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HIGH FIDELITY RECEIVING SYSTEM

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FIG. 1.

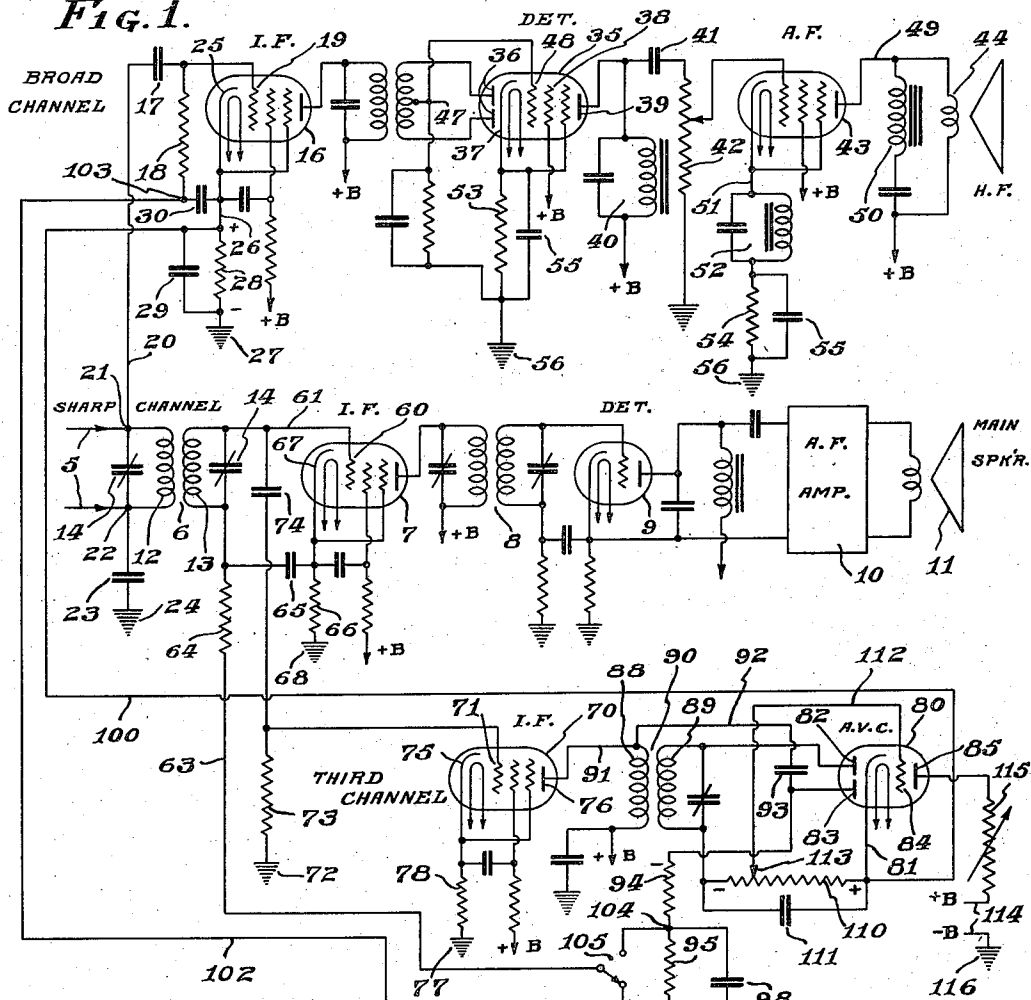
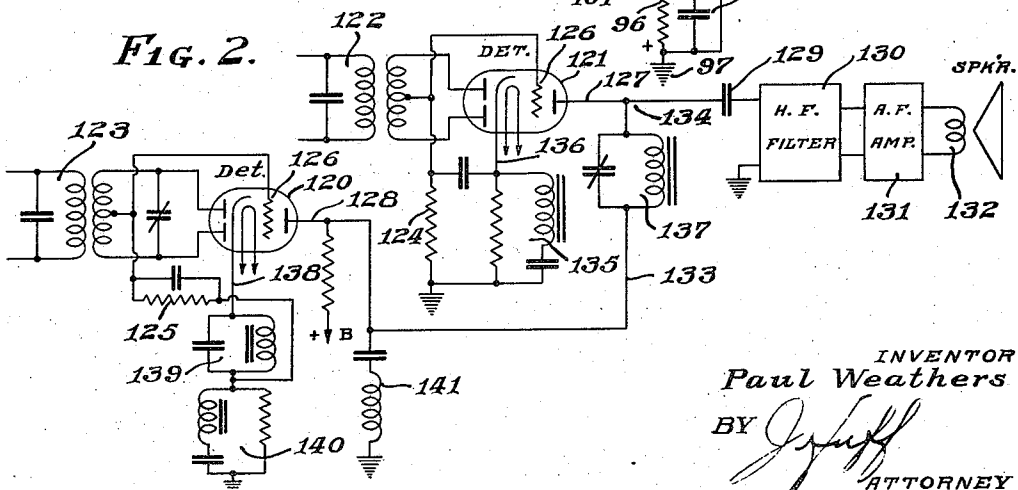


FIG. 2.



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HIGH FIDELITY RECEIVING SYSTEM

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18 Claims. (Cl. 250—20)

The present invention relates to high fidelity radio receiving systems, and has for its object to provide an improved receiving system of that character. It is also an object of the invention to provide an improved control circuit for noise suppression and automatic volume control which operates to improve the fidelity of the sound output from said receiving system when operating in response to strong carrier waves.

It is a further object of the present invention to provide a superheterodyne receiver having a plurality of intermediate frequency amplifier circuits or amplifying channels, each of which functions to provide a certain operating characteristic, resulting in an over-all improved audio frequency output characteristic or higher fidelity sound output.

It is also a further object of the present invention to provide a high fidelity superheterodyne receiving system having three intermediate frequency amplifier channels, all of which conduct the modulated carrier wave and one of which is utilized for control purposes, such as automatic volume, noise suppression and fidelity control.

It may also be considered to be an object of the present invention to provide a superheterodyne receiver, wherein the functions of receiving strong modulated carrier waves, the reception of modulated carrier waves of normal strength, and the control of the system are provided in separate amplifying channels associated with the intermediate frequency amplifier.

The invention will be better understood from the following description when considered in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the drawing:

Figure 1 is a schematic circuit diagram of an intermediate frequency amplifier in a receiving system embodying the invention, and

Figure 2 is a similar schematic circuit diagram of a portion of the circuit shown in Fig. 1, showing a modification thereof.

Referring to Figure 1, a radio receiving system is shown, wherein the circuit leads 5 represent an intermediate frequency carrier wave channel or circuit of the system, the preceding tuning, amplifying and detecting portions being omitted to simplify the drawing. The intermediate frequency circuit 5, which may be connected with a first detector (not shown), is coupled through a tuned intermediate frequency input transformer 6 with an intermediate frequency amplifier tube 7, in turn coupled through a second intermediate frequency coupling transformer 8 with a second

detector 9 and an audio frequency amplifier 10 which supplies the loud speaker device 11. The amplifying channel described, forms the main amplifying channel of the receiving system and represents any suitable sharply tuned intermediate frequency amplifier for a superheterodyne receiver.

The intermediate frequency input transformer 6 comprises a primary winding 12 and a secondary winding 13, each tuned by a capacitor 14 to a predetermined intermediate frequency, and the transformer 8 is similarly tuned to provide a comparatively sharply tuned amplifying channel responsive to a predetermined intermediate frequency.

The primary circuit, comprising the winding 12 and the capacitor 14, is coupled to a second intermediate frequency signal amplifying channel comprising a first stage amplifier tube 16. The coupling connection is provided through a coupling capacitor 17, and a coupling resistor 18 in circuit with the control grid indicated at 19. The connection to the coupling capacitor is made through a lead 20 with a terminal 21 on the tuned input or primary circuit, and the opposite terminal of the circuit, indicated at 22, is connected through a capacitor 23 to ground or chassis 24.

The cathode of the amplifier device 16 is indicated at 25 and is connected through a cathode lead 26 to ground or chassis 27. A series, voltage-drop producing resistor 28 provided with a bypass capacitor 29 at intermediate frequencies is connected in series with the cathode lead. The cathode end of the resistor 18 is likewise bypassed to the cathode lead 26 through a by-pass capacitor 30.

The remainder of the second signal amplifying channel of which the tube 16 is the first amplifier device, comprises a detector tube 35 of the diode rectifier type, having a pair of diode anodes 36 associated with a cathode 37 in conjunction with amplifier electrodes 38. The output anode 39 is connected with a tuned circuit 40 and a coupling capacitor 41 to provide coupling with an audio frequency volume control potentiometer 42. The volume control device is followed in circuit by an audio frequency amplifier tube 43, coupled to a loud speaker device 44.

In the amplifying channel the various coupling circuits are provided with filter means for improving the audio frequency amplifying characteristic of the channel, such as in the output circuit of the amplifying portion of the detector 35 a tuned circuit 40 is provided as a coupling

impedance. This is preferably tuned to respond broadly to a frequency in the upper portion of the audio frequency range, for example, seven kilocycles. A similar seven-kilocycle tuned circuit is provided in the output circuit 49 of the output amplifier 43, as indicated at 50.

The cathode circuit of the amplifier device 43, indicated at 51, is likewise provided with a series tuned circuit 52, sharply responsive to the upper limit of the audio frequency range, such as ten kilocycles, to operate degeneratively in the anode circuit, thereby to reduce the audio frequency response sharply at approximately ten kilocycles.

Each of the devices 35 and 43 is provided with suitable sources of bias potential, comprising, in the present example, self-bias resistors 53 and 54, provided with by-pass capacitors 55 in connection with the chassis or ground 56.

The sharp amplifying channel first stage amplifier 7 is provided with a control grid 60, which is connected through an input lead 61 and the secondary 13, with a bias potential supply lead 63, in which is provided a filter comprising a series resistor 64 and by-pass capacitor 65. The amplifier is also provided with a suitable self-bias resistor 66, providing a connection between the cathode, indicated at 67, and ground 68.

A third amplifying channel, comprises a first stage intermediate frequency amplifier device 30 having a control grid 71 connected to ground 72 through a grid resistor 73, and coupled to the high side 61 of the tuned input circuit for the tube 7, through a coupling capacitor 74 between the resistor 73 and the lead 61. The amplifier device 70 is provided with a cathode 75, and an output anode 76, and is preferably of the high gain type as indicated. In the present example, like the other amplifier tubes it is represented as a pentode amplifier device.

The cathode 75 is connected to ground 77 through a self-bias resistor 78. The amplifier device 70 is followed in circuit in the amplifying channel by a control tube 80 having a plurality of functions, and in the present example including a cathode 81, a pair of anode electrodes 82 and 83 associated therewith as diode rectifier anodes, a control grid 84, and a main output anode 85, whereby the tube comprises a suitable amplifier and a double diode rectifier.

The device 80 functions as a combined diode-signal biased amplifier and as an automatic volume control rectifier, and is coupled to the preceding intermediate frequency amplifier device 70 through the primary winding 88 and the secondary winding 89 of an intermediate frequency coupling transformer 90. The primary winding is located in the output anode circuit 91 of the amplifier device 70 and is coupled at its anode end through a lead 92 and a coupling capacitor 93 with the diode anode 83 which operates as a shunt connected automatic volume control diode in conjunction with the cathode 81. The diode output resistor for the diode-anode 83 is indicated at 94, 95 and 96 comprising three resistor sections in series between the diode anode 83 and ground indicated at 97. The sections 95 and 96 are provided with suitable by-pass capacitors 98.

From the ground 97, the diode output circuit is completed through the ground 27, the cathode resistor 28 of the first stage amplifier 16 in the broad channel, and a connecting return lead 100 to the cathode 81 whereby the cathode resistor 28 is included in the output circuit. The resulting automatic volume control potential derived from the resistors 94, 95 and 96 is taken from a tap

point 101 between the resistor sections 95 and 96 through a lead 102 to the bias supply terminal end 103 of the grid resistor 18 whereby the biasing potentials from the automatic volume control diode 83 are applied to the control grid 19.

Since the diode 83 is coupled directly to the primary winding 88 which is tuned more broadly than the secondary, the automatic volume control response is broader than that of the main amplifying channel and serves to reduce the response in the broad channel in the presence of received adjacent channel signals. Automatic volume control potentials are also applied to the first stage amplifier 7 of the sharp channel through the bias supply lead 63 which is connected with the tap point 101. It may also selectively be connected with a higher negative voltage tap point 104 through a suitable selector switch 105, as indicated.

The normal anode current flow through the resistor 28 of the first amplifier stage 16 of the broad channel is sufficiently large with respect to the rectified signal current from the diode 83, that the main control potential is derived from the resistor section 96 for controlling the grid 19 of the intermediate frequency amplifier 16 after the broad channel is placed in operation.

It will be seen that in connection with the first stage amplifier 7 of the sharp channel, the automatic volume control potential derived from the resistor section 96 is applied to the grid 60 in addition to the biasing potential derived from the resistor 66, automatically to reduce the gain through the channel in response to strong signals, and that the automatic volume control potential may be made relatively strong and effective because of the separate high gain amplifying channel provided.

Within certain limits of signal strength, the gain of the broad channel and of the sharp channel is controlled by the automatic volume control means, in such manner that the gain varies inversely with the carrier wave strength. This is particularly true for the relatively strong carrier waves which would cause overloading of the receiving system and distortion in the output system.

For normal carrier wave amplitudes, however, the automatic volume control means, comprising the diode rectifier 83, operates to reduce the gain as the carrier wave strength increases, thereby reducing the signal output through the sharp channel. For relatively weak signals or low carrier wave strength, the broad channel is cut off or prevented from operating to transmit signals to the output device, thus eliminating noises and interference when receiving weak signals.

The means provided for suppressing the broad signal comprises the second diode anode 82 which is connected across the tuned circuit comprising the secondary 89, and is provided with a diode output resistor 110 across which is connected an intermediate frequency by-pass capacitor 111. The diode circuit 89 for the diode 82 is, therefore, much more sharply responsive than the automatic volume control circuit which is connected with the primary 88.

The direct current biasing potentials derived from received signals and appearing in the diode output resistor 110, are applied to the control grid 84 through a lead 112 having a movable contact 113 in connection with the resistor 110. The grid 84 is, therefore, diode signal-biased and, in response to increasing signal strength or carrier wave strength, receives an increasing negative

biasing potential with respect to the cathode 81, and causes the anode current through the anode 85 to be reduced.

The anode current is derived from a potential supply source indicated by the leads 114 having polarities as indicated, and is supplied to the anode 85 through a series variable resistor 115. The anode circuit is completed through ground connection 116 and ground connection 27, resistor 28, and lead 100, thereby returning to the cathode 81.

It will be seen that the anode current from the device 80 is caused to flow through the cathode resistor 28 in the amplifier 16 for the broad channel, and the current flow is in such direction that the potential across the resistor 28 has a polarity as indicated, conforming to the flow of anode current in the device 16.

The grid 19 of the intermediate frequency amplifier device 16 in the broad channel, receives the biasing potential set up in the resistor 28, through the ground connection 27, thence to the resistor 96, through the lead 102, and the grid resistor 18.

It will be seen that, in response to increase in the signal strength which causes a reduction in the anode potential through the anode 85, the potential drop through the resistor 28 is reduced, thereby reducing the negative biasing potential on the grid 19 and, at a predetermined point determined by the biasing potential, permitting the broad channel to operate to receive signals to be amplified.

As the carrier wave amplitude further increases, the gain of the broad channel amplifier will thus further increase and, up to a certain point where the automatic volume control potential from the anode 83 becomes effective, the gain of the high frequency or broad channel varies directly with the carrier wave strength.

By varying the resistor 115 in relation to the resistor 28, the voltage drop in the anode circuit may be proportioned to permit the broad channel to function at any predetermined, desired signal strength.

The adjustment of potentiometer 113 toward positive end causes less rectified signal voltage to reach grid 84 which increases the plate current of tube 80 for a given intermediate frequency voltage which, in turn, reduces the gain of pentode 16 by virtue of the increased current through cathode resistor 28. Thus the adjustment of 113 determines the IF voltage at which pentode 16 and the broad or high frequency channel becomes operative.

The plate resistor 115 may be varied from zero resistance which confines all of the external voltage drop due to the plate current of tube 80 to the cathode resistor 28, to some high value of resistance which causes more of the external voltage drop to occur in resistor 115. Thus the approach to the operating condition of pentode 16 may be made gradual or abrupt by suitable adjustment of resistor 115.

If it is desired to utilize a single audio frequency channel for receiving the output of the two signal amplifying channels, the same may be arranged as shown in Fig. 2, to which attention is now directed.

Referring to Fig. 2, only the second detectors, 120 for the sharp channel, and 121 for the broad channel, are shown in the system. Each detector receives intermediate frequency signals through an input circuit.

In connection with the detector 121, an input

circuit 122 is shown, and in connection with the detector 120 an input circuit 123 is provided. The circuit 122 and the broad amplifying channel which it represents, are adapted to pass signals having an audio frequency fidelity up to 8000 cycles, and the sharp channel, represented by the circuit 123, is adapted to pass signals having an audio frequency fidelity up to 4500 cycles.

The sharp channel is, therefore, used for receiving signals from weak or distant signal sources, while the channel 122 responds to local or strong signals for higher fidelity operation under control of a suitable third channel, in the manner and as described in connection with Fig. 1. As this does not concern the mixing system shown in Fig. 2, and is fully described in connection with Fig. 1, the drawing has been simplified by the omission of the control system.

The detectors 120 and 121 may be of any suitable type, and in the present example are in the form of diode rectifiers of the double diode, full wave type, the diode output resistors being indicated at 124 and 125 for the detectors 121 and 120, respectively, and coupled to control grids 126 for the amplifying portions of the detectors for applying to the output circuits 127 and 128 the audio frequency signals rectified in the detectors.

The output lead 127 for the broad channel is coupled through a coupling capacitor 129 with a high frequency filter 130, which is adapted to remove any ten kilocycle beat note, and the filter is followed by a suitable audio frequency amplifier 131 and loudspeaker device 132. In the absence of a strong carrier wave sufficient to put into operation the broad channel 122, the sharp channel 123 is adapted to deliver audio frequency signals, through the output circuit 128, to an output lead 133 which is connected with the lead 127, whereby both channels may jointly operate to supply audio frequency signals thereto, at the junction point indicated at 134.

For the purpose of causing the amplifier channels to accentuate or compensate certain portions of the audio frequency range, suitable filters are included in the detector output circuits, which may be described as follows:

In the broad channel 122, following the detector, a 7500 cycle filter 135 is included in the cathode lead 136 of the detector 121, and serves to accentuate the audio frequency range in the high frequency end thereof, to compensate for wide band cutting in the tuning system. Likewise, in the output circuit and connected in the lead 133, is a similar filter 137 which is broadly responsive to 7500 cycles, to further accentuate the high frequency end of the audio frequency range, while the upper limit thereof is sharply cut off by the high frequency filter 130. By this arrangement, the broad channel 122 provides high audio frequency fidelity and a desirable high frequency response up to the limit permissible because of inter-channel interference.

In the main amplifier channel, or sharp channel 123, the cathode lead of the detector 120 is indicated at 138 and includes a pair of tuned filters 139 and 140, which are tuned, respectively, to 10 kilocycles and 4500 cycles, the former to cut off the 10 kilocycle response and the latter to compensate for side band cutting in the receiver circuits at 4500 cycles for the sharp channel.

The output lead 128 is also provided with a ten kilocycle filter 141, which serves to reduce the 10 kilocycle interference beat notes when operating on distant or weak signal sources, and it will be noted in this connection that the filter

137 is also in series with the lead 133 from the sharp channel and interposed between the sharp channel detector and the audio frequency output circuit 127, whereby audio frequency signals in the range of the filter 137, for example about 7500 cycles, are attenuated.

When the broad channel is in operation, however, the filter 137 is a shunt filter for the broad channel and serves to pass audio frequency signals in the 7500 cycle range.

It is advantageous to reduce the high audio frequency response simultaneously with the side band cutting of the radio frequency circuits to accomplish quiet operation on weak signals.

Proper selection of constants for filters 139, 140, 141, 135 and 137 results in a smooth transfer from limited high frequency response to extended high frequency response.

I claim:

1. A radio receiving system comprising in combination, a main signal amplifying channel and two additional signal amplifying channels, one only of said additional amplifying channels including means providing variable gain control potentials for the other amplifying channels in response to variations in carrier wave amplitude, certain of said amplifying channels including means whereby the frequency response characteristic of said channels are altered.

2. A superheterodyne radio receiving system having an intermediate frequency amplifier comprising a main signal amplifying channel and two additional signal amplifying channels, one only of said additional signal amplifying channels including means providing variable gain control potentials for the other amplifying channels in response to variations in carrier wave amplitude, and means in the other of said additional signal amplifying channels and the main signal amplifying channel for imparting thereto differing frequency response characteristics.

3. A radio receiving system in accordance with claim 1, further characterized by the fact that means are provided in connection with the variable gain control potential supply channel and in connection with the other amplifying channels, whereby the gain of one of the additional amplifying channels varies within predetermined limits directly with variations in the strength of a received carrier wave and the gain of the main signal amplifying channel varies inversely with the strength of said received carrier wave.

4. A radio receiving system comprising in combination, a main signal amplifying channel and two additional signal amplifying channels, one of said additional amplifying channels including means providing variable gain control potentials for the other amplifying channels in response to variations in carrier wave amplitude, and one of said last named amplifying channels including means for passing modulation frequencies in a wider frequency range than the main signal amplifying channel, and means for applying said control potentials to said wider frequency range and main amplifying channels to control the gain therethrough in opposite sense.

5. A superheterodyne receiving system, as defined by claim 4, further characterized in that it includes means providing a common audio frequency amplifier, an output circuit for the broadly and sharply responsive amplifying channels, and a high frequency filter connected with said audio frequency output circuits whereby it is in series with the sharply responsive signal channel to attenuate high frequency signals therefrom

and is in shunt relation to the broadly responsive signal amplifying channel whereby it operates to accentuate the high frequency response therefrom.

6. A superheterodyne radio receiving system comprising in combination, means providing intermediate frequency signals in response to a received modulated carrier wave, intermediate frequency amplifier means broadly responsive to said signals, intermediate frequency amplifier means more sharply responsive to said signals, a third intermediate frequency amplifier means for said signals, and means providing gain controlling potentials for said first and second named amplifier means connected with said third amplifier to receive amplified signals therefrom.

7. A superheterodyne radio receiving system in accordance with claim 6, further characterized by the fact that the broadly responsive amplifying means includes an electric discharge amplifying device having a control grid and a cathode, a biasing resistor in circuit between the control grid and the cathode, and that the gain controlling potential supply means includes an amplifier device responsive to carrier wave amplitude having an output anode circuit including a control resistor and said biasing resistor, thereby to vary the gain in the broadly responsive amplifying means directly in accordance with carrier wave strength.

8. In a superheterodyne receiving system, the combination of an intermediate frequency amplifier providing three signal amplifying channels connected in parallel relation to each other, common means for supplying intermediate frequency signals to said amplifying channels, means in two of said amplifying channels for varying the gain of said channels in response to variations in control potentials applied thereto, means connected with a third channel for deriving said control potentials from signals amplified therein, and means for applying said control potentials to said two amplifying channels in opposite sense whereby the gain in one channel varies directly with signal strength and the gain in the other channel varies inversely with signal strength.

9. In a superheterodyne receiver, the combination of means providing a plurality of intermediate frequency signal amplifying channels, sound output means connected with each of said channels, means for imparting to one of said channels a higher degree of audio frequency fidelity than another of said channels, and control means connected with a third of said amplifying channels for controlling the first and second named channels to provide an over-all uniform audio frequency output characteristic for high fidelity operation in response to carrier waves having a predetermined high amplitude.

10. A high fidelity superheterodyne receiver having three intermediate frequency amplifier channels, means in each of said channels for amplifying a modulated intermediate frequency carrier wave, demodulating means for said signals in connection with two of said amplifying channels, and means in connection with the third of said amplifying channels only for deriving from an amplified carrier wave gain control potentials for the first and second named amplifying channels.

11. A high fidelity superheterodyne receiver having three intermediate frequency amplifier channels, means in each of said channels for amplifying a modulated intermediate frequency carrier wave, demodulating means for said sig-

nals in connection with two of said amplifying channels, means in connection with the third of said amplifying channels for deriving from an amplified carrier wave, gain control potentials for the first and second named amplifying channels, and means for applying said control potentials to said demodulator channels in a sense to cause the gain in one channel to vary directly with carrier wave strength and to cause the gain in the other channel to vary inversely with carrier wave strength.

12. In a radio receiving system, means providing a plurality of modulated carrier wave amplifying channels, means in one of said amplifying channels providing a high degree of fidelity in response to a received modulated carrier wave, means in another of said channels providing a lesser degree of fidelity in response to said carrier wave, means in a third channel providing automatic volume and suppressor control potentials in response to said carrier wave, means for applying said automatic volume control potentials to the second named amplifying channel, means for applying said suppressor potentials to the first named amplifying channel, and means for adjusting the operation of said potential supply means whereby the first named amplifying channel operates in response to received signals having a predetermined high amplitude.

13. A superheterodyne radio receiving system comprising, in combination, an intermediate frequency amplifier providing three signal amplifying channels in parallel relation to each other, demodulator means terminating each of said amplifying channels, an audio frequency amplifier for demodulated signals connected with two of said channels for receiving the audio frequency output therefrom, said channels having differing frequency response characteristics, an amplifier tube connected with the demodulator of a third channel for receiving a biasing potential therefrom, said last named demodulator including a diode signal rectifier and an output resistor for said rectifier, means providing a variable bias potential supply connection for said control grid with said resistor, means connected with said third channel for deriving a controlling potential responsive to variations in the strength of received carrier waves for one of said signal amplifying channels, an electric discharge amplifier device in another of said signal amplifying channels having a cathode, a resistor in series with said cathode, and means for causing anode current from said first named amplifier device to flow through said cathode resistor, thereby to provide a suppressor control potential for the channel in which said electric discharge amplifier is connected.

14. A superheterodyne radio receiving system as defined in claim 13, further including means for causing the gain in the amplifying channel in which said last named electric discharge amplifier device is connected to vary directly with variations in carrier wave strength and the gain of said one of said amplifying channels to vary inversely with variations in carrier wave strength.

15. A superheterodyne radio receiving system comprising in combination, an intermediate frequency amplifier providing three signal amplifying channels in parallel relation to each other, means connected with one of said channels for controlling the gain in the other two channels, demodulating means terminating said other two

amplifying channels, an audio frequency amplifier for demodulated signals connected with each of said last named channels for receiving the audio frequency output therefrom, high frequency filter means connected in series between one of said demodulators and the audio frequency amplifier for attenuating high frequency signals from said one of said demodulators, and said filter being connected in parallel relation to output circuit of the other of said demodulators in connection with said audio frequency amplifier, to accentuate the high frequency response of signals from said other demodulator.

16. A superheterodyne receiving system including in combination, means providing an intermediate frequency amplifying channel having a relatively broad frequency response characteristic, means providing a second intermediate frequency amplifying channel having a relatively sharp frequency response characteristic for passing audio frequency signals in a frequency range substantially lower than the frequency range of the first named channel, means providing a third intermediate frequency amplifying channel, broadly responsive automatic volume control means in said last named channel connected with the second amplifying channel to provide a controlling potential therefor whereby the gain varies inversely with variations in carrier wave strength, and more sharply responsive means providing in connection with said third channel a diode signal-biased amplifier having an anode output circuit including a bias control resistor in the first named amplifying channel for varying the gain thereof directly with variations in carrier wave strength.

17. A superheterodyne receiving system including in combination, means providing an intermediate frequency amplifying channel having a relatively broad frequency response characteristic, means therein for effecting an audio frequency response throughout a frequency range uniformly below substantially ten kilocycles, means providing a second intermediate frequency amplifying channel having a relatively sharp frequency response characteristic for passing audio frequency signals in a frequency range substantially lower than the frequency range of the first named channel, means providing a third intermediate frequency amplifying channel, broadly responsive automatic volume control means in said last named channel connected with the second amplifying channel to provide a controlling potential therefor whereby the gain varies inversely with variations in carrier wave strength, means providing in connection with said third channel a diode signal biased amplifier having an anode output circuit including a bias control resistor in the first named amplifying channel, and sharply tuned transformer means having a tuned secondary for applying signals to said diode-biased amplifier to control the anode current thereof, thereby to vary the gain of the first named amplifying channel directly with carrier wave strength.

18. A superheterodyne receiving system including in combination, means providing an intermediate frequency amplifying channel having a relatively broad frequency response characteristic, means providing a second intermediate frequency amplifying channel having a relatively sharp frequency response characteristic for passing audio frequency signals in a frequency range substantially lower than the frequency range of the first named channel, means providing a third intermediate frequency amplifying channel,

automatic volume control means in said last named channel connected with the second amplifying channel to provide a controlling potential therefor whereby the gain varies inversely with variations in carrier wave strength, means providing in connection with said third channel a diode signal-biased amplifier having an anode output circuit including a bias control resistor in the first named amplifying channel

for varying the gain thereof directly with variations in carrier wave strength, means for varying the diode bias potential on said amplifier; and means including a second resistor in said anode circuit for proportioning the potential drop in said bias control resistor with respect to the potential drop through said anode circuit.

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