Aug. 8, 1939. H. A. WHEELER 2,168,461

AUTOMATIC SELECTIVITY CONTROL

Filed July 21, 1936 5 Sheets-Sheet 1

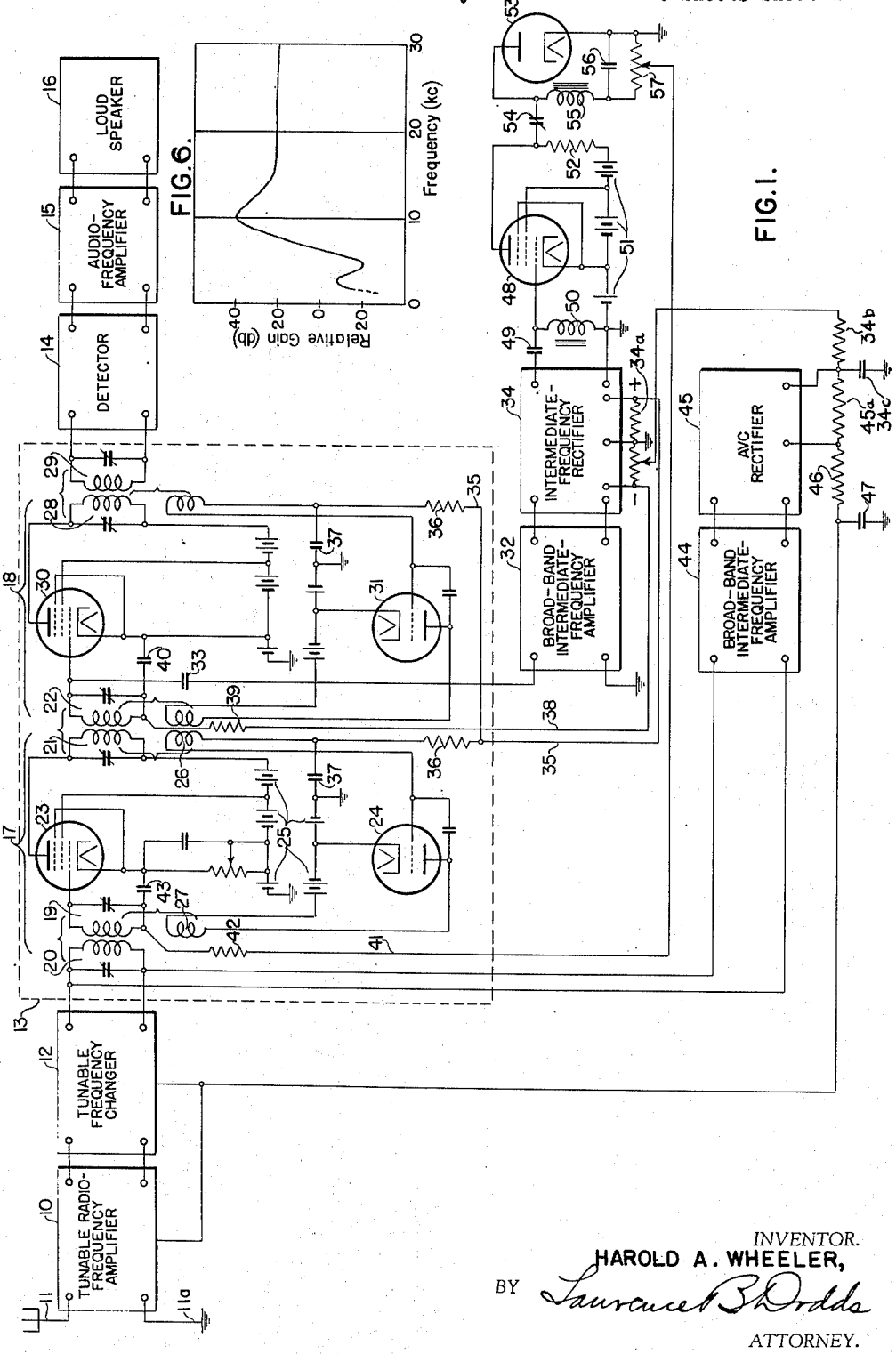


FIG. 1.




FIG. 6.

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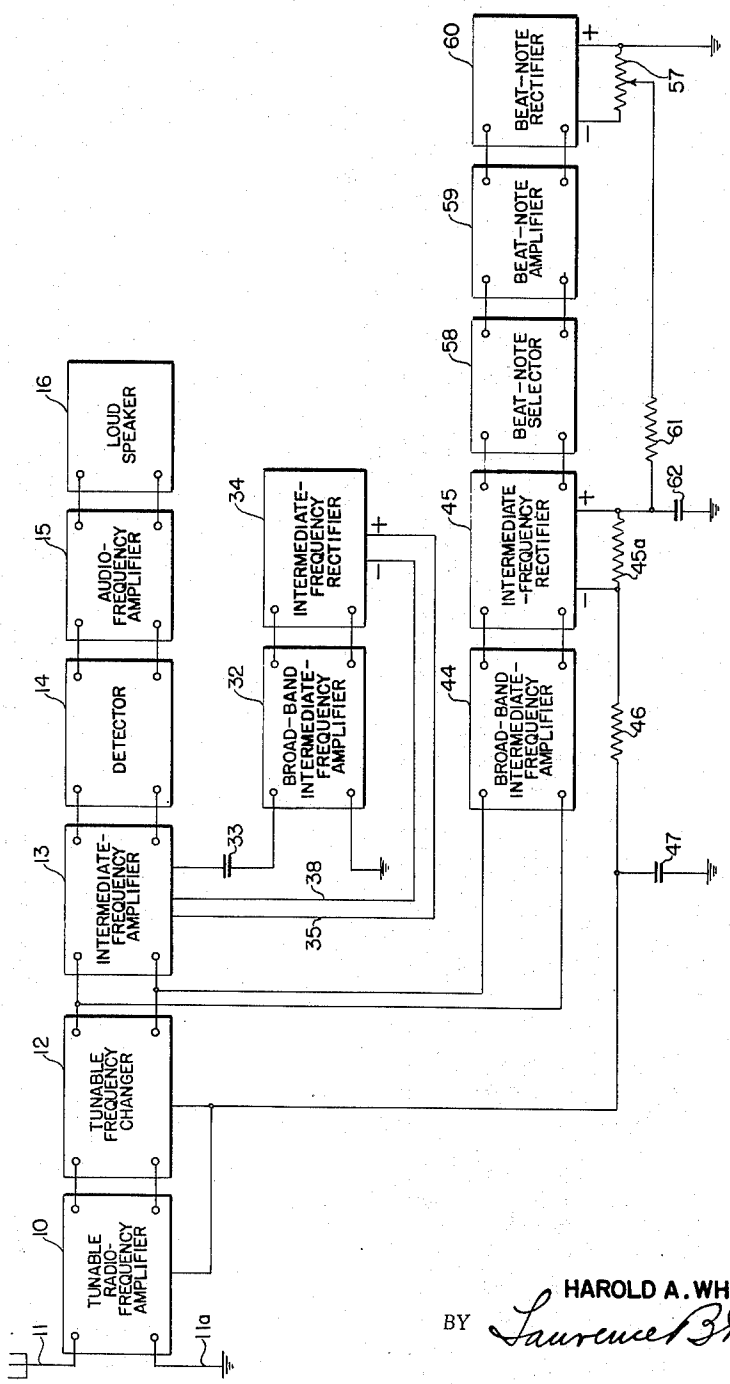


FIG. 2.

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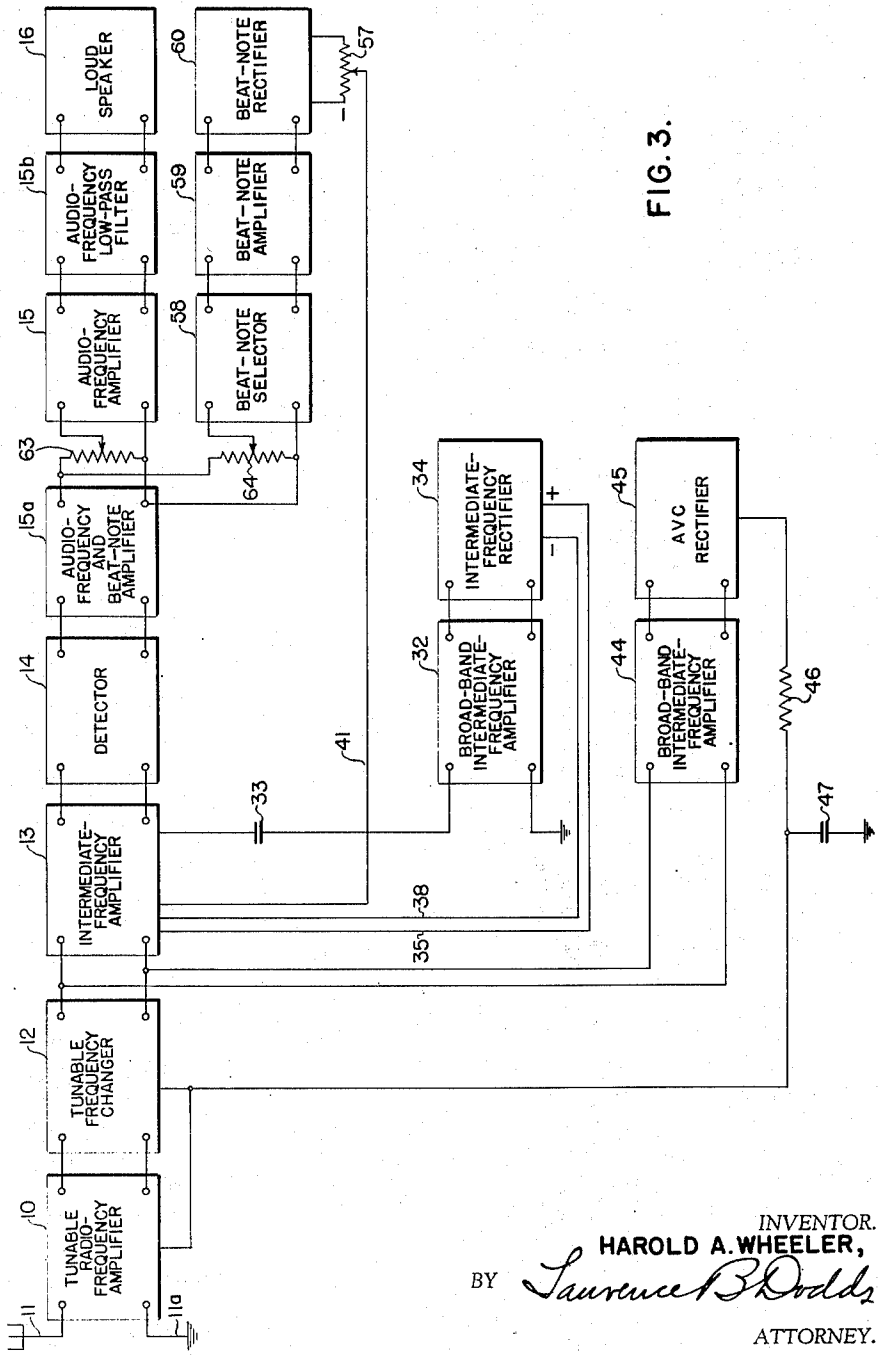


FIG. 3.

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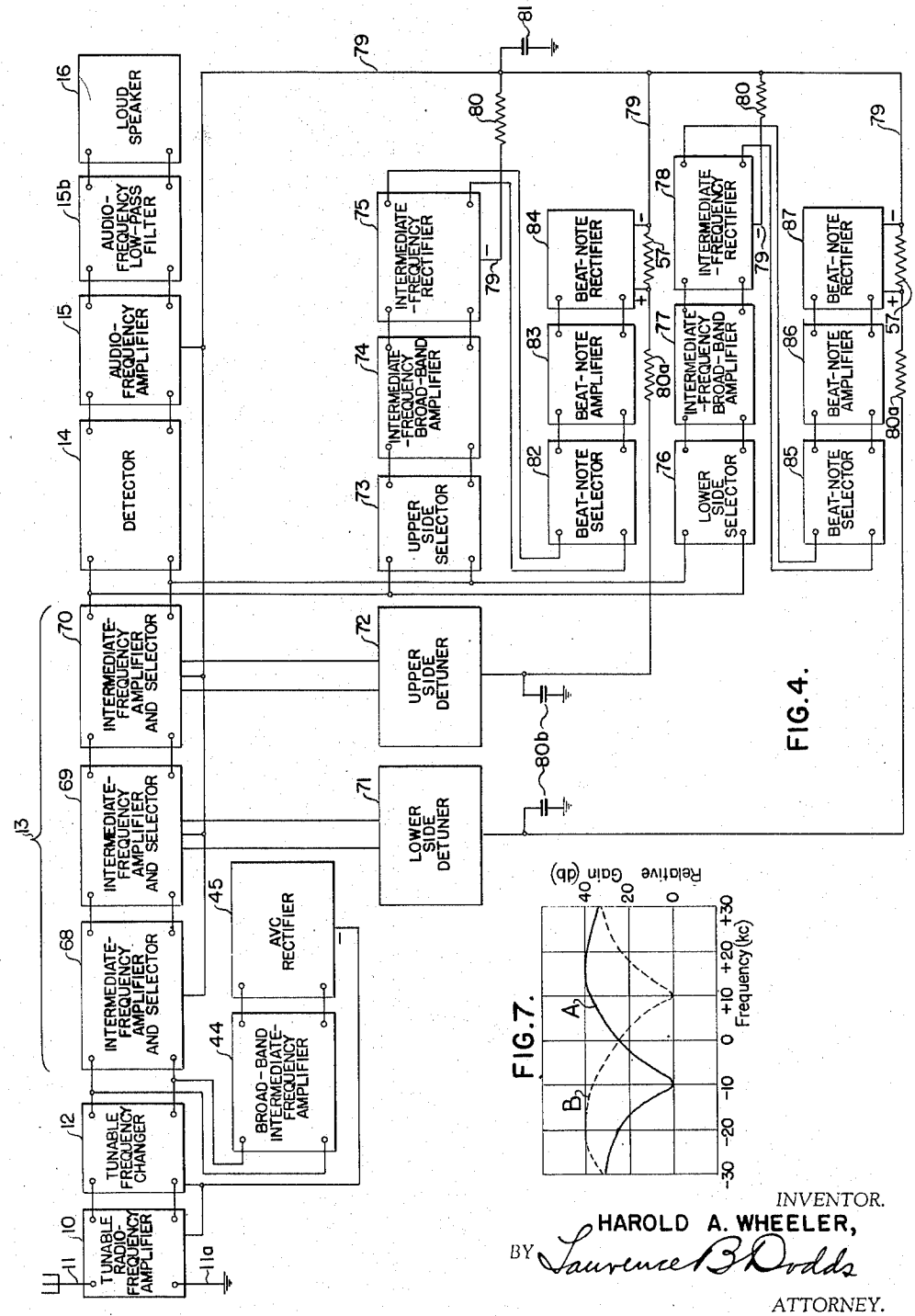


FIG. 4.




FIG. 7.

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AUTOMATIC SELECTIVITY CONTROL

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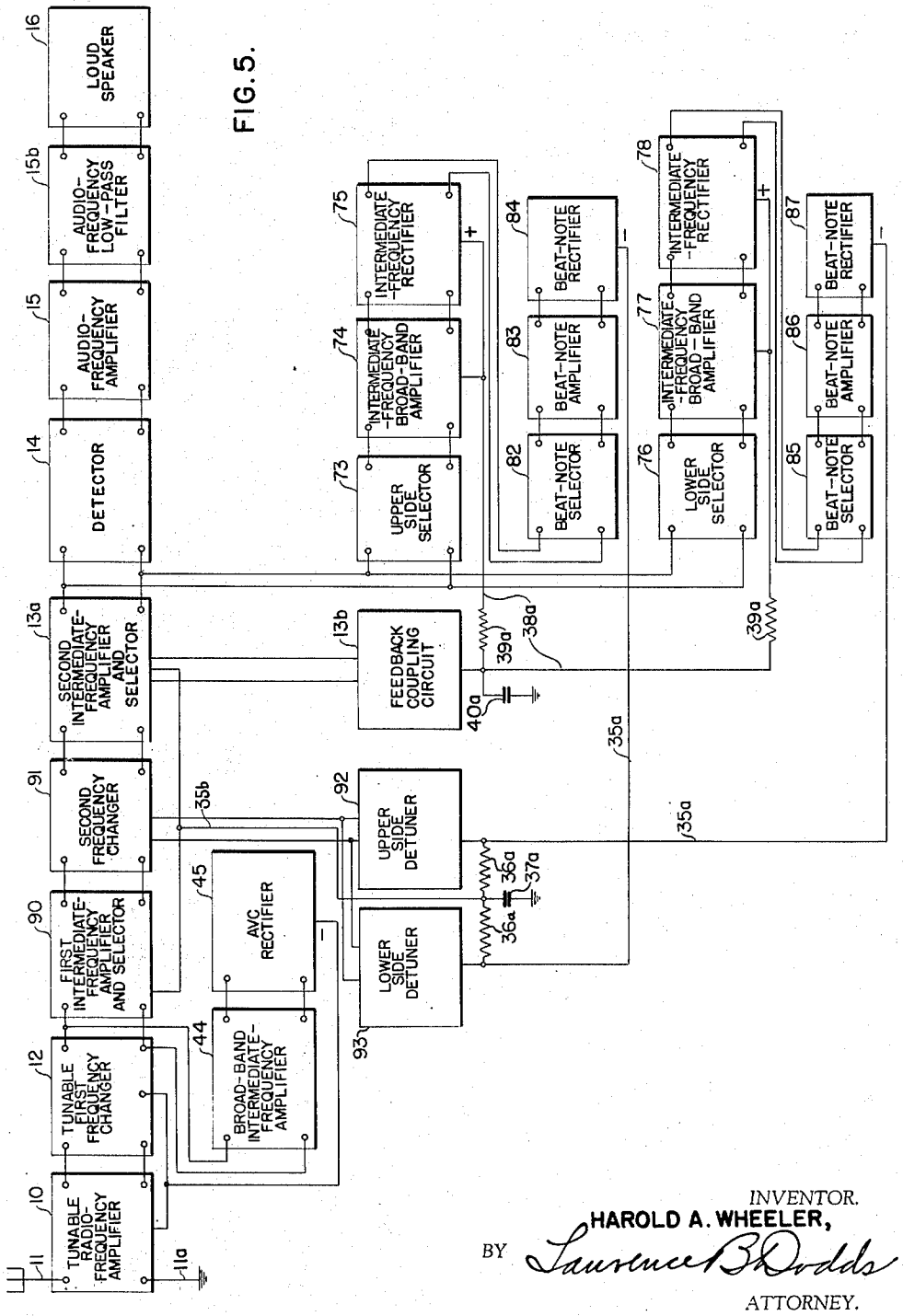
FIG. 5.

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Patented Aug. 8, 1939 2,168,461

# UNITED STATES PATENT OFFICE

2,168,461

## AUTOMATIC SELECTIVITY CONTROL

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Application July 21, 1936, Serial No. 91,657

26 Claims. (Cl. 250—20)

This invention relates to modulated-carrier signal receivers, and particularly to signal-selecting systems for such receivers, and to methods of, and means for, controlling the selectivity and fidelity of reproduction.

In the present system of broadcasting, the different programs or signals are transmitted on carrier frequencies separated by multiples of 10 kilocycles, and the sidebands of modulation of each signal cover ranges of frequency extending approximately 8 kilocycles above and below their respective carrier frequencies. In order to obtain the highest possible fidelity of reproduction of the desired signal consistent with the conditions of reception, it is necessary that the receiver operate to pass the desired signal carrier and as much as possible of its sidebands of modulation without undue interference from undesired signals on carrier frequencies adjacent the desired signal carrier. To this end, the width of the selected band of frequencies may be automatically controlled in accordance with the conditions of reception so that the band may be contracted when a weak desired signal is being received or when an undesired interfering signal is received with sufficient amplitude appreciably to impair the reception, while the selected band may be expanded to the maximum desired width for the reception of a strong desired signal and in the absence of such undesired signals.

Preferably, the control of the selecting system of the receiver should operate in response to undesired signals to contract only the sideband of the desired signal on the same side of the desired signal carrier as the undesired signal, so that the width of the other sideband passed may remain at a maximum, if conditions permit. It is, therefore, highly desirable that the automatic selectivity control be particularly responsive to the adjacent undesired signals. Furthermore, for ideal results, the control should be effective for all operating conditions including periods when the receiver is being tuned, as well as during the reception of a particular program, since, when the receiver is being tuned, the interference from the adjacent signal carriers is especially objectionable.

In applicant's copending application Serial No. 46,081, filed October 22, 1935, there is described a system for automatically controlling the selectivity and fidelity of reproduction of radio receivers in accordance with received signal conditions, that is, in accordance with the amplitude of both the desired signal and undesired signals adjacent the desired signal-carrier frequency. With such a system, difficulty is experienced in obtaining the required degree of sensitivity or responsiveness to the undesired signals. Moreover, since, in such systems, the undesired signals, per se, have been selected and utilized in effecting the selectivity control, during periods when the system is being tuned and undesired signal selection is not feasible, the control is not effective.

It is an object, therefore, of the present invention to provide an improved method of, and improved means for, automatically controlling the selectivity and fidelity of reproduction of a modulated-carrier signal receiver to obtain maximum fidelity of reproduction consistent with the relative intensities of the desired signal and undesired signals on carriers adjacent the desired signal-carrier frequency.

It is a particular object of the invention to provide an improved method and means of the character described above, whereby optimum sensitivity of the control system to the undesired signals may be obtained.

It is an additional object of the invention to provide an improved method and means of the character described above, whereby the desired selectivity and fidelity control is effective while the receiver is being tuned from one signal to another as well as during the reception of a desired program.

It is an additional object of the present invention to provide an improved method and means of the character described, whereby the selectivity control action is delayed a predetermined amount and the operating characteristic of the control means is otherwise so determined that optimum band width is obtained for any given desired received signal amplitude.

Briefly stated, the above objects are attained by providing, in a modulated-carrier signal system, an adjustable band-pass selector and automatic control means therefor. In this system, means are provided for deriving from the desired signal and undesired signals on carrier frequencies adjacent the desired signal carrier a control signal or signals comprising beat notes of said desired and undesired signals which are utilized for controlling the selector to adjust the width of the band of frequencies passed thereby inversely in accordance with the amplitude of the control signals.

The control or beat note signal may be obtained from the output of any of the rectifiers employed in the receiver. Thus, while in a preferred arrangement this signal is obtained from a rectifier employed for providing a control bias volt-

age, which is utilized for selectivity control as well as for automatic amplification control, it may also be derived from an auxiliary automatic amplification control rectifier of the receiver, or from the rectifier or detector which detects the desired signal modulation components.

In certain embodiments of the invention, the width of the band of frequencies passed by an adjustable selector of the receiver is controlled directly in response to the desired signal amplitude at a predetermined point in the system. So-called auxiliary automatic amplification control means are utilized for reducing the desired signal amplitude at such point in response to received adjacent undesired signals, and the band width is, therefore, symmetrically adjusted directly in accordance with the received desired signal amplitude and inversely in accordance with the received undesired signal amplitude. The beat note signal control means may be employed directly in connection with the adjustable selector and connected either to the main selectively control circuits or to the modulation detecting rectifier, or it may be employed indirectly; that is, in connection with the auxiliary amplification control means, in any case to provide effective response of the selectively control to the received undesired signals at all times. Also, in such arrangement, for the purpose of obtaining a delay in the selectivity control action, and otherwise providing the most desirable operating characteristic for the control means, auxiliary means are provided for indirectly modifying the action of the selectively control means. The auxiliary means may, for example, comprise an arrangement for controlling the signal input to the selector inversely in accordance with the desired signal output of the selector.

In another embodiment of the invention, the selector is automatically controlled so that the width of either of the two sidebands of the desired signal passed thereby is independently adjusted in response to an undesired signal near the desired signal carrier and on the same side thereof as the respective sidebands. In this embodiment, there are preferably employed two separate beat note control means of the type described which are individually responsive to beat note signals derived from the desired signal and adjacent undesired signals at opposite sides of the desired signal carrier to procure unsymmetrical selectivity control in response to the undesired signals.

For a better understanding of the invention, together with further objects thereof, reference is had to the following description taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the accompanying drawings, Fig. 1 is a circuit diagram of a complete superheterodyne receiver, partly schematic, embodying the present invention; Figs. 2, 3, 4, and 5 are schematic circuit diagrams of receivers embodying modified forms of the present invention; and Figs. 6 and 7 are graphs representing certain operating characteristics of the receiver to aid in the understanding of the invention.

Referring now more particularly to Fig. 1, there is shown schematically a superheterodyne receiver having selectivity control means embodying the present invention in a preferred form. In general, the receiver includes a tunable radio-frequency amplifier 10 having its input circuit connected with an antenna 11 and a ground 11a, and its output circuit connected to a tunable frequency changer 12, the output circuit of which is, in turn, connected to an intermediate-frequency amplifier and selector indicated generally by the numeral 13. The amplifier 13 embodies a band-pass selector system which is controlled in accordance with the present invention and is hereinafter described in detail. Connected to the output circuit to the amplifier 13, in cascade in the order named, are a detector 14, an audio-frequency amplifier 15, and a loud-speaking 16. It will be understood that the radio-frequency amplifier 10, frequency changer 12, detector 14, amplifier 15, and loud-speaker 16, may be of conventional construction and operation, the details of which are well known in the art, rendering a detailed description thereof unnecessary herein.

While, in accordance with the present invention, any suitable adjustable selector system, per se, may be employed, in the preferred arrangement shown in Fig. 1, the selector system embodied in the amplifier 13 includes two selecting and amplifying stages which are indicated generally at 17 and 18. The stage 17 comprises a tuned input circuit 19, which is loosely coupled to a tuned output circuit 20 of the frequency changer 12, and a tuned output circuit 21 coupled to the tuned input circuit 22 of the stage 18. The input and output circuits 19 and 21 are coupled forwardly and backwardly by means of directive coupling means, such as vacuum tubes 23 and 24, respectively. Suitable voltage sources, as indicated by the batteries 25, provide operating and biasing potentials to the electrodes of the tubes 23 and 24, as shown, and biasing resistors and by-pass condensers are provided where needed in accordance with conventional practice. The grid of the backward coupling tube 24 is initially biased to cutoff. The input electrodes of the tube 23 are coupled to the circuit 19 and the output electrodes of this tube are coupled to the circuit 21, as shown. The output circuit 21 is inductively coupled to the input electrodes of the tube 24 by means of an inductance element 26. The output electrodes of the tube 24 are inductively coupled back to the input circuit 19 by means of an inductance element 27.

The stage 18 is identical in all respects with the stage 17 and includes, in addition to the input circuit 22, a tuned output circuit 28 which is coupled to a tuned input circuit 29 of the detector 14. Directive coupling means are provided for coupling the circuits 22 and 28 in forward and backward directions, as in the stage 18, comprising tubes 30 and 31 and associated coupling circuits.

Each of the circuits 20, 19, 21, 22, 28, and 29 is tuned to the intermediate frequency at which the receiver is operated. Preferably, the circuits 19, 21, 22, and 28 are relatively sharply tuned and have a very low power factor, and the circuits 20 and 29 are relatively broadly tuned and have a power factor approximately twice that of the other circuits, so that the broadly tuned circuits tend to flatten out the double peaked response characteristic of the sharply tuned circuits. In the embodiment illustrated, the windings of the three intermediate-frequency transformers comprising the inductance elements of the six tuned circuits mentioned are loosely coupled.

Neglecting for the moment the particular operation of the selector system embodied therewith and embodying the principal features of the present invention as described hereinafter, the system described above comprising a conventional superheterodyne receiver. The operation of such

receiver is well understood in the art, and a detailed explanation thereof is, therefore, here unnecessary. In brief, however, signals intercepted by the antenna are selected and amplified in the amplifier 10 and delivered to the frequency changer 12 wherein they are converted into intermediate-frequency signals in the well-known manner. The intermediate-frequency signals are selected and amplified in the intermediate-frequency amplifier 13 and passed to the detector 14 wherein the audio-frequency signal is derived. This audio-frequency signal is further amplified in the amplifier 15 and is supplied in the usual manner to the loud-speaker 16 for reproduction.

In considerating the operation of the selector system 13, only that of the stage 17 need be described since the operation of the stages 17 and 18 are substantially identical. By utilizing the tube 23 in the forward coupling means, with no phase reversals in its inductive couplings with the circuits 19 and 21, the alternating voltages appearing across the circuit 21 are substantially reversed in phase with respect to the voltages across the input circuit 19 at frequencies in the vicinity of the resonant frequency of these circuits, at which frequencies these circuits are of high impedance and are substantially resistive. A second phase reversal is secured in the backward path in the tube 24, and a third reversal is secured in the coupling between the inductance 27 and the input circuit 19, so that the voltages impressed on the input circuit 19 through this backward coupling path are substantially reversed in phase at the frequencies indicated with respect to the input voltage directly impressed on this circuit, and the system is degenerative to the maximum degree at the intermediate frequency.

At frequencies substantially above the resonant frequency of the circuits 19 and 21 these circuits are capacitively reactive, so that the voltages at these frequencies across the circuit 21 lag behind the input voltages by phase angles approaching 90 degrees. The feed-back voltages at these frequencies impressed on the circuit 19 are similarly retarded by an additional angle also approaching 90 degrees, so that the feed-back voltages are nearly in phase with the input voltages at these frequencies and the coupling system is regenerative. At frequencies below the resonant frequency of the circuits 19 and 21 these circuits are inductively reactive and a similar phase shift occurs, but in opposite sense, so that the system is also regenerative at these frequencies. However, at these limiting frequencies the impedances of the circuits 19 and 21 are much less than at resonance, the transmission efficiency of the stages 17 and 18 being reduced and the amplitude of the feed-back voltage therefor being reduced, so that, while the system is regenerative, it is entirely stable in operation. At frequencies intermediate the limiting frequencies just described, the feed-back voltages have intermediate phase angles with respect to the input voltages, and the feed-back characteristic of the system thus has a gradual transition from degeneration to regeneration. Hence, the resultant reduction in amplitude of the frequencies near the intermediate frequency and increase in amplitude of the frequencies substantially above and below the intermediate frequency impart to the system a band-pass frequency characteristic like that of inductively coupled tuned circuits.

By adjusting the forward and backward coupling reactions between the resonant input and output circuits of the individual selector stages, the amplification obtained between the terminal circuits of the intermediate-frequency channel and the shape and width of the band-pass characteristic curve may be controlled as desired. Such coupling control is procured, in accordance with the present invention, by varying the bias potentials applied to the several control electrodes of the forward and backward coupling tubes as a function of the amplitude of the desired signal carrier, as well as of the amplitude of undesired signals on carriers adjacent the desired signal carrier.

In order then to produce the required biasing voltages for controlling automatically the amplification in the amplifier 13 and to adjust the width of the band of frequencies passed by the selector system embodied therein, there is provided a broad band intermediate-frequency amplifier 32 with its input circuit coupled to the input circuit 22 of the stage 18 by way of a suitable condenser 33 and an intermediate-frequency rectifier 34 coupled to the output circuit of the amplifier 32. This amplifier and rectifier may be of conventional design, only the load resistor 34*a* thereof being shown, so that a unidirectional voltage is developed across the resistor 34*a* variable in accordance with the intensity of the desired and undesired signal voltages across the circuit 22. The resistor 34*a* is grounded at an intermediate point and a portion of the unidirectional voltage developed thereacross is applied positively to reduce the initial negative bias on the input electrodes of the backward coupling tubes 24 and 31 by way of a lead 35 for varying the amount of backward coupling between the output and input circuits of the stages 17 and 18. Suitable filters including series resistors 36 and shunt condensors 37 are preferably included in the leads 35. A portion of the unidirectional voltage is also applied negatively to the input electrode of the forward coupling tube 30, by way of a lead 38 and a suitable filter comprising a series resistor 39 and a shunt condenser 40, for varying the amount of forward coupling in the stage 18. The control bias voltages developed by the rectifier 34 are proportional to the amplitude of the total signal input thereto.

In order to control this signal input amplitude in accordance with the intensities of received undesired signals and thereby indirectly to adjust the selectors in the stages 17 and 18, there is provided an auxiliary broad-band intermediate-frequency amplifier 44 having its input circuit connected to the output circuit of the frequency changer 12 and its output circuit connected to an automatic amplification control or AVC rectifier 45 having a load resistor 45*a* across which a unidirectional voltage is developed in the usual manner. The radio-frequency amplifier 10 is designed to pass a band of frequencies which is at least as wide as the fully expanded band of intermediate-frequency selector and amplifier 13, this relation being essential to obtain the full benefit of expansion. The intermediate-frequency amplifier 44, however, is designed to pass a broad band of frequencies including not only the desired signal but also all undesired signals which are passed by the radio-frequency amplifier, and which have sufficient amplitude to be capable of overloading the frequency changer or causing interference, and preferably is most responsive to undesired signals on adjacent channels. The rectifier 45 is designed and operates in conventional manner to develop a bias voltage proportional to the amplitude of the total signals supplied thereto. The bias voltage

thus developed is applied negatively, by way of a suitable filter including series resistor 46 and shunt condenser 47, to the control grids of one or more of the tubes of the radio-frequency amplifier 10 and frequency changer 12 to adjust the amplification therein inversely in accordance with the signal input of the rectifier 45. Hence, in the presence of interfering signals, the amplitude of the signal input to amplifier 13 and to amplifier 32 is reduced with a resultant contraction of the band width.

For the purpose of delaying the selectivity control action, and otherwise providing the most desirable operating characteristic for the control means, an adjustable tap is provided on the resistor 34a and is connected to the resistor 45a of the rectifier 45 by way of a suitable filter including a series resistor 34b and shunt condenser 34c. A portion of the voltage developed across the resistor 34a is thus applied in series with that developed by the rectifier 45, the connection being such that it augments the amplification control of the AVC rectifier, as described hereinafter.

In order to obtain increased responsiveness of the selectivity control to undesired signals and to provide such response under all operating conditions, there is provided a beat note selector, amplifier, and rectifier arrangement coupled to the rectifier 34 and responsive only to beat notes in the output thereof of frequencies of the order of 10 kilocycles or greater. This arrangement comprises an amplifier tube 48, which may be of the pentode type, having its input electrodes coupled to the output circuit of the rectifier 34 by way of a selective circuit including a series condenser 49 and shunt inductance element 50 tuned to the 10 kilocycles beat note frequency, the inductance element being grounded at its lower end, as shown. Biasing and operating potentials are applied to the electrodes of the tube 48 from a suitable source as indicated at 51, a coupling resistor 52 being included in the anode circuit of the tube, as shown. The output circuit of tube 48 is coupled to a diode rectifier 53 of the beat note control arrangement by means of a selective circuit including a condenser 54 and inductance element 55. The rectifier load circuit of rectifier 53 comprises a load resistor 57 and by-pass condenser 56. The condenser 54, inductance element 55, and condenser 56 together are tuned to the 10 kilocycles beat note, while the inductance element 55 and condenser 56 together effectively form a trap circuit tuned to 5 kilocycles. An adjustable portion of the unidirectional voltage developed across the resistor 57 is applied negatively to the control grid of the tube 23 by way of the lead 41 and a suitable filter comprising a series resistor 42 and a shunt condenser 43.

The rectifier 34 is preferably linear so that the amplitude of the beat frequency output voltage thereof is substantially equal to the amplitude of the weaker or undesired signal carrier input to the rectifier. The bias voltage, which is developed by this rectifier 34, however, is nearly as great as the peak voltage of the greater carrier of the desired signal. The normal signal level for this rectifier is preferably maintained on the order of 10 volts and the undesired carrier voltage is preferably maintained at a much lower value, such as from .1 to 1 volt. The beat note output of the rectifier 34, therefore, is amplified in the amplifier 48 to about 10 volts before rectification in the rectifier 53 in order that the beat note control may be fully effective.

In considering the operation of the automatic selectivity and fidelity control means of the system just described, it will be assumed that, initially, the bias potentials impressed on the control electrodes of the backward coupling tubes 24 and 31 by the voltage sources are of sufficient magnitude to bias these tubes considerably beyond cut-off and that the bias voltages applied to the forward coupling tubes 23 and 30 are of a magnitude such as to maintain the amplification in these tubes at a maximum in the absence of a received signal. When a relatively weak signal is received and no interfering adjacent signal is present, the negative bias voltage derived from the rectifier 34 and applied to the control grid of the tube 30 is small, while no bias voltage is derived from the beat note rectifier 53 to be applied to the control grid of the forward coupling tube 23. Consequently, the bias of these tubes at this time is large. The positive bias which is applied under these conditions to the backward coupling tubes 24 and 31, by way of the leads 35, is insufficient to overcome the normal fixed negative biases on these tubes and, consequently, no backward coupling or feedback is present between the terminals of the two stages 17 and 18. Hence, the band of frequencies passed by the system under these conditions is of minimum width.

Increases in the amplitude of the received desired signal carrier are accompanied by like increases in the input to the rectifier 34 and the control bias voltage developed thereby. Hence, the bias voltage applied negatively to the control grid of the forward coupling tube 30 is increased, tending to maintain constant the amplitude of the desired signal input to the detector tube 14 in the well-known manner. When the amplitude of the desired signal exceeds a predetermined value, the bias voltage developed by the rectifier 34 and applied positively to the control grids of the backward coupling tube 24 and 31 is sufficient to overcome these normal negative biases and to effect a backward coupling between the terminal circuits of the stages 17 and 18, thereby to expand the width of the frequency band passed through these stages and simultaneously decrease the amplification in the stage 18.

Preferably, the circuit constants of the control system are so proportioned that the forward transconductance of the stage 18 is decreased slightly and the backward transconductances of the two stages are increased greatly with increasing signal intensity above the predetermined signal intensity at which the backward coupling means become effective.

The operation of the control means as thus far described is thus dependent only upon the amplitude of the desired signal input to amplifier 13. When undesired signals on carrier frequencies adjacent the desired signal-carrier frequency are received, however, since the amplifier 44 is most responsive to such signals, the input to the rectifier 45 and the bias voltage developed thereby is increased. The effect of this action is correspondingly to decrease the amplification in the radio-frequency amplifier 10 and frequency changer 12, so that the amplitudes of the desired as well as the undesired signal inputs to the amplifier 13 are decreased. The resultant effect is a corresponding contraction of the band passed by the selector system in response to the undesired signals by virtue of the above-described direct responsiveness of the control circuits to the amplitude of the signal input to the amplifier 12.

Since a portion of the unidirectional voltage developed by the rectifier 34 is applied in series

with the voltage developed by the rectifier 45, the indirect selectivity control is also subject to an auxiliary control in accordance with the amplitude of the desired signal. More particularly, as the desired signal output of the stage 17 of the selector increases, thereby providing an increased negative bias voltage in series with that developed by the rectifier 45, the gain of the radio-frequency amplifier 10 and frequency changer 12 is further reduced by this additional indirect control voltage. Hence, the amplitude of the intermediate-frequency signal input to the rectifier 34 is correspondingly decreased, resulting in a delay in the expansion action until the received desired signal amplitude is sufficient to overcome the reduction in gain just mentioned. Moreover, this additional indirect control has the effect of decreasing the slope of the control characteristic, so that expansion of the band width is not only initiated at a higher signal input level, but the control is at a more gradual rate than would otherwise be the case, thus providing the optimum band width for any given received signal amplitude.

Moreover, when such undesired signals are received, there is developed in the rectifier 34 a control signal comprising beat notes of the desired and undesired signals. This control signal is selected, amplified, and rectified by the beat note control circuits in the manner described above, and the bias voltage thus derived applied negatively to the control electrode of the forward coupling tube 23 in the stage 17 substantially to decrease the amplification in this stage and, hence, the amplitude of the signal output of the stage 17 to which the selectivity control means is directly responsive.

In Fig. 6 there is shown a representative attenuation curve illustrating the response characteristic of the beat note control circuit arrangement as a whole. Here, frequencies in kilocycles are indicated by the abscissae and relative gain in decibels is indicated by the ordinates. As clearly shown by the curve, the control circuit arrangement is most responsive at the 10 kilocycles beat note frequency, and is also responsive at somewhat higher frequencies.

The width of the band passed by the system, therefore, is contracted to avoid the interference effects of the undesired signals whenever the undesired signals are of sufficient amplitude to result in appreciable beat notes. Since the beat note signal will be present during tuning adjustments as well as when a particular program is being received, whenever adjacent undesired signals are present, the beat note control means will be effective at all times to contract the width of the band passed by the selector system in the presence of such undesired signals.

In Figs. 2 and 3 there are illustrated modified forms of the present invention. In general, the circuit arrangements shown in these two figures are the same as that of Fig. 1, corresponding parts thereof being indicated by the same reference numerals in each of the three figures. The construction and operation of the portions of these two modified receivers, which are the same as in Fig. 1, need no further consideration, and only the features of the two modified embodiments which are different will be described.

In the embodiment shown in Fig. 2, a beat note control arrangement is coupled to the output of the rectifier 45 instead of the rectifier 34, as in Fig. 1. As in the system of Fig. 1, the control arrangement comprises a beat note selector 58, a beat note amplifier 59, and a beat note rectifier 60 coupled in cascade, in the order named, to the output circuit of the rectifier 45 for receiving the beat note signals therefrom. The beat note control circuits 58, 59 and 60 may be identical in construction and operation to the beat note control circuits of Fig. 1 which are coupled to the output circuit of the rectifier 34. Since no beat note control bias is derived from the output of the rectifier 34, the lead 38 therefrom is preferably connected to the control electrodes of the forward coupling tubes of both stages 17 and 18. The beat note bias voltage developed across the load resistor 57 of rectifier 60 is applied negatively, by way of a suitable filter including series resistor 61 and shunt condenser 62 and by way of a load resistor 45a of the rectifier 45, to the control grids of the tubes in the radio-frequency amplifier 10 and frequency changer 12; that is, the bias voltage developed by the rectifier 60 supplements the bias voltage developed by the rectifier 45 thereby to increase the effectiveness of control of the amplification in the tunable radio-frequency amplifier 10 and frequency changer 12 in response to the undesired signals. The selectivity and fidelity control thus obtained is responsive to the required degree to the undesired signals and, since it is dependent on signal carriers of fixed frequencies and independent of the selective properties of the receiver which vary during tuning adjustments of the receiver, the control is effective during such tuning adjustments as well as after tuning and during the reception of a particular program.

The embodiment illustrated in Fig. 3 is similar to that of Figs. 1 and 2 excepting for the particular arrangement of the beat note control means. Here there are provided an additional audio-frequency and beat note amplifier 15a interposed between the detector 14 and amplifier 15, and a low-pass filter 15b of any suitable conventional design interposed between the output circuit of amplifier 15 and the loud-speaker 16 for removing the beat notes from the signal-modulation components. The output circuit of the amplifier 15a may be coupled to the input circuit of the amplifier 15 by means of a suitable volume control voltage divider 63.

The amplifier 15a is also coupled by a similar voltage divider 64 to the beat note control circuit comprising a beat note selector 58, a beat note amplifier 59 and a beat note rectifier 60, coupled in cascade and similar in construction and operation to the corresponding circuits of Fig. 1. The unidirectional beat note control bias voltage developed by the rectifier 60 is applied from an adjustable tap of the load resistor 57 of the beat note rectifier 60 to the control electrode of the tube 23 of the amplifier 13. Therefore, the operation of this embodiment of the invention is substantially the same as that of Fig. 1. Here it will be noted the amplifier 15a serves to provide a part of the amplification of both the signal-modulation components and the beat note signal.

In Fig. 4 there is illustrated schematically a complete superheterodyne receiver embodying another arrangement of the present invention, whereby unsymmetrical adjustments of the band of frequencies passed by a selecting system of the receiver may be obtained. This embodiment of the invention comprises the following circuits connected in cascade in the order named: a tunable radio-frequency amplifier 10, a frequency changer 12, an intermediate-frequency amplifier indicated generally at 13, a detector 14, an audio-

frequency amplifier 15, an audio-frequency low-pass filter 15b, and a loud-speaker 16. A broad band intermediate-frequency amplifier 44 and an AVC rectifier 45 are also provided in connection with the amplifier 10 and frequency changer 12. All of these circuits correspond to circuits shown and similarly numbered in the previously described figures and, except as hereinafter set forth, are constructed and operate in the same manner as such corresponding circuits. Therefore, the construction and operation of only those parts of the receiver of Fig. 4 which are different from those of other embodiments of the invention will be hereinafter considered.

In Fig. 4, the amplifier 13 preferably comprises three amplifying and selecting stages 68, 69, and 70, each of which is responsive to the carrier frequency of the signal to be selected, the stage 68 being preferably relatively broadly selective and the stages 69 and 70 being relatively sharply selective. Means, hereinafter referred to as "detuners" and indicated generally at 71 and 72, are provided for detuning or adjusting the frequency response of the stages 69 and 70 in opposite directions with respect to the desired carrier frequency in order to control the width of the band of frequencies passed by the selector on each side of the carrier. The detuners 71 and 72 may be of any suitable type known in the art; for example, the stages 69 and 70 may include resonant circuits normally tuned to the intermediate-carrier frequency, and the detuners may comprise vacuum tubes connected in circuit with these resonant circuits and so arranged as to modify the apparent reactance of, and thereby to detune, the resonant circuits in response to variations in control grid-bias voltages applied to the detuners. An example of such a detuner is illustrated and described in the Proceedings of the Institute of Radio Engineers, volume 23, pages 1125–1141, inclusive, October, 1935, especially Fig. 8 thereof on page 1135. The arrangement shown in this figure is applicable to any tuned circuit, whether or not it happens to be employed in an oscillator, as illustrated.

For deriving the control bias voltages for the detuners 71 and 72, there are provided a plurality of control circuits coupled to the output circuit of the amplifier 13, proportioned to be responsive to the amplitude of the undesired as well as the desired received signals. The control circuits preferably are arranged in two separate channels, one channel comprising, in cascade, a selector 73 which is most responsive at frequencies just above the desired signal carrier, broad band amplifier 74 adapted to pass and amplify the desired signal as well as undesired signals on nearby frequencies, and a rectifier 75. The other channel similarly comprises, in cascade, a selector 76 which is most responsive at frequencies just below the desired signal carrier, broad band amplifier 77 adapted to pass and amplify both the desired signal and undesired signals on nearby frequencies, and a rectifier 78. The selectors 73, 76, amplifiers 74, 77, and rectifiers 75, 78 may be of conventional construction. Thus, there will be developed in the output circuits of the rectifiers 75, 78 unidirectional bias voltages and beat note signals substantially in the same manner as described with reference to the system of Fig. 1. Here, however, due to the action of the selectors 73 and 76, the beat note signal derived by the rectifier 75 will comprise mainly beat notes between the desired signal and upper undesired signals, while the beat note signal derived by the rectifier 78 will comprise mainly beat notes of the desired signal and lower undesired signals. The unidirectional voltages developed in the rectifiers 75 and 78 will depend mainly on the carrier output amplitude of the desired signal, which is greater than that of the undesired signals. These relations will be more readily apparent by reference to Fig. 7 comprising curves representing the frequency-response characteristics of the selectors 73 and 76. Here, frequency displacement in kilocycles from the intermediate frequency is indicated by the abscissae and relative gain in decibels is indicated by the ordinates. The solid-line curve A represents the response characteristic of the upper-side selector 73, while the dotted-line curve B indicates the response characteristic of the lower-side selector 76. It is thus apparent that, while both selectors are responsive to the desired intermediate-carrier frequency, indicated at zero, the upper-side selector 73 is substantially unresponsive to an undesired signal carrier 10 kilocycles below the desired signal carrier, but is substantially most responsive to an undesired signal carrier 10 kilocycles above the desired signal carrier. On the other hand, the lower-side selector 76, while being substantially unresponsive to an undesired signal carrier 10 kilocycles above the desired signal carrier, is substantially most responsive to an undesired signal carrier 10 kilocycles below the desired signal carrier.

For automatically controlling the amplification of the intermediate-frequency amplifier 13 regressively and that of the audio-frequency amplifier 15 progressively, the unidirectional bias voltages developed by the rectifiers 75 and 78 are applied negatively by way of a lead 79 to the control grids of one or more of the tubes of these amplifiers. Suitable filters comprising series resistors 80 and a shunt condenser 81 are included in the lead 79, as shown.

In order to control the selectivity of the receiver in accordance with the beat note control signals, there are connected to the output circuits of the rectifiers 75 and 78 beat note control circuit arrangements. More particularly, a beat note selector 82, amplifier 83, and rectifier 84 are coupled in cascade, in the order named, to the output circuit of the rectifier 75 and, similarly, a beat note selector 85, amplifier 86, and rectifier 87 are coupled to the output of the rectifier 78. The beat note control circuits may be of the same construction as the corresponding circuits described in detail in connection with Fig. 1. Since the beat note signal developed by the rectifier 75 comprises beat notes of the desired signal carrier and undesired signals above the desired signal, while the beat note signal developed by the rectifier 78 comprises beat notes of the desired signal carrier and undesired signals below the desired signal, the bias voltages developed by the rectifiers 84 and 87 vary mainly in accordance with the amplitudes of the upper and lower undesired signals, respectively. It is apparent that the bias voltage developed by the rectifiers 75 and 78, and applied by way of the lead 79 to the amplifiers 13 and 15 for automatic amplification control explained as above, is equal to the average of the rectified voltages of these two rectifiers. The control effected by this voltage is, therefore, responsive mainly to the desired signal carrier amplitude. This average bias voltage is also applied equally and indirectly, by way of the load resistors 57 of both of the beat note rectifiers and suitable filter

resistors 80a and condensers 80b, both to the lower-side detuner 71 and to the upper-side detuner 72, to obtain symmetrical adjustment of the band passed by the selecting system.

For obtaining unsymmetrical adjustment of the band passed by the selector in response to adjacent undesired signals, however, the rectified voltage from each of the rectifiers 84 and 87 is applied positively to its respective detuner 72, 71 in opposition to bias voltage negatively applied thereto from the rectifiers 75 and 78.

In the operation of the receiver shown in Fig. 4, when a relatively strong desired signal is received in the absence of an interfering signal of appreciable strength, the amplitude of the desired signal intermediate-frequency input to the selectors 73 and 76 is correspondingly strong. Since both of these selectors are responsive to the desired signal intermediate-frequency carrier, both of their associated rectifiers 75 and 78 under these conditions develop correspondingly substantial bias voltages. These bias voltages are applied negatively, as explained above, to control the amplification of the amplifiers 13 and 15, thereby to maintain the amplitude of the signal output of the receiver within a relatively narrow range for a wide range of variations in signal input to the amplifiers and they are also applied negatively to both of the detuners 71 and 72, thereby to cause detuning or adjustment of the frequency responsiveness of the selectors 69 and 70 toward frequencies lower and higher, respectively, than the desired signal intermediate-frequency carrier, and hence to effect symmetrical expansion of the band of frequencies passed by the selector system, affording increased fidelity of reception in accordance with well-known principles. Subsequent decreases and increases in amplitude of the desired signal obviously result in corresponding symmetrical contraction and expansion, respectively, of the width of the band passed by the receiver.

When an adjacent undesired signal of appreciable amplitude is being received at one side of the desired received carrier, resulting in an intermediate-frequency signal which is adjacent and above the selected intermediate-frequency carrier, the selector 73 favors this undesired signal and it is amplified with the desired signal in the amplifier 74 and rectified by the rectifier 75, wherein a beat note signal is developed having an amplitude proportional to that of the said undesired signal. This beat note signal is thereupon selected by the selector 82, amplified by the amplifier 83, and rectified by the rectifier 84 similarly to the corresponding operations described in connection with Fig. 1. Thus, a unidirectional control bias voltage is developed by the rectifier 84 in response to the upper undesired signal and is applied positively, in opposition to the bias voltage from the rectifiers 75 and 78, to the detuner 72, thereby decreasing the upper-side detuning, shifting the tuning or frequency response of the selector 70 toward a lower frequency, and effectively contracting the band passed by the selecting system in such a manner as to attenuate such an undesired signal while leaving unattenuated the desired signal sideband on the lower side, if conditions otherwise permit. Obviously, when an undesired signal is received which results in an interfering intermediate-frequency signal adjacent and below the desired signal intermediate-frequency carrier, the selector 76, amplifier 77, rectifier 78, and the beat note selector, amplifier and rectifiers 85, 86, and 87 act in a similar manner to shift the tuning or frequency response of the selector 69 to a higher frequency and effectively to contract the band passed by the selecting system 13 in a direction to avoid the interference component then present. When two interfering signals are present at the same time at opposite sides of the desired carrier, the resultant shift in the mean resonant frequency of the band passed by the selecting system 13 is in a direction away from the side of the undesired signals having the greatest interference value.

The control circuits are so proportioned that the bias voltages developed by the beat note rectifiers 84 and 87 can never exceed the average bias voltage developed by the rectifiers 75 and 78, so that the upper-side detuner can never operate actually to detune its selector 70 to be more responsive to the lower sideband of the desired signal and the lower-side detuner can never operate to detune its selector 69 to be more responsive to the upper sideband of the desired signal, which actions would effect expansion instead of the contraction of the band in response to undesired signals.

It will be noted that the amplifier 44 and rectifier 45 will also operate in connection with the amplifier 10 and frequency changer 12 in the manner described in connection with Fig. 1, so that, with the reception of undesired and desired carriers, the amplitudes of both the desired and undesired signal input to the succeeding stages of the receiver, particularly the selectors 73 and 76, will be reduced, resulting in a symmetrical contraction of the band passed by the system, as explained above.

Referring now to the arrangement of the invention shown in Fig. 5, there is illustrated a complete superheterodyne receiver which is generally similar to the system shown in Fig. 4, and corresponding parts of the two embodiments are designated by corresponding reference numerals. Particular consideration will, therefore, be given only to the portions of the receiver of Fig. 5 which are different from those of Fig. 4.

The receiver of Fig. 5 comprises the conventional tunable radio-frequency amplifier 10 and first frequency changer 12. Connected in cascade to the output circuit of the frequency changer 12, in the order named, are a first intermediate-frequency amplifier 90, a second nontunable frequency changer 91, a second intermediate-frequency amplifier 13a, a detector 14, an audio-frequency amplifier 15, an audio-frequency low-pass filter 15b, and a loud-speaker 16.

Considering briefly the operation of the receiver as thus far described, which is mainly conventional, the desired received signal is selected and amplified in the amplifier 10 and converted to a first intermediate-frequency signal in the frequency changer 12. The first intermediate-frequency signal is selected and amplified in the amplifier and selector 90 and is thereupon converted by the second frequency changer 91 to a second intermediate-frequency signal which is, in turn, selected and amplified in the second intermedate-frequency amplifier and selector 13a and converted by the detector 15 into the audio frequencies of modulation. The audio frequencies are amplified in amplifier 15, beat note frequencies present in the signal being by-passed therefrom by the filter 15b, and the desired signal reproduced by the loud-speaker 16.

A broad band intermediate-frequency amplifier 44 and AVC rectifier 45 are provided in con-

nection with the radio-frequency amplifier 10 and frequency changer 12 in substantially the same manner as in Fig. 1.

For the purpose of adjusting the width of the band of frequencies passed by the intermediate-frequency channel symmetrically in accordance with the amplitude of the received desired and undesired signals, the intermediate-frequency amplifier and selector 13a may be constructed similar to the amplifier 13 of Fig. 1 and include feed-back coupling means which are here indicated separately at 13b for the purpose of clarity. Obviously, however, any other suitable selector arrangement may be employed to effect the symmetrical band width adjustment in the second intermediate-frequency amplifier. The circuits for deriving the control bias voltages for effecting the selectivity adjustments are arranged similar to the corresponding circuits of Fig. 4 and, as mentioned above, the same reference numerals are employed to identify corresponding elements in both figures. The average of the unidirectional bias voltages developed by the rectifiers 75 and 78, mainly in response to the desired signal, is applied positively by way of the leads 38a to the control grids of the backward coupling tubes of the feed-back coupling circuit 13b as in corresponding circuits of Fig. 1. Suitable filters may be included in the control leads 38a, as indicated by the series resistors 39a and shunt condenser 40a.

The average of the unidirectional voltages which are developed in the rectifiers 84 and 87 in response to the beat note signals is applied negatively, by way of the leads 35a and a filter including the resistors 36a and condenser 37a, to the forward coupling tubes of the amplifier 13a. The same reference numerals with the letter a attached have been employed to designate the circuit elements utilized in connection with the amplifier 13a as are employed for the corresponding elements in Fig. 1, and the arrangement and operation of the circuits including these elements are substantially identical in the embodiments shown in both figures.

For the purpose of unsymmetrically contracting the band of frequencies passed by the system in a direction to avoid interfering signals, there is provided in connection with the second frequency changer means for shifting the intermediate frequencies developed thereby, which means are hereinafter referred to generally as lower- and upper-side detuners and are indicated, respectively, at 92 and 93 in the drawings. The detuners in this embodiment may be of the same construction and operation as the detuners of Fig. 4, but in this instance they are both connected in circuit with the second frequency changer 91, as, for instance, to control the frequency of the oscillation circuit thereof. By shifting the oscillation frequency, the lower-side detuner 93 serves to shift the intermediate frequencies developed by the second frequency changer to higher frequencies with respect to the mean resonant frequency of the second intermediate-frequency amplifier and selector 13a, thereby effectively to contact the upper sideband, while the detuner 92 similarly serves to shift the intermediate frequencies to lower frequencies effectively to contract the lower sideband.

In order to control such unsymmetrical contraction in accordance with interfering signals, the beat note control bias voltages developed by the rectifiers 84 and 87 are applied to the detuners 93 and 92, respectively, by way of the leads 35a and the filter comprising series resistors 36a and shunt condenser 37a. Hence, the bias voltage developed by the rectifier 84, in response to an upper-side undesired signal, effects an increase in the intermediate frequencies developed in the second frequency changer 91, thereby substantially to attenuate the upper-side undesired signal interference component passed through the amplifier and selector 13a. Similarly, the bias voltage developed by the rectifier 87, in response to a lower-side undesired signal, effects a decrease in the intermediate frequencies developed in the second frequency changer, thereby substantially to attenuate the lower-side undesired signal interference component. The resultant detuning of the oscillation circuit of the frequency changer 91 is proportional to the difference in the interference values of undesired signals present, respectively, on the upper-side and on the lower-side of the desired signal carrier frequency. When there is the same amount of interference on both sides, the resultant detuning is zero and only symmetrical adjustment of the band width is effected by the undesired signals, as described with reference to the preceding figures. It will be apparent that arrangements of both Figs. 4 and 5 comprise means for deriving from the desired and undesired signal a control signal comprising beat notes of the desired and undesired signal, together with means responsive to the amplitude of the control signal for increasing the frequency difference between the undesired signal and the mean frequency of the band passed by the selector. In the system of Fig. 4 the increase in the frequency difference is accomplished by detuning the intermediate-frequency selector circuit with respect to the desired and undesired intermediate-frequency carrier waves, while in the system of Fig. 5, this is accomplished by shifting the frequencies of the signal-carrier waves relative to the mean resonant frequencies of the selector circuits.

While there have been described what are at present considered the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and, therefore, it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a modulated-carrier signal receiver, a band-pass selector for selecting a desired signal comprising a carrier and a band of modulation frequencies and incidentally passing an undesired signal on a carrier frequency near the desired signal carrier frequency, means for deriving from said desired and undesired signals a control signal comprising beat notes of said desired and undesired signals, and means responsive to the amplitude of said control signal for increasing the frequency difference between said undesired signal and the mean frequency of the band passed by said selector directly in accordance with said amplitude of said undesired signal.

2. In a modulated-carrier signal receiver, a band-pass signal selector and amplifier for selecting and amplifying a desired signal comprising a carrier frequency and a band of modulation frequencies, means coupled to said amplifier for deriving a control bias voltage proportional to the signal amplitude in said amplifier and for deriving from said desired signal and an unde-

sired signal on a carrier adjacent the desired signal-carrier frequency a control signal comprising beat notes of said desired and undesired signals, means for utilizing said bias voltage for controlling said selector primarily to adjust the width of the band of frequencies passed thereby directly in accordance with the desired signal amplitude in said selector, and means for utilizing said control signal primarily to adjust the amplification in said amplifier inversely in accordance with the amplitude of said control signal, thereby indirectly to contract said band sufficiently to substantially limit the amplitude of the undesired signal output from said amplifier.

3. In a modulated-carrier signal receiver, a band-pass selector for selecting a desired signal comprising a carrier frequency and a band of modulation frequencies, means responsive to the amplitude of the signal in said selector for automatically adjusting the width of the band directly in accordance with said signal amplitude, means for deriving from said desired and an undesired signal on a carrier frequency adjacent the desired signal carrier frequency in said selector a control signal comprising beat notes of said desired and undesired signals and means for utilizing said control signal to adjust said band inversely in accordance with the amplitude of said control signal, and auxiliary means responsive to the amplitude of received undesired signals on carriers adjacent the desired signal carrier frequency for controlling the amplitude of the signal input to said selector inversely in accordance with said undesired signals, whereby said band is contracted sufficiently to substantially limit the amplitude of the undesired signal output from said selector.

4. In a modulated-carrier signal receiver, a band-pass selector for selecting a desired signal comprising a carrier frequency and a band of modulation frequencies, means for adjusting the width of the band of frequencies passed by said selector, means for deriving from said desired signal and an undesired signal on a carrier signal adjacent said desired signal carrier frequency a control signal comprising beat notes of said desired and undesired signal, means for automatically controlling said adjusting means primarily to adjust said band directly in accordance with the amplitude of the desired signal input to said selector, and means responsive to the amplitude of said control signal primarily for adjusting the amplitude of the desired signal input inversely in accordance with said amplitude of said control signal, thereby indirectly to contract said band sufficiently to substantially limit the amplitude of the undesired signal output from said selector.

5. In a modulated-carrier signal receiver, a band-pass signal amplifier for selecting a desired signal comprising a carrier frequency and a band of modulation frequencies, means for varying the signal amplification in said amplifier inversely in accordance with the amplitude of the desired signal carrier input to said amplifier to maintain the output thereof within a relatively narrow range for a wide range of input signal amplitudes and for simultaneously adjusting the width of the band of frequencies passed by said amplifier directly in accordance with the amplitude of the desired signal carrier input thereto, means for deriving from the received desired signal and a received undesired signal on a carrier frequency adjacent the carrier frequency of said desired signal a control signal comprising beat notes of said desired and undesired signal, and means responsive to the amplitude of said control signal primarily for adjusting the amplitude of said desired signal carrier input inversely in accordance with said amplitude of said control signal, said means being mutually proportioned indirectly to contract the width of said band sufficiently to maintain the amplitude of the undesired signal less than a predetermined small value in the output of said amplifier.

6. In a modulated-carrier signal receiver, a band-pass signal selector for selecting a desired signal comprising a carrier frequency and a band of modulation frequencies, means for adjusting the width of the band of frequencies passed by said selector directly in accordance with the amplitude of the desired signal carrier input thereto, means responsive to the received desired signal and undesired signals on carriers adjacent the desired signal carrier frequency for deriving a control bias voltage proportional to the amplitude of said undesired signals and for deriving from said desired signal and at least one of said undesired signals a control signal comprising beat notes of said desired and undesired signals, and means responsive to the amplitudes of said control-bias voltage and said control signal primarily for adjusting the amplitude of said desired signal carrier input inversely in accordance with said amplitudes of said control bias voltage and said control signal, said means being mutually proportioned indirectly to contract the width of said band sufficiently to maintain the amplitude of the undesired signal less than a predetermined small value in the output of said amplifier.

7. In a modulated-carrier signal receiver, a band-pass selector for selecting a desired signal comprising a carrier and a band of modulation frequencies and incidentally an undesired signal on a carrier frequency near the desired signal carrier frequency, control means for adjusting the width of the band of frequencies passed by said selector, means responsive to the signal amplitude in said selector for adjusting said control means thereby to adjust said band width directly in accordance with the amplitude of the desired signal in said selector, means for deriving from said desired and undesired signals the modulation components of the desired signal and a control signal comprising beat notes between the desired signal carrier and the undesired signal, means responsive to the amplitude of received undesired signals on carriers adjacent the desired signal carrier frequency for controlling the amplitude of the signal input to said selector inversely in accordance with said undesired signal amplitude, and means responsive to said control signal for adjusting said control means thereby to contract the band of frequencies passed by said selector in accordance with the amplitude of said beat notes, whereby the amplitude of said undesired signals is maintained less than a predetermined small value in the output of said selector.

8. In a modulated-carrier signal receiver, a band-pass selector for selecting a desired signal comprising a carrier and two modulation sidebands, means selectively responsive to an undesired signal on a carrier frequency at one side of the carrier frequency of said desired signal for deriving from said desired and undesired signals a control signal comprising beat notes of said desired and undesired signals, and means re-

sponsive to the amplitude of said control signal for adjusting the width of the desired signal sideband passed by said selector only on the same side of said carrier frequency as said undesired signal and inversely in accordance with said amplitude of said control signal.

9. In a modulated-carrier signal receiver, a band-pass selector for selecting a desired signal comprising a carrier and a band of modulation frequencies, means for deriving from said desired signal and an undesired signal on a carrier frequency adjacent the carrier frequency of said desired signal a control signal comprising beat notes of said desired and undesired signals, and means for automatically adjusting the width of the band passed by said selector inversely in accordance with the amplitude of said control signal and for simultaneously effectively shifting the mean resonant frequency of said selector in a direction away from said undesired signal.

10. In a modulated-carrier signal receiver, a band-pass selector for selecting a desired signal comprising a carrier frequency and a band of modulation frequencies, means for deriving from said desired signal and an undesired signal on a carrier frequency adjacent the carrier frequency of said desired signal a control signal comprising beat notes of said desired and undesired signals, and means for contracting the width of the band passed by said selector in accordance with the amplitude of said control signal and for simultaneously shifting the mean resonant frequency of said selector an amount substantially equal to one-half the amount of said contraction in a direction away from said undesired signal.

11. In a modulated-carrier signal receiver, a band-pass selector for selecting a desired signal comprising a carrier and a band of modulation frequencies, means for deriving from said desired signal and an undesired signal on a carrier frequency adjacent the carrier frequency of said desired signal a control signal comprising beat notes of said desired and undesired signals, and means for adjusting the width of the band passed by said selector inversely in accordance with the amplitude of said control signal and for simultaneously effectively shifting the mean resonant frequency of said selector in a direction away from said undesired signal and to an extent depending upon the amplitude of said control signal.

12. In a modulated-carrier signal receiver, a band-pass selector for selecting a desired signal comprising carrier frequency and modulation sidebands, means for deriving from said desired signal and undesired signals on carrier frequencies adjacent the carrier frequency of said desired signal and at either side thereof control signals comprising beat notes of said desired and undesired signals, and means for automatically contracting the width of the band of frequencies passed thereby in accordance with the amplitude of said control signals and tending simultaneously to shift the mean resonant frequency of said selector in a direction away from the undesired signals having the greater interference value, whereby said band is adjusted symmetrically when said undesired signals at said opposite sides have equal interference values and unsymmetrically when said undesired signals at said opposite sides have unequal interference values.

13. An electric circuit arrangement for controlling the selectivity of a modulated-carrier signal receiver to discriminate against undesired signals on carrier frequencies near the desired signal carrier frequency and at either side thereof comprising a band-pass selector adapted to pass the desired signal carrier frequency and its modulation sidebands, means for deriving from said desired signal and an undesired signal on a carrier frequency on one side of the desired signal carrier frequency a first control signal comprising beat notes of said desired signal and said undesired signal, control means for adjusting, inversely in accordance with said first control signal, the width of the modulation sideband passed by said selector at the same side of the desired signal carrier as said undesired signal, separate means for deriving from said desired signal and a second undesired signal on the opposite side of the carrier frequency of said desired signal a control signal comprising beat notes of said desired signal and said second undesired signal, and a second control means for adjusting, inversely in accordance with the amplitude of second control signal, the width of the modulation sideband passed by said selector at said opposite side of said desired signal carrier frequency.

14. In a modulated-carrier signal receiver, a band-pass selector for selecting a desired signal comprising a carrier and two modulation sidebands, means including a selective circuit most responsive at a frequency at the outer edge of one of the sidebands of frequencies passed by said selector for deriving from said desired signal and an undesired signal at said edge a control signal comprising beat notes between said desired and undesired signal, and means for automatically adjusting the width of one of said sidebands passed by said selector independently of the width of the other and inversely in accordance with the amplitude of said control signal.

15. In a modulated-carrier signal receiver, a band-pass selector for selecting a desired signal comprising carrier and two modulation sidebands, means including a pair of selective circuits most responsive respectively at frequencies at either outer edge of the sidebands of frequencies passed by said selector for deriving from said desired signal and undersired signals at said edges control signals comprising beat notes between said desired and undesired signals, and means for adjusting the width of either of said sidebands independently of the width of the other of said sidebands and inversely in accordance with the amplitude of the control signals derived from the desired and undesired signals at their respective outer edges.

16. In a modulated-carrier signal receiver a band-pass selector for selecting a desired signal in the presence of undesired signals on carrier frequencies adjacent the desired signal carrier frequency, means for adjusting the width of the band of frequencies passed by said selector symmetrically directly and in accordance with the amplitudes of said desired signal and inversely in accordance with the amplitude of said undesired signals, means for deriving from said desired signal and undesired signals control signals comprising beat notes of said signals, and means for automatically unsymmetrically contracting the width of the band of frequencies passed by said selector in accordance with said beat note signals in a direction away from the undesired signal having the greater interference value.

17. In a modulated-carrier signal receiver, a band-pass selector for selecting a desired signal in the presence of an undesired signal on a carrier frequency adjacent the desired signal carrier

frequency, means for automatically expanding the width of the band of frequencies passed by said selector symmetrically in accordance with the amplitude of said desired signal, and separate means for automatically contracting the width of the band of frequencies passed by said selector unsymmetrically in a direction to avoid said undesired signal.

18. In a modulated-carrier signal receiver, a frequency changer for converting received signals to corresponding signals of intermediate frequency, a band-pass selector for selecting the desired intermediate-frequency signal, means for deriving from the desired signal and an undesired signal on a carrier adjacent the carrier frequency of said desired signal a control signal comprising beat notes of said desired and undesired signals, means for automatically adjusting said frequency changer in accordance with the amplitude of said control signal to shift said intermediate-frequency signal in a direction to increase the difference between the mean resonant frequency of said selector and the intermediate-carrier frequency of said undesired signal.

19. In a modulated-carrier signal receiver, a frequency changer for converting received signals to corresponding signals of intermediate frequency, a band-pass selector for selecting the desired intermediate-frequency signal, means for deriving from the desired signal and undesired signals on carriers adjacent the desired signal-carrier frequency and at either side thereof control signals comprising beat notes of said desired and undesired signals, means for automatically adjusting said frequency changer in accordance with the amplitudes of said control signals to shift said intermediate-frequency signal in a direction to increase the frequency difference between the undesired signal having the greatest interference value and the mean resonant frequency of said selector.

20. In a modulated-carrier signal receiver, a frequency changer for converting received signals to corresponding signals of intermediate frequency, a band-pass selector for selecting the desired intermediate-frequency signal, means for adjusting said selector to control the width of the band passed thereby directly in accordance with the amplitude of the desired signal and inversely in accordance with the amplitudes of an undesired signal on a carrier frequency adjacent the carrier frequency of the desired signal, means for obtaining in response to desired signals and said undesired signal a control signal comprising beat notes of said desired signal and said undesired signal, means for automatically adjusting said frequency changer in accordance with the amplitude of said control signal thereby to shift said intermediate-frequency signal in a direction to increase the difference between the mean resonant frequency of said selector and the intermediate frequency of said undesired signal.

21. In a modulated-carrier signal receiver, a frequency changer for converting received signals to corresponding signals of intermediate frequency, a band-pass selector for selecting the desired intermediate-frequency signal, means for adjusting said selector to control the width of the band passed thereby directly in accordance with the amplitude of the desired signal and inversely in accordance with the amplitudes of undesired signals on carrier frequencies adjacent the carrier frequency of the desired signal, means for deriving from the desired signal and undesired signals on carriers adjacent the desired signal carrier frequency and at either side thereof control signals comprising beat notes of said desired and undesired signals, means for automatically adjusting said frequency changer in accordance with the amplitudes of said control signals to shift said intermediate-frequency signal in a direction to increase the frequency difference between the undesired signal having the greatest interference value and the mean resonant frequency of said selector.

22. In a modulated-carrier signal receiver, a band-pass selector, means for adjusting the width of the band of frequencies passed thereby, means for controlling said adjusting means directly in accordance with the desired signal output of said selector, means responsive to undesired signals on carriers adjacent the desired signal carrier for controlling the signal input to the selector inversely in accordance with the undesired signal input, an auxiliary means for modifying the action of said last-named means comprising means for controlling the signal input to said selector inversely in accordance with the desired signal output of said selector.

23. In a modulated-carrier signal receiver, a band-pass selector for selecting a desired signal comprising a carrier frequency and a band of modulation frequencies, means for adjusting the width of the band of frequencies passed by said selector, means for controlling said adjusting means directly in accordance with the amplitude of said desired signal, means responsive to an undesired signal on a carrier near the desired signal carrier for controlling said adjusting means inversely in accordance with the input amplitude of said undesired signal, and auxiliary means for modifying the action of the last-mentioned means comprising means for controlling the signal input to said selector inversely in accordance with the desired signal output of said selector.

24. The method of adjusting the selectivity of a band-pass selector in the signal-selecting system of a modulated-carrier signal receiver, which comprises deriving from a desired signal and an undesired signal on a carrier frequency adjacent the carrier frequency of said desired signal a control signal comprising beat notes of said desired and undesired signals, automatically adjusting the width of the band of frequencies passed by said selector directly in accordance with the amplitude of the desired signal input to said selector and controlling the desired signal input to said selector inversely in accordance with the amplitude of said control signal, thereby indirectly to adjust said band width inversely in accordance with the amplitude of said undesired signal.

25. The method of controlling the selectivity of a modulated-carrier signal receiver to discriminate against an undesired signal on a carrier frequency adjacent the carrier frequency of a desired signal and at one side thereof, which comprises selecting the desired signal including its carrier and modulation sidebands, deriving from said desired and undesired signals a control signal comprising beat notes of said signals, and independently adjusting the width of the selected sideband of said desired signal on the same side thereof as said undesired signal inversely in accordance with the amplitude of said control signal.

26. The method of controlling the selectivity of a modulated-carrier signal receiver to discriminate against undesired signals on carrier

frequencies near the carrier frequency of a desired signal and at either side thereof, which comprises selecting the desired signal including its carrier and modulation sidebands, deriving from the desired signal and undesired signals on carrier frequencies at either side of the carrier frequency of said desired signal control signals comprising beat notes of said desired and undesired signals, and independently adjusting the width of either of the selected sidebands inversely in accordance with the amplitude of the control signal produced from the desired signal and undesired signal at the same side of the carrier frequency of said desired signal as the respective sideband.

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