifier, means for connecting a cold electrode of said triode to said one diode,

means for connecting the cold electrode of the other diode to said second amplifier output to receive signals therefrom, and a direct current connection between said last cold electrode and the input circuit of the first amplifier.

14. A receiver including at least an amplifier and a detector, a resonant signal input circuit connected to the amplifier, a similarly resonant network coupling the amplifier output electrodes to the detector input electrodes, a second amplifier having a signal electrode coupled to said amplifier input circuit, a control tube of the type provided with at least two independent diode systems and a multi-electrode system all having a common cathode, a direct current connection between the common cathode and the first amplifier input circuit, a sharply resonant circuit, coupled to said coil, connected to one of said diode systems and adapted to receive amplified energy from the second amplifier, means for connecting a cold electrode of said multi-electrode system to said one diode, means for connecting the cold electrode of the other diode to said second amplifier output to receive signals therefrom, and a direct current connection between said last cold electrode and the input circuit of the first amplifier.

15. A receiver including at least an amplifier and a detector, a resonant signal input circuit connected to the amplifier, a similarly resonant network coupling the amplifier output electrodes to the detector input electrodes, a second amplifier having a signal electrode coupled to said amplifier input circuit, a control tube of the type provided with at least two independent diode systems and a multi-electrode system all having a common cathode, a direct current connection between the common cathode and the first amplifier input circuit, a sharply resonant circuit connected to one of said diode systems and adapted to receive amplified energy from the second amplifier, means for connecting a cold grid electrode of said multi-electrode system to said one diode, means for connecting the cold electrode of the other diode to the coil in said second amplifier output to receive signals therefrom, and a direct current connection between said last cold electrode and the input circuit of the first amplifier.

16. A receiver including at least an amplifier and a detector, a resonant signal input circuit connected to the amplifier, a similarly resonant network coupling the amplifier output electrodes to the detector input electrodes, means in the detector output for controlling the energy output thereof, a second amplifier having a signal electrode coupled to said amplifier input circuit, a control tube of the type provided with at least two independent diode systems and a triode system all having a common cathode, a direct current connection between the common cathode and the first amplifier input circuit, a sharply resonant circuit connected to one of said diode systems and adapted to receive amplified energy from the second amplifier, means for connecting a cold electrode of said triode to said one diode, means for connecting the cold electrode of the other diode to said second amplifier output to receive signals therefrom, and a direct current connection between said last cold electrode and the input circuit of the first amplifier.

17. A receiver including at least an amplifier and a detector, a resonant signal input circuit connected to the amplifier, a similarly resonant network coupling the amplifier output electrodes to the detector input electrodes, a second amplifier having a signal electrode coupled to said amplifier input circuit, a control tube of the type provided with at least two independent diode systems and a multi-electrode system all having a common cathode, a direct current connection between the common cathode and the first amplifier input circuit, a sharply resonant circuit connected to one of said diode systems and adapted to receive amplified energy from the second amplifier, means for connecting a cold electrode of said multi-electrode system to said one diode, means for connecting the cold electrode of the other diode to said second amplifier output to receive signals therefrom, and a direct current connection between said last cold electrode and the input circuit of the first amplifier, an amplifier preceding the first amplifier, and means to manually adjust the sensitivity of the preceding amplifier.

18. In combination with an amplifier having a signal input circuit and an output circuit, a rectifier coupled to said signal input circuit, a control tube having its grid connected to said rectifier and its cathode connected to the amplifier cathode whereby said amplifier is biased to cut-off in the absence of signals, and an additional rectifier, coupled to said signal input circuit to receive signals therefrom, including a direct current connection to a gain control electrode of said amplifier for automatically regulating the gain of the amplifier when signals impressed on the amplifier input vary from a desired level, and an additional tube, including an electrical illuminating means and an energizing source therefor in its output circuit, having its input circuit connected to the said signal input circuit whereby said source is ineffective to energize said illuminating means when said amplifier is biased to cut-off.

19. In combination with an amplifier having a signal input circuit and an output circuit, a rectifier coupled to said signal input circuit, a control tube having its grid connected to said rectifier and its cathode connected to the amplifier cathode whereby said amplifier is biased to cut-off in the absence of signals, and an additional rectifier, coupled to said signal input circuit to receive signals therefrom, including a direct current connection to a gain control electrode of said amplifier for automatically regulating the gain of the amplifier when signals impressed on the amplifier input vary from a desired level and means for selectively rendering the control tube ineffective to control said amplifier.

20. In a receiver including a radio frequency amplifier, a detector, and an audio frequency amplifier, a rectifier arranged to receive signal energy from said radio amplifier, a direct current connection from the rectifier to said radio amplifier to automatically regulate the gain thereof, a second rectifier arranged to receive signal energy from said radio amplifier, a direct current connection from the second rectifier to said radio amplifier to automatically bias the latter to cut-off when signals are not received, an electrical illumination device operatively associated with the audio amplifier anode circuit, and a direct current connection from the second rectifier to the space current path of said audio amplifier to control the intensity of illumination of said device.

21. In a super-heterodyne receiver, a radio fre-

quency amplifier, a first detector, an intermediate frequency amplifier and a second detector, an automatic volume control arrangement connected between the input circuit of the intermediate frequency amplifier and the input circuits of the radio frequency amplifier and the first detector, said volume control arrangement being constructed to vary the gain of said radio frequency amplifier to a greater extent than that of the first detector, and a manual sensitivity control means comprising means for maintaining a normal negative bias on the grids of the radio frequency amplifier and first detector, and means for varying the said normal negative bias, means, responsive to a decrease in received signal amplitude below a predetermined amplitude, for rendering the signal transmission to the second detector inefficient, a device for rendering the last means ineffective, and means for actuating the said device upon a predetermined adjustment of said bias varying means.

22. In a super-heterodyne receiver, a radio frequency amplifier, a first detector, an intermediate frequency amplifier and a second detector, an automatic volume control arrangement connected between the input circuit of the intermediate frequency amplifier and the input circuits of the radio frequency amplifier and the first detector, and a manual sensitivity control means comprising means for maintaining a normal negative bias on the grids of the radio frequency amplifier and first detector, and means for varying the said normal negative bias, a background noise suppressor arrangement connected between the input circuit of said intermediate frequency amplifier and the cathode circuit of the latter, a device for rendering the suppressor arrangement inoperative or operative at will, and a common control means for mechanically coupling said manual sensitivity control and said device.

23. In a radio receiver, a radio frequency amplifier, a succeeding detector, an electron discharge tube of the type including a cathode, control grid, a main anode, and a pair of diode anodes disposed adjacent said cathode outside the electron stream to said main anode, a signal coupling path between the input circuit of said amplifier and a tuned input circuit connected between the said cathode and one of said diode anodes, a direct current connection between said tuned input circuit and the input circuit of said amplifier, a signal coupling path between the input circuit of said amplifier and a diode rectifier circuit comprising said cathode and the other diode anode, a direct current connection between the said diode rectifier circuit and the input circuit of said amplifier, a direct current path between said main anode and the said cathode, and a connection between the said control grid and said tuned input circuit.

24. In a radio receiver, a radio frequency amplifier, a succeeding detector, an electron discharge tube of the type including a cathode, control grid, a main anode, and a pair of diode anodes disposed adjacent said cathode outside the electron stream to said main anode, a signal coupling path between the input circuit of said amplifier and a tuned input circuit connected between the said cathode and one of said diode anodes, a direct current connection between said tuned input circuit and the input circuit of said amplifier, a signal coupling path between the input circuit of said amplifier and a diode rectifier circuit comprising said cathode and the other diode anode, a direct current connection between the said diode rectifier circuit and the input circuit of said amplifier, a direct current path between said main anode and the said cathode, a connection between the said control grid and said tuned input circuit, and a signal coupling path between the anode circuit of said amplifier and said detector, the signal coupling path to the first diode anode and the detector being relatively more sharply tuned than the signal coupling path to the said diode rectifier circuit.

25. Radio receiving apparatus comprising, in combination, signal selecting means turnable to receive any signal of a desired frequency in a predetermined signal frequency range, a demodulator coupled to the selecting means, an audio amplifier following said demodulator, light indicating means connected to said amplifier for producing variations in light in accordance with the average current flowing through the amplifier, and means for automatically controlling the current flow through said amplifier in response to a variation in amplitude of a received signal.

26. Radio receiving apparatus comprising, in combination, signal selecting means tunable to receive any signal of a desired frequency in a predetermined signal frequency range, an amplifier following said means, light indicating means connected to said amplifier for producing variations in light in accordance with the average current flowing through the amplifier, means for automatically controlling the current flow through said amplifier in response to a variation in amplitude of a received signal, a detector disposed between the selecting means and the amplifier, and said amplifier being connected to amplify the audio component of the detected signal current.

27. Radio receiving apparatus comprising, in combination, signal selecting means tunable to receive any signal of a desired frequency in a predetermined signal frequency range, a demodulator coupled to the selecting means, an audio amplifier following said demodulator, light indicating means connected to said amplifier for producing variations in light in accordance with the average current flowing through the amplifier, means for automatically controlling the current flow through said amplifier in response to a variation in amplitude of a received signal and independent means for automatically regulating the amplification of a selected signal prior to impression upon said amplifier.

28. In combination, in a radio receiver, a signal amplifier, means for detecting the amplified signal, an automatic gain control circuit operatively associated with the amplifier for regulating the gain thereof in a sense to maintain the signal carrier amplitude at the detecting means substantially constant, noise suppressor means responsive to a predetermined decrease in received carrier amplitude for substantially decreasing the signal transmission through the receiver prior to said detecting means, manually adjustable means for varying the gain of the amplifier independently of the said gain control circuit, and additional means for rendering the noise suppressor means inoperative, said additional means being mechanically coupled with said manually adjustable means to function at the minimum gain adjustment point of said manually adjustable means.

29. In a high frequency signal reception system of the type comprising a demodulator, a high fre-

quency signal amplification network feeding signals to the demodulator, a demodulated signal transmission network coupled to the demodulator output, means, responsive to received signal amplitude increase, for automatically decreasing the transmission of signals to the demodulator, noise suppressor means independent of the first means for automatically decreasing the signal transmission to the demodulator upon a decrease of the received signal amplitude below a predetermined intensity level.

30. In a high frequency signal reception system of the type comprising a demodulator, a high frequency signal amplification network feeding signals to the demodulator, a demodulated signal transmission network coupled to the demodulator output, means, responsive to received signal amplitude increase, for automatically decreasing the transmission of signals to the demodulator, noise suppressor means independent of the first means for automatically decreasing the signal transmission to the demodulator upon a decrease of the received signal amplitude below a predetermined intensity level, a manually adjustable device for regulating the signal transmission efficiency of the amplification network, a manually adjustable device for controlling the demodulated signal transmission efficiency.

31. In a high frequency signal reception system of the type comprising a demodulator, a high frequency signal amplification network feeding signals to the demodulator, a demodulated signal transmission network coupled to the demodulator output, means, responsive to received signal amplitude increase, for automatically decreasing the transmission of signals to the demodulator, noise suppressor means independent of the first means for automatically decreasing the signal transmission to the demodulator upon a decrease of the received signal amplitude below a predetermined intensity level, a manually adjustable device for regulating the signal transmission efficiency of the amplification network, a manually adjustable device for controlling the demodulated signal transmission efficiency, and means for rendering the noise suppressor means ineffective.

32. In a high frequency signal reception system of the type comprising a demodulator, a high frequency signal amplification network feeding signals to the demodulator, a demodulated signal transmission network coupled to the demodulator output, means, responsive to received signal amplitude increase, for automatically decreasing the transmission of signals to the demodulator, noise suppressor means independent of the first means for automatically decreasing the signal transmission to the demodulator upon a decrease of the received signal amplitude below a predetermined intensity level, and said suppressor means having a sharper signal selectivity characteristic than said first means.

33. In a high frequency signal reception system of the type comprising a demodulator, a high frequency signal amplification network feeding signals to the demodulator, a demodulated signal transmission network coupled to the demodulator output, means, responsive to received signal amplitude increase, for automatically decreasing the transmission of signals to the demodulator, noise suppressor means independent of the first means for automatically decreasing the signal transmission to the demodulator upon a decrease of the received signal amplitude below a predetermined intensity level, said amplification network including at least one amplifier tube, and said suppressor means including a direct current connection to a gain control electrode of the tube.

34. In a high frequency signal reception system of the type comprising a demodulator, a high frequency signal amplification network feeding signals to the demodulator, a demodulated signal transmission network coupled to the demodulator output, means, responsive to received signal amplitude increase, for automatically decreasing the transmission of signals to the demodulator, noise suppressor means independent of the first means for automatically decreasing the signal transmission to the demodulator upon a decrease of the received signal amplitude below a predetermined intensity level, a light emitting device electrically associated with the demodulated signal network, and means responsive to said signal amplitude decrease for decreasing the light emitted by the device.

35. In a high frequency signal receiver of the type comprising a detector, a tunable high frequency amplifier preceding the detector and feeding it, an audio amplifier fed by the detector, a tuning indicator light emission device operatively associated with the audio amplifier space current path, a source of alternating current coupled to the said space current path to energize the light device, and means, responsive to amplitude variations at the high frequency amplifier, for controlling the light emitted by the device.

WENDELL L. CARLSON.
LOREN R. KIRKWOOD.