

May 3, 1938.

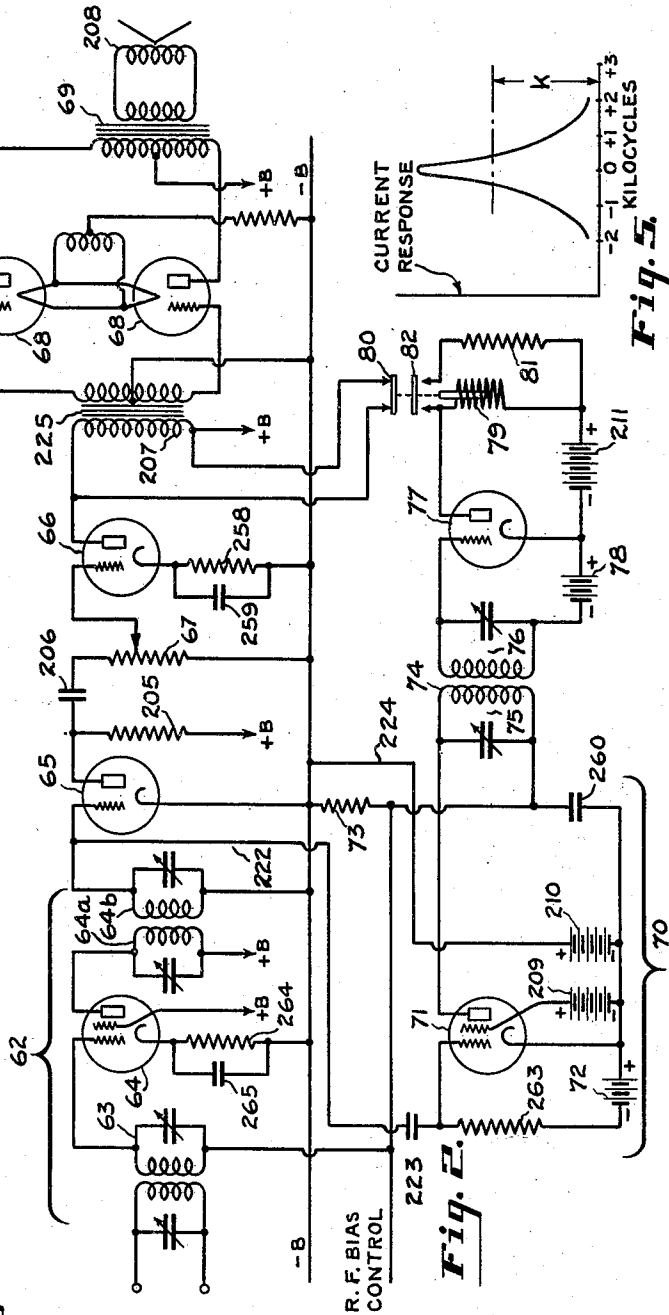
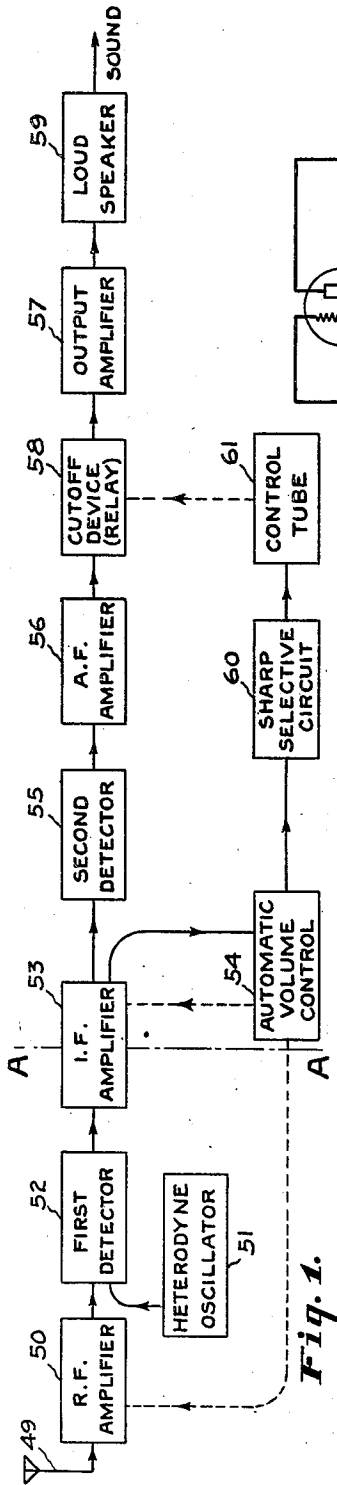
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2,115,813

METHOD AND APPARATUS FOR CONTROLLING RADIO RECEIVERS

Original Filed Feb. 13, 1932

4 Sheets-Sheet 1



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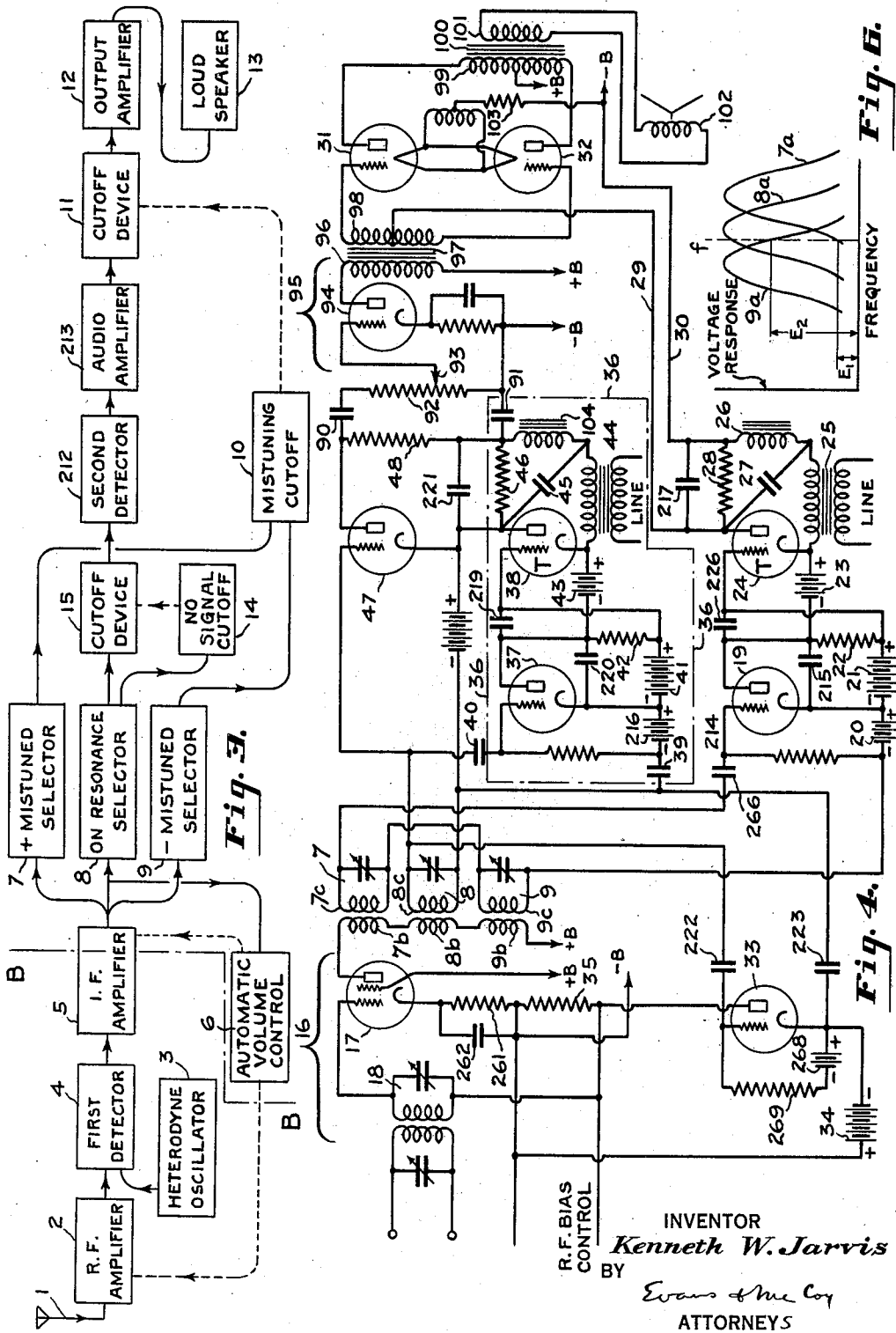
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4 Sheets-Sheet 3

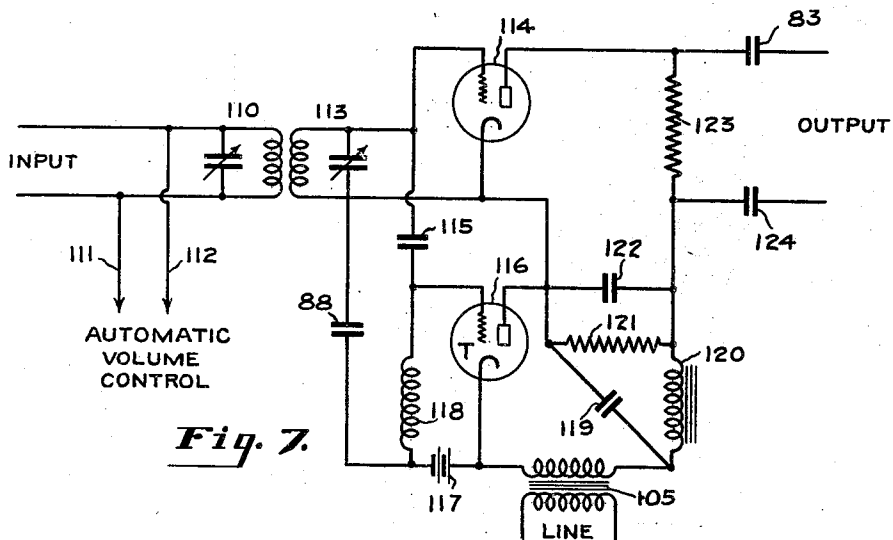


Fig. 7.

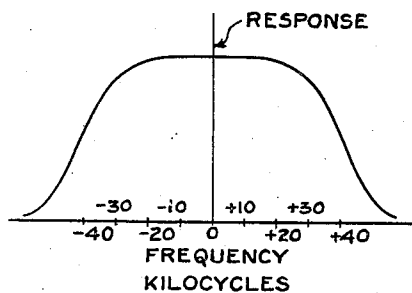


Fig. 8.

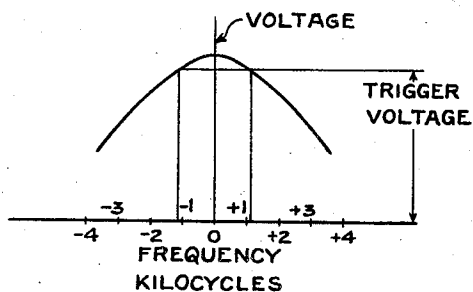


Fig. 9.

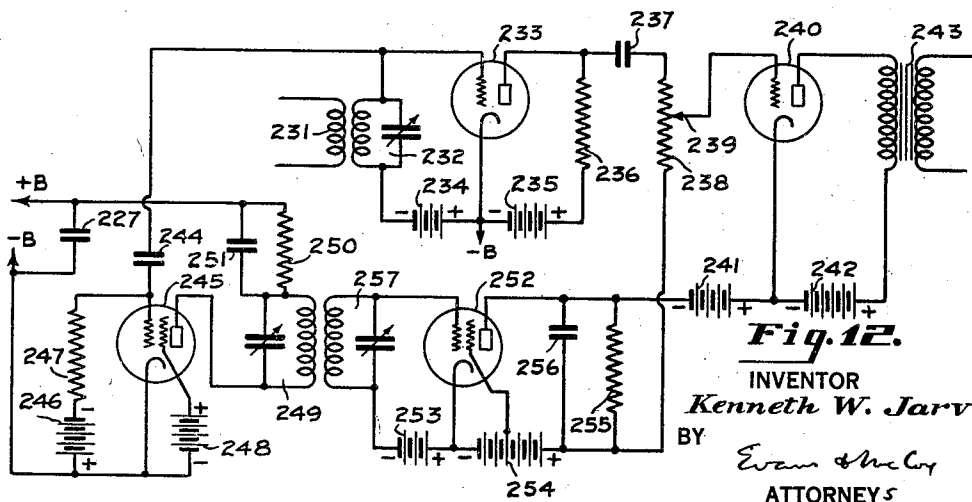


Fig. 12.

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4 Sheets-Sheet 4

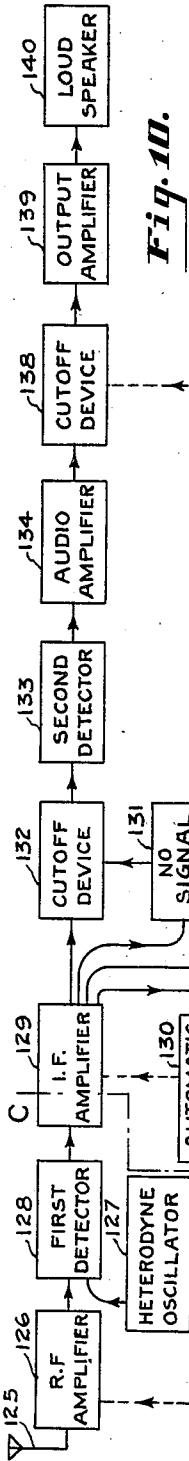


Fig. 10.

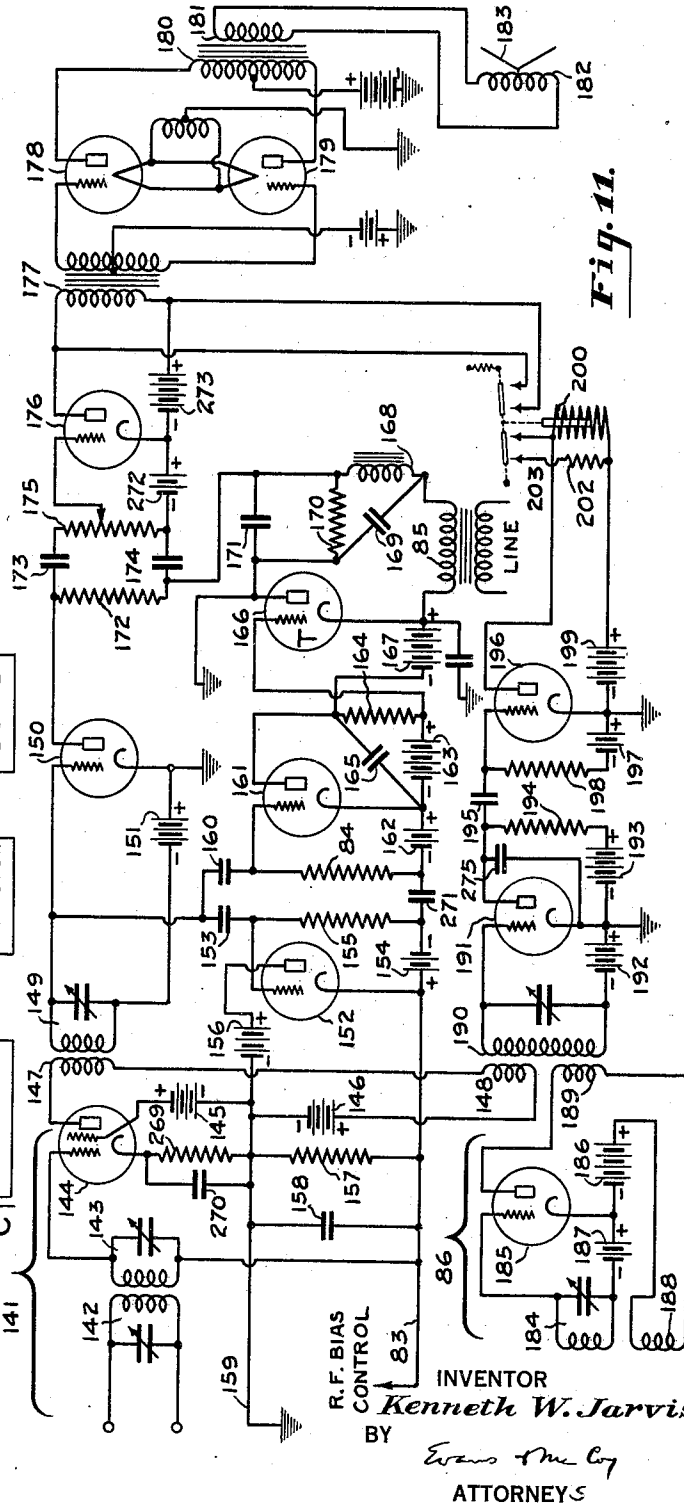


Fig. 11.

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METHOD AND APPARATUS FOR CONTROLLING RADIO RECEIVERS

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Renewed January 21, 1938

31 Claims. (Cl. 250—20)

This invention is concerned with radio or allied arts and particularly wherever it is desired to choose at will and more exactly any one of a number of energy carriers. Still more specifically it deals with a new method of control in such choosing, means for accomplishing the said control, and means for applying said control units to the various elements of the system to obtain the desired characteristics.

An object is the adding of supplementary control mechanisms of independent selective character to the ordinary selective networks.

Another object is the provision of independent control means sensitive to the frequency of the incoming signal acting at a point in the receiver as regards signal transmission subsequent to the point of actuation of the control means.

A further object is the provision of additional methods of control in which the change in the operation of the receiver is made relatively abrupt at a predetermined small change of resonance frequency on either side of the point of exact tuning for the desired energy carrier, these points being so close to this point that reception is possible with a given energy carrier only in a narrow range of tuning on either side of the exact point of tuning for the energy carrier.

Another object is the use of means whereby the frequency response characteristics of a receiver when tuned to the energy carrier, are substantially those of the normal frequency selecting circuits, but as the point of tuning of the receiver is shifted from the resonance position for the carrier the change in response is much greater than that which the characteristics of the normal frequency selecting circuits would of themselves accomplish.

Another object is a provision of methods and of means whereby the receiver cannot be detuned very far from the carrier without the audio response falling below audibility.

Another object is the provision of methods and means whereby there is a large amount of no response tuning space between adjacent signals with the consequent removal of the possibility of reception of two stations, static noises, et cetera.

It has been the practice hitherto to achieve selection of a given energy carrier by the use of resonant or selective circuits. If a signal is impressed on such a resonant circuit at the natural frequency of the resonant circuit, the response within the circuit will be a maximum, falling away on either side as the resonance frequency of the receiver is tuned away from the frequency of the signal.

By proper provision of resonant circuits we can within reason make this response as sharp as we like. It is to be remembered, however, that the modulated energy carriers which constitute the incoming signal can be analyzed into the carrier frequency, plus a band of frequencies differing from the carrier frequency plus and minus by the highest modulation frequency which is being transmitted. In order to secure faithful reproduction of the band frequencies in the proportion in which they exist in the incoming signal the selective characteristics of the circuit must be made relatively broad. On the other hand, if this is done the circuit fails in selectivity to the extent that signals on adjacent carrier frequencies to the one desired are received to a greater or less extent. It is accordingly desirable to use a selective circuit which is sharper than is desirable for the greatest faithfulness of reproduction of the modulated frequencies and to compensate for the impaired reception of the side band frequencies and consequent discrimination in reception against the higher audio frequencies by selective audio circuits which tend to restore the higher audio frequencies to their original relative amount. If, however, this device is used very exactly on the carrier wave which it is desired to receive. Another complication in achieving faithful reproduction is present when automatic volume control is employed. In this case the signal response to the operator remains relatively constant in volume over a considerable tuning interval and he has no means unless a visual meter is used other than his judgment of tone quality to indicate to him the point of tuning for the best response as regards quality of reproduction; that is, with receivers constructed according to the most advanced present practice as regards faithfulness of reproduction and constancy of operation, it is necessary in tuning to pass through considerable intervals between the points of exact tuning where the quality of reception is very bad and this is appreciated by the operator as a serious objection in the operation of the receiver. He also objects to the fact that between stations the sensitivity of such a receiver is maintained at a maximum. Consequently, static and noise are received at the maximum intensity at these points. The present invention obviates these disadvantages of the most advanced present day receivers by rendering the receiver inoperative by other means than through the ordinary selective networks, except in a narrow frequency band immediately adjacent to the point of exact

tuning for the desired frequency, this band being preferably not more than one or two kilocycles wide. Throughout this band the normal characteristics of the ordinary selective circuits operate and the reception accordingly remains excellent throughout the band. At either side of it, however, there is a very sharp or entirely abrupt cut-off so that in the tuning interval where the quality of reception would ordinarily be poor the receiver is wholly inoperative. This method of operation can be secured in various ways. Five such ways of applying the principle of this invention are described as illustrative ways of carrying out the general method, one based on balanced mistuned additional selective circuits and the voltage response therein to the incoming signal, the second based on the voltage response thereto in an additional extremely selective circuit, not forming a portion of the regular selective circuits, and the third consisting of the use of a local oscillator tuned to the intermediate frequency developing beat frequencies in a control detector tube which beat frequencies when present actuate the cut-off device.

The fourth method uses the voltage response in a normal selective or resonant circuit to control the operation of a mechanism having relatively abrupt cut-off characteristics.

The fifth method differs from the other four in affording a less abrupt independent control of the output of the receiver but uses the same general principle.

In the drawings,

Figure 1 is a block diagram of the second method;

Fig. 2 is a circuit diagram of a receiver using the same method;

Fig. 3 is a block diagram of a method based on the use of mistuned selective circuits;

Fig. 4 is a circuit diagram of a receiver using this method of operation;

Fig. 5 is a plot of the current response against varying frequencies of the incoming signal in the detector controlled by the very selective control circuit used in Figs. 1 and 2;

Fig. 6 is a plot of the voltage response in the main selector circuit used in Figs. 3 and 4 against the frequency of the incoming carrier, and of the voltage response of the mistuned selector circuits used to actuate the control mechanism against this frequency;

Fig. 7 is a portion of a receiving circuit in which the voltage response in a normal resonant circuit is used to control a special mechanism to obtain a sharper control of output with variation of the resonant frequency than the voltage response is itself capable of producing;

Fig. 8 and Fig. 9 are plots showing the voltage response in two portions of the circuit shown in Fig. 7 as illustrating the operation of the device shown in this figure;

Fig. 10 is a block diagram similar to Figs. 1 and 3, of a method of control employing a local oscillator;

Fig. 11 is a circuit diagram of the receiver shown more diagrammatically in Fig. 10; and

Fig. 12 is a portion of a circuit diagram showing a less abrupt independent method of control than is illustrated in the four preceding methods.

In Fig. 1 there is given a block diagram of apparatus for carrying out this method in which the change in voltage in resonant circuits when change in frequency in the incoming signal occurs is directly employed to obtain the result desired. In this figure and in Figs. 3 and 10 solid

lines denote signal currents and dotted lines denote control currents. In this figure, 49 is an antenna system; 50 a radio frequency amplifier; 51 a heterodyne oscillator; 52 a first detector; 53 an intermediate frequency amplifier; 54 is an automatic volume control system receiving signals from the last stage of an intermediate frequency amplifier 53 and in turn controlling one or more tubes in that amplifier and in the radio frequency amplifier 50. Signal voltage in this way is maintained at relatively constant voltage at the last stage of the intermediate frequency amplifier 53 from which point the second detector 55 is controlled. The second detector 55 furnishes signals to the audio frequency amplifier 56. The output of the audio frequency amplifier 56 passes to the output amplifier 57 through the cut-off device 58 and the output amplifier 57 supplies loud speaker 59. Signals from the automatic volume control system 54 pass to the sharp selective circuit 60 and the voltage in this circuit controls the operation of the control tube 61 which controls the cut-off device 58.

Referring now to Fig. 2, which shows the circuit diagram corresponding to the block diagram in Fig. 1, to the right of the lines A—A in Fig. 1, there is shown the last intermediate frequency stage of amplification 62 consisting of resonant circuit 63, screen grid tube 64 and resonant circuit 64^a. The intermediate frequency stage 62 impresses a signal on the resonant circuit 64^b, the potential of which is applied to the grid of the second detector 65. The grid of this tube is negatively biased by the resistance 264 shunted by the condenser 265 in the lead from the negative supply to the cathode of this tube. This negative bias may be increased by the automatic volume control system later to be described. The varying plate current in the second detector tube 65 passing through the resistance 205 induces variations in the potential at the point between the plate and the resistance 205 corresponding with the variations in the plate current itself. These variations are transmitted by way of the condenser 206 to the end of the resistance of the normal volume control 67, the variable contact of which impresses a proportional varying potential on the grid of the audio tube 66. The grid of this tube is negatively biased by the resistance 258 shunted by the condenser 259 in the lead from the negative supply to the cathode of this tube.

The varying plate current in the tube 66 so obtained impresses through the transformer 207 a varying potential on the grids of the push-pull amplifier tubes 68, the plate currents of which pass through the primary of the speaker transformer 69, the secondary of which operates the loud speaker 208. There is supplied the automatic volume control system 70. This consists of the screen grid tube 71 the grid of which is biased approximately to cutoff by the battery 72 through the resistance 263. Its screening grid is biased by the battery 209, the battery 210 energizing its plate circuit through the resistance 73 and the tuned circuit 75. The grid potential of the tube 71 is, however, also affected by the potential in the resonant circuit 64^b through the lead 222, the condenser 223 being interposed in the lead 222, and through the resistance 73 and condenser 260. Increase of potential in the resonant circuit 64^b causes changes in the bias of the control grid in the tube 71 and increases in plate current in this tube. The plate current of this tube passes through the lead 224 and

through the automatic volume control plate load resistance 73. The potential across the resistance 73 is increased with increase of plate current in the tube 71, and this increase in potential serves to bias more negatively the control grid of the amplifier tube 64 acting at the intermediate frequency and also the control grid in one or more tubes of the radio frequency amplifier, not shown in this figure. This change in control grid bias decreases the amount of amplification, this mechanism tending to preserve a relatively constant voltage in the resonant circuit 64 over very wide ranges of intensity of incoming signals. The plate current of the automatic volume control tube 71 also passes through the coil 74 constituting part of the very selective resonant circuit 75 which is coupled with the highly selective resonant circuit 76. There is provided the control tube 77, the grid of which is normally biased approximately to cutoff or beyond by the battery 78, whose plate circuit is energized by the battery 211. The potential in the resonant circuit 76 is, however, also applied to the grid of this tube. The plate circuit of this tube serves to energize the relay 79. This relay operates the contact points 80 which normally,—that is, when no current is flowing in the plate circuit of the control tube 77—are in contact, and when in such contact, serve to short circuit the primary of the audio transformer 207. Under these conditions the plate current of the audio tube 66 does not pass through the primary of the transformer 207 and the system is inoperative beyond this point.

As the frequency of the signal impressed upon the last stage of the intermediate frequency network approaches the resonance frequency of the tuned circuits 75 and 76, the voltage in 76 rises, causing flow of current in the plate circuit of the control tube 77. As circuits 75 and 76 are very selective this rise is very sharp as the resonance frequency is approached and might be represented by the curve in Fig. 5, abscissa representing the departure from the resonance frequency and the ordinates current response. When the current increases above the value k , say, in this figure, the armature of the relay 79 is attracted and separate the points 80 and the transformer 207 thereupon becomes operative. Relays have commonly the characteristic of asymmetric operation in such manner that the rising current necessary to operate them is considerably greater than the falling current at which operation in the reverse direction occurs. There is, accordingly, provided the shunt resistance 81. Passage of current through it is controlled by the contact points 82. On operation of the relay the points 82 are closed and the current through the relay is thereby reduced the necessary amount to insure that the amount of plate current necessary to operate the relay in one direction is about the same as the current below which it is necessary to go to operate the relay in the other direction.

In the preceding description I have described a method and apparatus for obtaining a control of the operation of a radio receiver, added to the ordinary selective networks and having sharper tuning characteristics than such networks can be made to possess without interfering with the quality of reception, the control being based on a method in which the change of voltage in independent resonant circuits, when change in the incoming frequency occurs, is directly used to obtain the result desired. It is possible to use numerous other ways of obtaining this result

utilizing again the same general principle of adding an independent mechanism for selection on the ordinary selective networks.

In Figs. 3, 4 and 6, there is shown a method of securing a sharp cutoff imposed on the ordinary methods of selection of energy carrier by use of selective resonant circuits. Referring first to Fig. 3, which is a block diagram figuring the various circuit elements and their relation to one another, the antenna 1 transmits the incoming signal to the radio frequency amplifier 2 where the resulting radio frequency signal is amplified. The local oscillator 3 produces a local oscillating current, the two producing, by means of the first detector 4, the intermediate frequency signal which is amplified in the intermediate frequency amplifier 5.

The automatic volume control system 6, controlled in the usual way by the signal voltage resulting from operation of the intermediate frequency amplifier 5, controls one or more tubes in the radio frequency and intermediate frequency systems by varying the grid bias in the usual way to obtain constant output of the intermediate frequency amplifier 5. The output of this amplifier is now impressed on three selector circuits 7, 8 and 9, 8 being tuned to the intermediate frequency, 7 being tuned to a slightly higher frequency and 9 to a slightly lower one, the difference in resonance frequencies from the base frequencies, plus and minus, being approximately equal in the two cases. Figure 6 shows the voltage response of these three selector circuits with change of frequency of the incoming signal, frequency being plotted as the abscissae, and the voltage response in the three circuits being plotted as ordinates forming the curves 7^a, 8^a and 9^a. It will be seen that the voltage responses in selectors 7 and 9 are equal at but one frequency, this frequency being the point of exact resonance for selector circuit 8. If, now, the voltage responses in 7 and 9 are opposed their algebraic sum is zero only at this frequency. A phase correcting system may be used so that these voltages do add exactly to zero. Such systems are well known and are omitted for simplicity. This combined opposed response is used to control the mistuning cutoff 10 which controls the cutoff device 11 interposed between the audio amplifier 213 and the output amplifier 12, in such manner that signals are allowed to pass to the output amplifier 12 and to the loud speaker 13 only when the condition of zero output from the selectors 7 and 9 to the mistuning cutoff 10 is obtained.

Since, however, the condition of no incoming signal from the intermediate frequency amplifier 5 will produce the condition of no input on the mistuning cutoff 10, from selectors 7 and 9, it is desirable to have a further control which renders the transmission of signals possible only where a signal of the desired frequency is actually being received. The no signal cutoff 14 controlling cutoff device 15 is therefore provided, which is controlled from the selector circuit 8 in such manner as to render the transmission of signals (such as static, etc.) impossible unless current is flowing in the selector circuit 8. The cutoff device 15 is interposed between the on resonance selector 8 and the second detector 212.

A detailed circuit diagram of a receiving system capable of carrying out these functions is shown in Fig. 4. This diagram shows the circuit arrangements to the right of the line B—B in Fig. 3. Referring to this figure, 16 is the last stage of intermediate frequency amplification consist-

ing of the screen grid tube 17 and oscillating circuit 18. The grid of the tube 17 is biased negatively with respect to the cathode by means of the resistance 261 interposed in the lead from the common -B return which is shunted by the condenser 262. The plate current from the tube 17 passes through the coils 7^b, 8^b and 9^b, which are in coupled arrangement with the coils 7^c, 8^c and 9^c of the resonant circuits 7, 8 and 9. The potential developed in the circuit 8 is impressed on the grid of the second detector tube 47 in the plate circuit of which is the resistance 48. The potential between the extremities of the resistance 48 is impressed through the condensers 90 and 91 on the resistance of the normal volume control 92, the variable contact thereof 93 being connected to the grid of the tube 94 of the first audio stage of amplification 95. The plate current of the audio tube 94 passes through the primary 96 of the push-pull transformer 97, the extremities of the secondary 98 thereof being connected to the grids of the push-pull tubes 31 and 32 of the second audio stage. The plates of these tubes are connected to the ends of the primary 99 of the speaker transformer 100, the secondary thereof, 101, actuating the loud speaker 102.

Returning now to the resonant circuits 7, 8 and 9, 7 is tuned to a frequency greater than the intermediate frequency, 8 is tuned to the frequency of the intermediate frequency and 9 is tuned to a frequency less than the intermediate frequency. The difference in the resonance frequencies of 7 and 8 is approximately the same as the difference between the resonance frequencies of 8 and 9. The circuits 7 and 9 are connected in opposed relationship and the difference of their voltage responses is impressed on the grid of the control tube 19 through the condenser 266. The grid of the control tube 19 is biased by the battery 20 so that customarily no current flows through the plate circuit of this tube which is energized by the battery 21 and in which is included the plate load resistance 22 shunted by the condensers 215 and 226. One end of the plate load resistance 22 is connected through the biasing battery 23 with the cathode of the thyatron tube 24, the other end being connected to the grid of this tube, the battery 23 having such a potential that normally no plate current flows in this tube. The plate potential on the tube 24 is secured from the secondary of the transformer 25, the choke 26 and filter condenser 27 and the loading resistance 28 being provided, the resistance 28 being shunted by the condenser 217. Leads 29 and 30 are provided from the extremities of the resistance 28. Lead 29 passes to the middle of the secondary 98 of the push-pull transformer 97, the extremities of which are connected to the grids of the tubes 31 and 32. Lead 30 passes to the minus B supply of the push-pull tubes 31 and 32, from which through the resistance 103 connection is made to the cathodes of tubes 31 and 32. Under operating conditions no potential exists between the leads 29 and 30 and the grids of the output tubes 31 and 32 are biased only by the potential drop across the resistance 103. This is the case, as may be seen by reference to Fig. 6, when the intermediate frequency is at the proper value. Under these conditions the voltages developed in the resonant circuits 7^c and 9^c exactly cancel one another if proper phase correction is carried out and the biasing voltage of the battery 20 is such that no current flows in the plate circuit of the tube 19, and similarly the biasing voltage from the battery 23 is such that

no current flows in the thyatron tube 24. If, now, the intermediate frequency approaches say the value f in Fig. 6, the potential in the oscillating circuit 7^c has the value E_1 , whereas the voltage in the circuit 9^c is E_2 and their difference is no longer zero. Under these conditions the effective positive voltage on the grid of tube 19 is increased and current flows in its plate circuit. This in turn varies the bias of the grid in the thyatron tube 24 in a positive direction. These tubes have the characteristic that there is a certain critical potential which can be applied to the grid at which potential the change in plate current with change in the grid potential is extremely abrupt. A negative potential slightly greater than this potential insures that no current shall pass in the plate current. At a negative bias potential slightly less than this critical potential the grid loses its control and the impedance of the tube during one-half of the cycle becomes extremely small. Under these conditions the potential developed by the transformer 25 during this half of the cycle is nearly wholly impressed on the plate load resistance 28 and this potential is manifested between the leads 29 and 30. Under these conditions the grids of the output tubes 31 and 32 are so heavily biased that they become inoperative and no operation of the loud speaker occurs.

As above noted, the foregoing control does not take care of the conditions where no signal on the desired frequency is being received. In order to prevent operation of the audio circuits under this condition there is supplied the control system 36 consisting of the control tube 37 and the thyatron tube 38 with their auxiliary apparatus. The grid of the control tube 37 is normally biased by the battery 216 approximately to cutoff. The plate of tube 37 is supplied by the battery 41 through the loading resistance 42. The potential developed in the circuit 8 is impressed through the condensers 39 and 40 on the grid of the tube 37, and when such a potential exists the bias is altered sufficiently to allow current to flow in the plate circuit of this tube in which is the loading resistance 42. The resistance 42 is shunted by the condenser 219 and the cathode of tube 37 is coupled to the filament of tube 38 by the condenser 220. The grid of the thyatron tube 38 is similarly biased by the battery 43 through the resistance 42. The plate circuit of the thyatron tube 38 is energized by the secondary of the transformer 44, the primary of which is supplied with the line voltage, there being supplied the filter condenser 45, the filter choke 104, and the plate loading resistance 46 shunted by the condenser 221. One extremity of the plate loading resistance 46 is connected to the cathode of the second detector tube 47 and the other to the plate through the plate loading resistance 48. When now there is no potential in the circuit 8, there is no flow of current in the plate circuit of the control tube 37 by reason of the grid bias. Similarly there is no flow of current in the plate circuit of the thyatron tube 38 and consequently there is no energizing potential on the plate of the second detector tube 47. This tube is consequently inoperative and no signal will be heard for that reason. In this way static bursts will not be heard in the loud speaker. When, however, a potential is impressed on the circuit 8 the biasing potential of the tube 37 is so modified as to permit plate current to flow in the control tube 37. This in turn modifies the biasing potential in the thyatron tube 38 below the critical point. The im-

pedance of this tube accordingly drops nearly to zero on the positive one half of the cycle, and the potential developed in the transformer 44 is nearly wholly impressed on the loading resistance 46 and in turn on the plate of the second detector 47. This tube thereupon becomes operative and signals can be transmitted through it.

The circuit is provided with a usual type of automatic volume control system consisting of the tube 33 on the grid of which is impressed the potential of the selective circuit 8 through the condensers 222 and 223. The grid of the tube 33 is biased approximately to cutoff by the battery 268 through the resistance 269. The plate circuit of the tube 33 energized by the battery 34 has in it the automatic volume control plate load resistance 35, and the grid of the intermediate frequency tube 17 is biased by the potential across the extremities of this resistance 35. The grid of the tube 33 is biased by the battery 36 so that under the condition of low voltage on the circuit 8 little or no plate current flows in the plate circuit of tube 33. There is, therefore, little or no potential across the automatic volume control plate load resistance 35 and the grid of the tube 17 is only normally biased and works at full sensitivity. As voltage increases in the circuit 8 the negative bias on the tube 33 is decreased, current flows in its plate circuit 34 and potential is developed across its plate load resistance 35, which potential makes the bias of the grid of the tube 17 more negative and the amplification here decreases. This control can be and usually is extended to a tube in the radio frequency amplifier.

While it is usually desirable that separate selective circuits be used of sharper tuning characteristics than the normal selective circuits, it is not wholly necessary to use them. We may, for example, have one part of the circuit which has a broad tuning characteristic and another part of the circuit which has a sharper tuning character. This is particularly the case if automatic volume control is employed.

Referring to Figs. 7, 8 and 9, there is shown a portion of a circuit in which this principle is utilized. The other portions of the circuit may conveniently be similar in character to that of Figs. 1 and 2. In Fig. 7, 110 is the last stage of the intermediate frequency amplifier from which are led the automatic volume control leads 111 and 112. Owing to the operation of the automatic volume control the tuning response to this circuit may have a shape somewhat similar to the curve in Fig. 8. The resonant circuit 113, however, which is coupled with this circuit, has a much sharper tuning characteristic which may be represented in Fig. 9. The potential of this circuit is impressed on the grid of the second detector tube 114. It is also, however, impressed through the blocking condensers 88 and 115 on the grid of the thyatron tube 116, in addition to the biasing potential developed by the battery 117 acting through the choke 118. As before, this tube is energized by the secondary of the transformer 105, the primary of which is energized by the line voltage, there being provided the filter condenser 119 and the choke 120 together with the plate loading resistance 121 and by-pass condenser 122. The potential across the resistance 121 is used to cause a plate potential in the second detector tube 114 through the plate loading resistance 123, the potential across 123 leading to the output through the condensers 124 and 83. It is to be remembered that the thyatron tube 116 has a trigger or

critical voltage necessary on the grid before plate current commences, and that after it does commence the grid loses control. Accordingly, if the negative biasing potential developed by the battery 117 is above a certain amount, no current will flow in the plate circuit of this tube and there will be no plate supply to the second detector tube 114. When, however, the peak voltage in the resonant circuit 113 rises above a certain trigger value, shown in Fig. 9, the thyatron tube 116 is suddenly made operative. The second detector tube 114 is energized and the receiver as a whole becomes operative.

It will be seen, by reference to Fig. 9, that if this trigger voltage is placed at a proper value the frequency interval on either side of the base frequency within which the receiver is operative is much narrower than the frequency interval within which maximum potential exists in the resonant circuit 110. The operation of the thyatron tube 116 may, of course, be used to control the operation of the receiver in various other ways, for example, in providing a proper bias to the first audio stage or in numerous other ways which will be apparent to those skilled in the art.

It will be seen that the above described circuits illustrate means for carrying out the method of operation described herein. Other methods are possible as above noted, for example, a local oscillator of variable frequency can be used in which the variation in frequency is made to go in step with the period of natural resonance of the selective networks employed. If the frequency of the incoming signal together with the frequency of the local oscillator is impressed on a detector, there will occur a beat frequency of audio frequency, and this frequency will fall to zero at points where the selective network is tuned exactly to the frequency of an incoming carrier. The plate current from such a detector can be passed through the primary of a transformer and the induced current can then be rectified. Under these circumstances the rectified current will fall to zero at the point where the selective networks are in exact resonance with the frequency of the incoming signal. The rectified current or a potential produced by its flow across a resistance may be used in the same way the opposed voltage response of the mistuned selective circuits in Figs. 3 and 4 are used to control the operation of the receiver proper.

The use of my method in this way but using a superheterodyne receiver for purposes of simplicity in description is figured in Figs. 10 and 11.

Referring to Fig. 10, 125 is the antenna or other collecting mechanism; 126 is the radio frequency amplifier; 127 is the heterodyne oscillator, and 128 is the first detector; 129 is the intermediate frequency amplifier controlling the automatic volume control system 130 which in turn controls one or more elements of the radio frequency amplifier system 125 and the intermediate frequency amplifier system 129; 131 is the no station cutoff, and 132 is the cutoff means actuated thereby; 133 is the second detector; 134 is the audio amplifier; 135 is the intermediate frequency limit oscillator; 136 is the control detector controlling the control device 137 which actuates the cutoff 138 which is interposed between the audio amplifier 134 and the output amplifier 139, the output from 139 going to the loud speaker 140.

Referring now to Fig. 11, which is a circuit diagram to the right of the line C—C in Fig. 10, 141 is the last stage of intermediate frequency amplification consisting of the resonant circuit 142, the

resonant circuit 143 coupled therewith, the vacuum tube 144 on the grid of which is imposed the potential developed in the resonant circuit 143. Tube 144 is of the screen grid type, the screen grid being positively biased by the battery 145, the plate potential being supplied by battery 146 through the coils 147 and 148. The resonant circuit 149 is in coupled arrangement with the coil 147 and the potential developed therein is imposed on the grid of the second detector tube 150, the grid of which is biased negatively by the battery 151. The potential in the resonant circuit 149 is also imposed on the grid of the automatic volume control tube 152 through the condenser 153, in addition to the biasing potential developed by the battery 154 through the resistance 155, the value of the potential developed by the battery 154 being such that ordinarily no current flows in the plate circuit of the tube 152. Potential for the plate circuit of the tube 152 is furnished by the battery 156 through the plate load resistance 157 which is by-passed by the condenser 158. The potential developed across the resistance 157 is impressed on the grid of the intermediate frequency amplifier tube 144 and also through the leads 83 and the ground 159 on the grid of one or more of the radio frequency amplifier tubes, that is, the operation of this tube is such that an increase in potential in the resonant circuit 149 increases the bias on the grid of the tube 144 and on one or more of the radio frequency amplifier tubes to reduce the amplification at these points. The grid of tube 144 receives a positive bias on account of the resistance 269 shunted by the condenser 270 connecting its cathode with the ground return. The potential developed in the resonant circuit 149 is also through the condenser 160 impressed on the grid of the tube 161, the grid of which is biased by the battery 162 through the resistance 84, and the plate circuit of which is supplied by the battery 163 through the resistance 164, the battery 163 and the resistance 164 being shunted by the condenser 165. The potential developed on the resistance 164 is applied to the grid of the thyatron tube 166, the grid of which is also biased by the battery 167. The plate circuit of the thyatron tube 166 is energized by the secondary of the transformer 85, the primary of which is energized by the line voltage, includes the choke 168, the filter condenser 169, and the plate loading resistance 170 which is shunted by the condenser 171. The potential across the resistance 170 is applied to the plate of the second detector tube 150 through the plate loading resistance 172. The operation of this part of the system is as follows:

When no signal is being received, the grid of the tube 161 is so biased by the battery 162 that no current flows in the plate circuit. When a signal is received a potential exists in the resonant circuit 149, this bias is interfered with, and plate current flows. This produces a potential on the resistance 164 which decreases the biasing potential exerted by the battery 167 to a point where the grid of the thyatron tube 166 becomes inoperative and current flows in the plate circuit of this tube. This produces a potential on the resistance 170, which potential supplies current to the second detector tube 150 and renders it operative. The plate current in this tube flows through the resistance 172 and the variations of the potential on this resistance are applied through the condensers 173 and 174 to the resistance of the normal volume control 175, the contact point of this control being led to the grid

of the first audio stage amplifier 176. The grid of this tube is biased by the battery 272 and its plate is supplied by the battery 273. The plate circuit of this tube passes through the primary of the push-pull transformer 177, the secondary potential of which is impressed on the grids of the push-pull tubes 178 and 179. The plate circuit of these tubes passes through the primary of the loud speaker transformer 180, the secondary thereof 181 energizing the coil 182 of the loud speaker 183.

There is provided the local oscillator 86 oscillating at the intermediate frequency consisting of the oscillating circuit 184, vacuum tube 185 and plate battery 186, biasing battery 187, a feedback coil 188 coupled to the coil of 184 in the plate circuit of the tube 185, this circuit also including the coil 189. Coil 189, together with the coil 148 in the plate circuit of the intermediate frequency amplifier tube 144, are in coupled arrangement with the resonant circuit 190, the potential of which is impressed on the grid of the control detector tube 191, this grid being biased by the battery 192. The plate circuit of this tube is supplied by the battery 193 and includes the resistance 194 shunted by the condenser 275. If there is a variation in frequency between the current in the coil 148 which is the incoming intermediate frequency on the coil 189 which is the base intermediate frequency, beat frequencies are imposed on the plate current of the tube 191 and the variations in potential thereby occurring are transmitted by means of the condenser 195 to the grid of the tube 196 which is also biased by the battery 197 through the resistance 198. The plate circuit of the tube 196 is energized by the battery 199, the current thereof passing through the coil of the relay 200. The tube 196 is ordinarily biased by the battery 197 so that no current flows in the plate circuit thereof. If, however, there are beat frequencies developed in the tube 191, current flows in the plate circuit of 196 depending in amount on the frequency of the beat frequencies developed. If it rises above a predetermined amount the relay 200 operates and in so doing short-circuits the primary of the push-pull transformer 177 and shunts its coil through the resistance 202 by the points 203 as before. In this way the loud speaker 183 is thrown out of operation. As before noted, the apparatus just described controls the output of the receiver in such manner that it is only operative when the receiver is tuned to a resonance within a small frequency interval on either side of the signal frequency.

The preceding examples of the application of my invention have all contemplated a means of control in which the operation is sharper in character than that of the normal selective circuit. Under certain circumstances it is desirable to use a supplementary control in which the control is of less abrupt character. Such a control is shown in Fig. 12, which is a circuit diagram of a portion of a receiver using a control of this sort. The other portion of the circuit may be of any type as, for example, those shown in Fig. 2 or Fig. 4. In Fig. 12, 231 is a coil constituting part of the last stage of intermediate frequency amplification in coupled arrangement with the coil of the resonant circuit 232. The potential in this circuit is impressed on the grid of the second detector tube 233, the grid of this tube being biased by battery 234 and the plate being energized by the battery 235, the plate circuit including the resistance 236. The variations in potential at the point between

this resistance and the plate of the tube 233 are impressed by means of the condenser 237 on one end of the resistance 238 of a normal volume control, the variable contact 239 of which is connected to the grid of the first audio stage tube 240. This tube has its grid biased by the battery 241 and its plate circuit is energized by the battery 242. Its plate current passes through the primary of the push-pull transformer 243, the circuit from this point being like that in the other examples shown.

As before, the potential in the resonant circuit 232 is impressed via the condenser 244 to the grid of the automatic volume control tube 245, the grid of which is negatively biased by the battery 246 acting through the resistance 247. This tube, which is of the screen grid type, has its screen grid biased by the battery 248. Its plate circuit includes the resonant circuit 249 and the plate loading resistance 250 shunted by the condenser 251. The potential across the resistance 250 is applied as before as a biasing potential to control the operation of one or more of the intermediate frequencies and radio frequency tubes, this control not being shown in these drawings.

In coupled relationship to the resonant circuit 249 is the resonant circuit 257, the potential of which is applied to the grid of the control tube 252 which is biased approximately to cutoff by the battery 253. This tube which is of the screen grid type, has its screen biased by part of the potential developed by the battery 254 which supplies the plate circuit. This circuit includes the resistance 255 shunted by the condenser 256 and the potential across the resistance 255 is applied to the grid of the first audio tube in opposition to the battery 241 which is initially of such potential as to practically cut off the operation of this tube. When signal conditions exist in which the incoming frequency approaches that of the resonant frequency of the circuits 249 and 257, plate current flows in the control tube 252 and the bias of the tube 240 is decreased sufficiently so that the tube becomes operative. In this way it will be seen a control is superimposed on the ordinary control offered by the selective circuit, to make the operation of the receiver more selective and to remove the disadvantages in the way of noise between stations, magnified static burst, etc., which ordinarily are met with in a receiver using automatic volume control. The control, however, differs from the controls previously described in being of more gradual character than is the case in the previous methods outlined.

All five of the examples previously given contemplate the use of a superheterodyne circuit. It is, of course, possible to use identically the same principle of control in the case of a circuit employing tuned radio-frequency. Here, however, as the selective circuits are made continuously variable, it is necessary that the control mechanisms, whether the very selective circuit used in Fig. 1 or Fig. 2 or the mistuned selector circuits used in Fig. 3 and Fig. 4, or the local oscillator used in Fig. 10 and Fig. 11, be themselves variable in resonant frequency and that by means of this variability they shall be made to preserve the same relationship to the corresponding variable tuned stages of radio-frequency that the described control mechanisms bear to the fixed intermediate frequency of the superheterodyne circuits described herein. As the problems here are wholly mechanical and the electrical considerations are precisely the same, this case of

application has not been specifically described, but it is to be noted that the invention may be extended to and comprises application to such uses. Similarly, the examples given have contemplated the use of automatic volume control, inasmuch as the method is peculiarly applicable to receivers using this device. It is, however, highly useful in receivers not employing automatic volume control and its use in such receivers also constitutes use of the invention.

The points of control also can be varied from the points selected in these illustrative methods. Examples may include the operation from the detector in the case of tuned radio frequency amplifiers or the second detector in the case of superheterodyne circuits, or as above shown from the automatic volume control tube, when this is used.

It will thus be seen that I have outlined a method of radio receiver control which combines the advantages as regards selectivity of very sharply resonant circuits with the advantages as regards quality, of reception selective mechanisms which are broader in selective character. It will also be seen that I have devised a method whereby certain disadvantages of modern receivers, particularly those provided with an automatic volume control are successfully met, in particular, the disadvantage of these receivers consisting of uncertainty in the point of exact coincidence of the receiver resonant frequency to the incoming signal and the increased noise between stations. Furthermore, in this way it is insured that the receiver must always operate at points in which the audio response is the most faithful reproduction of the original transmitted sound. It will also be seen that receivers operated according to the methods outlined herein have an apparent selectivity which is very high, which advantage increases the ease of operation thereof.

Furthermore, it is to be understood that the particular form of apparatus shown and described and the particular procedure set forth, are presented for purposes of explanation and illustration and that various modifications of said apparatus and procedure can be made without departing from my invention as defined in the appended claims.

What I claim is:

1. In a radio receiver, signal energy carrier resonant networks sufficiently broad in selective characteristics so as not to impair proper reception of a side band frequency of the energy carrier, and a more selective resonant network, said more selective resonant network controlling by means of the voltage response therein caused by variations in the frequency of the incoming signal, a control mechanism comprising means for rendering possible the transmission of the signal whenever the voltage response in said more selective network exceeds a desired amount and comprising means for rendering such transmission impossible whenever the voltage response in said more selective network is less than the desired amount.

2. In a radio receiver, main signal selective and transmission circuits resonant to a signal carrier frequency, and a control tube having a grid and an ionized atmosphere, whereby said control tube has an abrupt increase of plate current when the negative bias of the grid of said control tube is slightly decreased below a certain critical value, means including a tuned network other than said main circuits for decreasing said bias below the critical value when the

frequency of the incoming signal departs a predetermined amount from the resonant frequency of the selector circuits, and means for causing such increase in plate current in the control tube to prevent transmission of the signal.

3. In a radio receiver, signal selective and transmitting networks, two mistuned selector circuits, a control tube the grid of which is biased to have a predetermined space current when less than a desired signal intensity is received and also controlled by the voltage difference of said two mistuned selector circuits, a control mechanism actuated by the plate current in the control tube, comprising means for causing the operation of said control mechanism to impair the transmission of the signal in said selective and transmitting networks.

4. In a radio receiver, main selective networks for the choice of signal energy carriers of a desired frequency, an automatic volume control mechanism, resonant circuits posterior to the point of actuation of said volume control and resonant to frequencies of about the carrier frequency of the signal, and an independent control mechanism, the point of actuation of said independent control mechanism being subsequent to said resonant circuits and posterior to the point of actuation of said automatic volume control mechanism, said independent mechanism being operatively associated with said resonant circuits, and means for causing said independent control mechanism to control the transmission of the signal.

5. In a radio receiver, main selective networks for the choice of signal energy carriers of a desired frequency, an automatic volume control mechanism, resonant circuits posterior to the point of actuation of said volume control and resonant to frequencies of about the carrier frequency of the signal, and an independent control mechanism, the point of actuation of said independent control mechanism being subsequent to said resonant circuits and posterior to the point of actuation of said automatic volume control mechanism, said independent mechanism being operatively associated with said resonant circuits, and means for causing said independent control mechanism to control the transmission of the signal, the point of control of said independent control mechanism being posterior to the point of actuation of said independent control mechanism.

6. In a radio receiver, resonant circuits for selecting, transmitting and amplifying a signal energy carrier frequency, together with mechanism for giving automatic volume control of the output of the receiver, and a supplementary control mechanism responsive to the carrier frequency, such supplementary control mechanism being actuated from a point in the resonant circuits later as regards the direction of transmission of the signal to the point at which actuation of the automatic volume control mechanism is caused, means for causing such supplementary mechanism to be operated by any desired difference between the frequency of an incoming signal and the resonant frequency of said resonant circuits and means for causing such operation to impair transmission of the signal at some point in the receiver.

7. In a radio receiver, customary selective circuits and a second circuit of more sharply selective character, a control mechanism designed to render a portion of the customary circuits inoperative, means including said second circuit for

controlling said control mechanism, said control mechanism including means to render said customary circuits inoperative except when the voltage response at some point in the second more selective circuit is above a predetermined fraction of the magnitude of the maximum voltage response in said more selective circuit.

8. In a radio receiver, customary tuned circuits having a given sharpness of selective characteristics, and a second selective circuit having a sharper tuning characteristic than the customary selective circuits, means for impressing the carrier frequency on said second selective circuit and means for causing the degree of response in the more selective circuits to control the transmission of signals in the customary selective circuit.

9. In a radio receiver, customary tuned circuits having a given sharpness of selective characteristics, and a second selective circuit having a sharper tuning characteristic than the customary selective circuits, means for impressing the carrier frequency on said second selective circuit and means for causing the degree of response in the more selective circuit to control the transmission of signals in the customary selective circuits, said means of control being provided with an abrupt operative character whereby change of operativeness of the receiver from full operative character to non-operative character occurs in a very small frequency interval on either side of the point of exact tuning for the given energy carrier.

10. In a radio receiver responding to an energy carrier of a given frequency, selective resonant networks, and a second more selective network in which a relatively large change of voltage response occurs when the resonance frequency of said second selective network is at a relatively small difference in frequency from that of the frequency of the energy carrier, means for varying such second network as to its resonant frequency substantially in step with the resonance frequency of the first selective networks used for reception, transmission and amplification of the incoming signal, and means for utilizing said large change of voltage response in said second selective network to control the transmission of the signal in the first selective circuits.

11. In a radio receiver responding to an energy carrier of a given frequency, selective resonant networks, sufficiently broad in selective character so as not to impair proper reception of the side band frequencies of the energy carrier, and two selector circuits, one having a resonance frequency slightly above that of the resonant frequency of the first selective networks used for reception, the other having a resonant frequency slightly below that of the first selective networks used for reception, the difference in resonance frequencies in each case being substantially the same, means for impressing the voltage response of the two mistuned selector circuits in opposed relationship on a cut-off mechanism, and means for operating said cut-off mechanism whereby one or more elements of the receiver are rendered inoperative whenever the sum of the opposed voltages of the two mistuned selector circuits departs substantially from zero.

12. In a radio receiver responding to an energy carrier of a given frequency, selective resonant networks, and two selector circuits, one having a resonance frequency slightly above that of the resonance frequency of the first selective networks used for reception, the other having a frequency slightly below that of the first selective networks used for reception, the difference in

resonance frequencies in each case being substantially the same, a cut-off mechanism, means for impressing the voltage response of the two mistuned selector circuits in opposed relationship on said cut-off mechanism and means for operating said cut-off mechanism whereby one or more elements of the receiver are rendered inoperative whenever the sum of the opposed voltages of the two mistuned selector circuits departs substantially from zero.

13. In a radio receiver responding to an energy carrier of a given frequency, a selective resonant network sufficiently broad in selective characteristics so as not to impair proper reception of the side band frequencies of the energy carrier, a local oscillator operating substantially at the resonance frequency of the selective or resonant network, means for regulating the transmission efficiency of said network in a sense opposite to received carrier amplitude variations, means for impressing the network signal output and the output of the local oscillator on a detector tube, a control mechanism, means for utilizing the beat frequencies in the plate current of said detector tube to operate said control mechanism, and means for causing said operation to render a portion of the receiver inoperative.

14. In a radio receiver responding to an energy carrier of a given frequency, a local oscillator of variable frequency, means for impressing the output of said local oscillator and said energy carrier on a detector tube whereby an energy carrier of an intermediate frequency is produced, selective resonant networks tuned to a fixed intermediate frequency, a second local oscillator oscillating at the fixed intermediate frequency, means for detecting the audio component of said intermediate frequency energy carrier and means for amplifying the same, means for impressing said intermediate frequency and the output of said second local oscillator operating at the intermediate frequency on a second detecting mechanism whereby beat frequencies between said intermediate frequency and the output of said second oscillator may be detected, and means for causing such beat frequencies if above a desired frequency to impair the transmission of the signal energy in said radio receiver.

15. The method of operation of a radio receiver involving the selection of modulated radiant energy carriers of a given frequency, which comprises transforming such modulated energy carriers into electric current, filtering such current as to frequency components with such lack of sharpness as to secure adequate transmission of the side band frequencies of said modulated energy carrier, independently filtering said modulated energy carrier as to frequency components so as to obtain a second filtered electric current comprising the carrier frequency of the first current but a decreased proportion of the side band frequencies thereof, and causing the amplitude of the second or more selectively filtered signal to control the transmission of the first or less selectively filtered signal.

16. In a radio receiver, main signal selective and transmission circuits, and a control tube having a grid and an ionized atmosphere, whereby said control tube has an abrupt increase of plate current when the negative bias of the grid of said control tube is slightly decreased below a certain critical value, means including a tuned input circuit other than said main circuits for decreasing said bias below the critical value and means for causing such increase in plate current

in the control tube to control transmission of the signal.

17. In a radio receiver, customary selective and transmitting networks, two mistuned selector circuits, a control tube the grid of which is biased to have a predetermined space current when less than a desired signal intensity is received and also controlled by the voltage difference of said two mistuned selector circuits, means comprising a control mechanism actuated by the plate current in the control tube, and comprising means for causing the operation of said control mechanism to render impossible the transmission of the signal in said customary selective and transmitting networks.

18. A method of controlling the output of a radio receiver which consists in changing the frequency of the energy carrier of a received signal to an intermediate frequency, variably amplifying said signal in accordance with the signal strength of such signal whereby increase in said signal strength causes a diminished amplification of said signal, further modifying the frequency of said signal to a frequency in the audio range, and independently controlling the amplification of the modified signal by said amplified but unmodified signal after a selection of the latter sufficient to render the independent control action sharper than said variable amplification action.

19. In a radio receiving set, a radio frequency amplifying system, an audio frequency amplifying system, means for automatically controlling the volume of the signal output of the radio frequency amplifier by adjustment of the sensitivity of the latter, means for automatically controlling the volume of the signal output of the audio frequency amplifier, in such a manner that its sensitivity is at a minimum when the sensitivity of the radio amplifier is substantially a maximum, said last mentioned means including a highly selective controlling circuit actuated by the output of the radio frequency amplifier.

20. In a radio receiving set, a radio frequency amplifying system, an audio frequency amplifying system, means for automatically controlling the volume of the signal output of the radio frequency amplifier by adjustment of the sensitivity of the latter, means for automatically controlling the volume of the signal output of the audio frequency amplifier in such a manner that its sensitivity is at a minimum when the sensitivity of the radio amplifier is substantially a maximum and no signals are received, said last control means including a highly selective resonant network adapted to pass only signals of a given frequency.

21. In combination with an amplifier having an output circuit resonant to an operating super-audible frequency, a detector having an input circuit coupled to said circuit resonant to said frequency, an amplifier for the audible frequency output of the detector, said last amplifier being normally maintained inefficient to amplify, a control network having an input circuit, sharply resonant to said super-audible frequency, coupled to said first output circuit, the output of said network being connected to the audible frequency amplifier for rendering the latter efficient to amplify whenever energy of said super-audible frequency is impressed upon said super-audible frequency amplifier.

22. In combination with an amplifier having an output circuit resonant to an operating super-audible frequency, a detector having an input

circuit coupled to said circuit resonant to said frequency, an amplifier for the audible frequency output of the detector, said last amplifier being normally maintained inefficient to amplify, a control network having an input circuit, resonant to said super-audible frequency, loosely coupled to said first output circuit to secure high selectivity, the output of said network being connected to the audible frequency amplifier for rendering the latter efficient to amplify whenever energy of said super-audible frequency is impressed upon said super-audible frequency amplifier.

23. In combination with an amplifier having an output circuit resonant to an operating super-audible frequency, a detector having an input circuit coupled to said circuit resonant to said frequency, an amplifier for the audible frequency output of the detector, said last amplifier being normally maintained biased to cut-off whereby it is inefficient to amplify, a control network having an input circuit, sharply resonant to said super-audible frequency, coupled to said first output circuit, the output of said network being connected to the audible frequency amplifier for rendering the latter efficient to amplify whenever energy of said super-audible frequency is impressed upon said super-audible frequency amplifier.

24. In combination with an amplifier having an output circuit resonant to an operating super-audible frequency, a detector having an input circuit coupled to said circuit resonant to said frequency, an amplifier for the audible frequency output of the detector, said last amplifier being normally maintained inefficient to amplify, a control network having an input circuit, sharply resonant to said super-audible frequency, coupled to said first output circuit, the output of said network being adjustably connected to the audible frequency amplifier for rendering the latter efficient to amplify whenever energy of said super-audible frequency is impressed upon said super-audible frequency amplifier.

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

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

27. In a radio receiver, the combination of an audio frequency amplifier, a network resonant to a desired operating frequency preceding the amplifier input, and coupled thereto, for providing an audio frequency signal to be amplified, means for normally maintaining an input elec-

trode of the amplifier biased to cut-off, and a control circuit of higher selectivity than said resonant network adjustably connected between said electrode and a desired point in said network for sufficiently reducing the bias to render the amplifier conductive only when said signal is provided.

28. In a radio receiver provided with at least a high frequency signal amplifier, a demodulator, a demodulated signal amplifier and a control arrangement, responsive to variations in signal intensity level, for adjusting the gain of said first amplifier in such a manner that the signal input level to the demodulator is substantially constant, a second control arrangement, responsive to variations in the gain of said first amplifier, for rendering the said second amplifier inefficient when the gain of the first amplifier increases above a predetermined level, and said second control arrangement including a selective network resonant to an operating signal frequency and the last named selective network having a higher degree of selectivity than said first control arrangement.

29. In a radio receiver provided with at least a high frequency signal amplifier, a demodulator, a demodulated signal amplifier and a control arrangement, responsive to variations in signal intensity level, for adjusting the gain of said first amplifier in such a manner that the signal input level to the demodulator is substantially constant, a second control arrangement, responsive to variations in the gain of said first amplifier and including a rectifier for developing a control bias potential, for rendering the said second amplifier inefficient when the gain of the first amplifier increases above a predetermined level, and said second control arrangement including a selective network resonant to an operating signal frequency and the last named selective network having a higher degree of selectivity than said first control arrangement.

30. In a radio receiver provided with at least a high frequency signal amplifier, a demodulator, a demodulated signal amplifier, and a control arrangement, responsive to variations in signal intensity level, for adjusting the gain of said first amplifier in such a manner that the signal input level to the demodulator is substantially constant, a second control arrangement, responsive to variations in the gain of said first amplifier and including a rectifier for developing a control bias potential, for rendering the said demodulator inefficient when the gain of the first amplifier increases above a predetermined level, and said second control arrangement including a selective network resonant to an operating signal frequency and the last named selective network having a higher degree of selectivity than said first control arrangement.

31. In a superheterodyne radio receiver, tuning means including a frequency converting oscillator, manually controllable means for adjusting the tuning means to syntony with a desired incoming radio signal, means for silencing the receiver during the tuning operation until approximate syntony with the desired signal is attained, a local oscillator and means conjointly responsive to the intermediate frequency signal and to potentials derived from said local oscillator for abruptly rendering the silencing means inoperative when approximate syntony is attained and for maintaining the said silencing means inoperative during a further adjustment of the tuning means over a limited range.