UNITED STATES PATENT OFFICE

2,262,707

ADJUSTABLE BAND-PASS SELECTOR

John F. Farrington, Flushing, N. Y., assignor to Hazeltine Corporation, a corporation of Delaware

Application February 12, 1936, Serial No. 63,577

11 Claims. (Cl. 250—20)

This invention relates to carrier-frequency signaling systems and particularly to band-pass selectors for such systems adjustable to control the selectivity thereof.

In radio broadcasting systems in general use, programs are transmitted from each station on a carrier frequency which ordinarily has two sidebands of signal-modulation frequencies extending 6 kilocycles or more on each side of the carrier frequency. The various broadcasting stations are allotted carrier frequencies which are uniformly spaced throughout the frequency range, usually 10 kilocycles apart. In many instances, therefore, the sideband frequencies of one carrier overlap those of adjacent carriers received at the same location, or closely encroach thereon. This condition frequently renders it difficult to tune a broadcast receiver to a desired signal without interference from undesired signals on carrier frequencies near the desired signal carrier, particularly when the strength of the undesired signal is comparable to, or exceeds that of, the desired signal. Static and other so-called background noises, which are ordinarily at the higher frequencies of the sidebands, also frequently interfere with quiet operation.

Various types of selecting systems have been devised for use in such receivers to pass a band of desired modulation frequencies sufficiently narrow to reduce greatly the undesired signals and noise. Such narrowing of the band, however, tends to impair the fidelity of reception of the desired signals, since the outer frequencies of the sidebands, corresponding in radio broadcasting to the higher audio frequencies of modulation, are suppressed. Therefore, it is highly desirable that selecting systems be made adjustable so that the width of the selected band may be contracted when an undesired signal or noise of sufficient amplitude to cause interference is present and, in its absence, may be expanded sufficiently to admit and pass all of the sideband frequencies of the desired signal and thereby obtain optimum fidelity of reception.

Especially advantageous arrangements have been devised whereby the width of the selected band is adjusted automatically in accordance with the amplitude of both the desired signal and the undesired signals and noise. Specifically, in such arrangements, the width of the band is adjusted directly in accordance with the amplitude of the desired signal and inversely in accordance with the amplitude of the undesired signals.

Herefore, the adjustment of the width of the band of frequencies passed by a selector system has been accomplished, in most instances, by varying the mutual reactance between reactively coupled circuits or by detuning circuits of the system relative to each other. Certain systems have also been devised whereby the adjustment of the band width is accomplished by the use of adjustable resistors. Systems of the latter type, however, while having certain advantages, have not proved entirely satisfactory for various reasons, chief among which being that, in order to obtain the desired band-pass characteristic in such systems, a plurality of cascaded selecting systems or relatively complicated arrangements have been necessary.

It is an object of the present invention to provide an improved carrier-frequency band-pass selector system by means of which there may be procured optimum fidelity of transmission consistent with the intensities of the desired and undesired signals near the desired signal carrier frequency.

More particularly, it is an object of the invention to provide a band-pass selector system of the type described, wherein adjustable resistive impedance means are employed in a simple and effective arrangement for effecting the selectivity control.

It is a further object of the invention to provide a selector system of the type described, wherein vacuum tube conductances are utilized as the adjustable impedance means.

A further object is to provide a selector system of the character described, whereby the selectivity is automatically controlled in accordance with the amplitudes of the received signals.

For a better understanding of my invention, together with other and 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 accordance with the present invention, an electric circuit arrangement for controlling the selectivity of a modulated-carrier signal band-pass selector comprises input and output terminal circuits and an intermediate circuit reactively coupling said terminal circuits. Each of these circuits is a resonant circuit and is tuned to the desired carrier frequency, the coupling between the circuits being, in the preferred embodiment of the invention, by mutual inductance. The coupling is initially adjusted in accordance with well-known design principles to obtain the maximum desired transmission frequency band.
An adjustable resistive impedance means, in the preferred embodiment a vacuum tube conductance, is effectively connected in circuit with the intermediate circuit and is adjustable over a range including substantially a value providing a power factor for the intermediate circuit which is substantially less than the coefficient of coupling between the intermediate circuit and each of the terminal circuits and a maximum value providing a power factor for the intermediate circuit which is substantially greater than the said coefficient of coupling. Means are provided for adjusting the impedance means over such range, thereby substantially to adjust the width of the band of frequencies passed by the selector.

Adjustable resistive impedance means, such as a vacuum tube conductance, is also preferably effectively connected in circuit with one of the terminal circuits, to provide a proper termination impedance for the selector and effect uniform transmission of frequencies in the band passed by the system. By adjusting the impedance means in the intermediate circuit to increase the decrement thereof and thus, in effect, to decrease the coupling of the input and output circuits and by simultaneously adjusting the impedance means in the terminal circuit to reduce the losses therein, successively narrower transmission characteristics are obtained. Smooth transition from maximum to minimum bandwidth is effected by the provision of unicontrol means for simultaneously adjusting the impedance means in both of the circuits.

In accordance with a preferred embodiment of the invention, the width of the band of frequencies passed by the selector is automatically controlled by adjusting the adjustable impedance means in accordance with the amplitude of desired signal input to the selector. Means are also provided responsive to the amplitude of desired signal on a carrier frequency near the desired signal carrier frequency to vary the amplitude of the desired signal input to the selector inversely with the amplitude of the undesired signal. Thus, the adjustment of the band width of the selector is automatically in accordance with the amplitude of the undesired signal. This arrangement preferably includes also an amplifier preceding the selecting system the amplification of which is automatically controlled in accordance with the amplitude of the selected carrier to maintain the signal output thereof within a relatively narrow range for a wide range of signal input amplitudes, and the same control means is utilized to effect both adjustment of the band width and the automatic amplification control.

Also in accordance with the invention, a radio-frequency receiving system comprises a plurality of cascade-coupled amplifiers and includes means for controlling the selectivity thereof in accordance with the relative amplitude of potentials derived respectively from electrical energy in a limited range of frequencies and from electrical energy in frequency bands adjacent to the limited range. The controlling means comprises at least one coupling device for at least two of the amplifiers, the coupling device including tuned circuits connected with each of the amplifiers and a link circuit for coupling the tuned circuits. The system includes also means responsive to the relative amplitude of the above-mentioned potentials for varying the effectiveness of the link circuit in coupling the tuned circuits.

2,262,707 In the accompanying drawings, Fig. 1 is a circuit diagram of a selector system embodying the present invention; Fig. 2 is a group of curves representing certain operating characteristics of the selector system, to aid in the understanding thereof; Figs. 3 and 4 are circuit diagrams of other forms of the invention; Fig. 5 is a circuit diagram of a complete superheterodyne receiver, partially schematic, embodying the present invention; and Fig. 6 is a curve illustrating the resonance characteristic of the broad band intermediate-frequency amplifier of the receiver shown in Fig. 5.

Referring now more particularly to Fig. 1, there is represented an electric circuit arrangement for controlling the selectivity of a modulated-carrier signal band-pass selector embodying the present invention in which the transmission band is directly controlled by adjustable resistors. A source of carrier-frequency voltage is represented by the amplifier tube 10 having means 11 for applying signal voltage to its control grid. The tube 10 may be, for example, an intermediate-frequency tube of a superheterodyne receiver. Connected to the output circuit of the tube 10 is the selector system of the present invention, comprising a plurality of resonant circuits including an input circuit 11, an output circuit 12, and an intermediate coupling, or link, circuit 13. Each of these circuits comprises one or more inductance elements 12 and one or more tuning condensers 13, by means of which the circuits are individually tuned to a selected frequency, for example, the intermediate-carrier frequency, where the system is used in the intermediate-frequency portion of a superheterodyne receiver. Inductance elements 12 of the circuits I and II and of the circuits II and III, respectively, are inductively coupled. The couplings between the circuits I and II and between II and III are initially adjusted in accordance with well-known design principles to obtain the maximum desired transmission frequency band.

A resistive impedance means, for example, a resistor 14, is connected effectively in circuit with the indirectly varied inversely in accordance with the amplitude of the undesired signal. This arrangement preferably includes also an amplifier preceding the selecting system the amplification of which is automatically controlled in accordance with the amplitude of the selected carrier to maintain the signal output thereof within a relatively narrow range for a wide range of signal input amplitudes, and the same control means is utilized to effect both adjustment of the band width and the automatic amplification control.

With the selector circuit elements initially adjusted to provide maximum band width transmission, upon adjustment of the resistor 14 gradually to increase its resistance, and thus increase the decrement and power factor of the circuit II, a decoupling of the input and output circuits I and III is gradually effected, and consequently the frequency band passed by the system is progressively narrowed. The resistor 15 serves to provide a proper termination resistance for the selector and a flat-top or uniform transmission characteristic therefrom. It is initially adjusted to meet these requirements when the system is adjusted to provide the maximum desired band width. By simultaneously adjusting the resistor 14 to decrease the losses in the circuits II, and the resistor 15 to decrease the losses in the circuits III so that a proper termination impedance for the selector is maintained for all band-width adjustments, the desired transition from broad band...
to sharp selectivity characteristic may be obtained. The adjustable elements of resistors 14 and 15 are preferably connected by uncontrol means, as indicated at U, for the simultaneous control thereof, to effect a smooth transition from minimum to maximum frequency limits of the circuit. The power factor of the tuned circuit constants were approximately as follows: All coils—4.8 millionhenries, all condensers—170 micro-microfarads and mutual inductance between the coupled coils—36 millichem. Since, in an arrangement such as is shown in Fig. 1,

\[
K = \frac{M}{\sqrt{L_1 L_2}}
\]

where the inductances \( L_1 \) and \( L_2 \) are the total inductances of the respective coupled circuits, in the present instance

\[
K = 0.86/4.8 \times 9.6 = 0.082
\]

In varying the bandwidth from maximum to minimum conditions the required power-factor changes were as follows: In circuit II, from 1.7% to 60% and in circuit III, from 9% to 1.7%. The power factor of circuit I was constant 1.7% and determined chiefly by the inherent circuit losses. That is, the power factor of circuit II is adjusted from a value substantially less than that of the coefficient of coupling between the circuits to one substantially greater than, or of the order of ten times, that of this coefficient of coupling, and this provides the desired range of selectivity adjustment.

In Fig. 3 there is illustrated an embodiment of the present invention in which vacuum tube condensates are utilized to effect the band-width adjustment instead of resistors such as are employed in the embodiment shown in Fig. 1. Here, as in the embodiment of Fig. 1, the selector comprises three reductively coupled resonant circuits I, II and III connected to the output circuit of a vacuum tube amplifier 10. Vacuum tubes 16 and 17 are employed as the adjustable resistive impedance elements in circuits II and III, respectively, their space-current paths being effectively in circuit with their respective resonant circuits. The anode-cathode circuit of the tubes 16 is connected in shunt with the maximum impedance point of the circuit II, that is, across the whole inductance of this circuit, and the anode-cathode circuit of the tube 17 is connected in shunt with the maximum impedance point of the circuit III. The tubes 16 and 17 are shown as pentode tubes, connected for triode operation. The cathodes of tubes 16 and 17 are maintained at different potentials by means of a voltage divider comprising resistors 18, 19 and 20 and are connected to ground through high-frequency bypassing condensers 21 and 22, respectively.

A source of unidirectional voltage for controlling the selectivity of the system is applied to terminals 23 of a voltage divider 24. Resistors 25 and 26, connected in series and grounded at their junction, are connected across an adjustable portion of the voltage divider 24. Opposite, and in this case equal, variable voltages from the terminals of resistors 25 and 26 are applied to the grids of the tubes 16 and 17, respectively. In the grid lead of each of the tubes 16 and 17 is included a series resistor 21 and a shunt condenser 28, constituting filter networks for suppressing alternating voltages on the control grids. In the output of the circuit III a coupling condenser 29 and shunt resistor 30 are also provided, constituting a filter for passing the selected band of frequencies to the succeeding part of the
In considering the operation of the selector system of Fig. 3 it will be assumed that initially the control voltages applied to the grids of the tubes 16 and 17 from the voltage divider 24 are reduced to zero; that the cathode bias of the tube 16 is such that the plate impedance of this tube is low, so that the losses and power factor of the circuit II are high; and that the cathode bias on the tube 17 is such that this tube has a very high plate impedance, so that the losses of the circuit III are at a minimum. These conditions correspond to minimum transmission band-width, that is, greatest selectivity of the system. Thereafter as the control voltages applied to the grids of the tubes 16 and 17 are increased in opposite senses, the impedance of the tube 16 increases, thus lowering the losses and power factor of circuit II, while the impedance of the tube 17 decreases, thus increasing the losses and power factor of circuit III, until maximum transmission-band-width conditions are attained, at which time the plate impedance of the tube 16 is very high, approaching infinity, and the plate impedance of the tube 17 corresponds to the correct shunt termination resistance for the maximum-band-pass conditions.

Selectivity curves similar to those of Fig. 2 were obtained from tests of an embodiment of the invention shown in Fig. 3, with control bias adjustments, in volts, as follows:

<table>
<thead>
<tr>
<th>Curve</th>
<th>Tube 16</th>
<th>Tube 17</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>-6</td>
<td>-6</td>
</tr>
<tr>
<td>B</td>
<td>-5.5</td>
<td>-5.5</td>
</tr>
<tr>
<td>C</td>
<td>-5</td>
<td>-4.5</td>
</tr>
<tr>
<td>D</td>
<td>-4.5</td>
<td>-3.5</td>
</tr>
<tr>
<td>E</td>
<td>-3.5</td>
<td>-2.5</td>
</tr>
<tr>
<td>F</td>
<td>-2.5</td>
<td>-1.5</td>
</tr>
<tr>
<td>G</td>
<td>-1.5</td>
<td>-0.5</td>
</tr>
</tbody>
</table>

The tubes 16 and 17 were type 57 pentodes with 180 volts applied to their anodes and cathode biases of 5.5 volts and 14 volts, respectively.

Referring to Fig. 4, there is shown a simplified form of the invention also utilizing vacuum tubes to control the damping of the circuits and thereby effect the band-width adjustments. In this arrangement the adjustable termination impedance means is applied in shunt with circuit I, instead of with circuit III, as in the two previously described arrangements. This termination resistance is provided by the dynamic plate impedance of the pentode vacuum tube 31, which also acts as a signal amplifier. A tube 32 is connected in shunt with the circuit II, substantially in the same manner as the tube 16 in the embodiment shown in Fig. 3, for controlling the damping of this circuit. Tube 32 is shown as a pentode connected and operated as a triode although, of course, any other suitable type of tube may be employed. A source of unidirectional voltage, indicated at 33, is applied across the voltage divider 34 one end of which is grounded and the adjustable tap of which is connected to the control grid of the tube 32 and the suppressor grid of tube 31, through series resistors 35 and shunt condensers 36, which serve as filters substantially in the same manner as described with reference to the corresponding elements in Fig. 3. The plate impedance of the tube 31 is regulated by the adjustment of a negative biasing potential applied to its suppressor grid. The impedance of the tube is maximum when the bias is zero and diminishes to low values with increasing negative potential. A gradual cut-off tube, for example a type 58 tube, is preferably employed in this position.

By adjustment of the voltage divider 34, the damping of the circuits I and II may be effected simultaneously and in opposite senses, thereby to adjust the width of the frequency band passed by the system.

As the alternating-current impedance of the tube 31 is reduced by increasing the negative potential applied to its suppressor grid, the mutual conductance of the tube also diminishes, thus reducing the gain of this tube as a signal amplifier. Such performance, however, is generally desirable in cases where the selectivity is controlled automatically since the change in gain brought about in this manner may cooperate with or be used in lieu of conventional automatic amplification control.

Referring now to Fig. 5, there is illustrated a complete superheterodyne receiver embodying the present invention in a manner whereby adjustment of the selectivity of the receiver is effected automatically in accordance with the amplitudes of both the desired and the undesired signals at the input of the receiver. In general, the receiver includes a tunable radio-frequency amplifier and frequency changer connected in series with a variable band-pass filter embracing two amplifiers 30 and 31, having its input connected with an antenna 41 and ground 42 and its output connected to an intermediate-frequency amplifier 43 by means of a band-pass selector system 44. A selective coupling network 45 serves to couple the output of the intermediate-frequency amplifier 43 to an amplifier 46 which is in turn coupled to an audio-frequency system 47.

The selector system 44, coupling network 45, rectifier 46 and the automatic amplification control means form parts of, or cooperate with, the system of the present invention and will be hereinafter described in more detail.

Neglecting for the moment the operation of these parts of the receiver, the apparatus just described constitutes, in general, a conventional superheterodyne receiver. The operation of such a receiver is well-known in the art and a detailed explanation thereof is, therefore, unnecessary. In brief, however, signals intercepted by the antenna are selected, amplified and converted to intermediate frequencies in the well-known manner in the tunable radio-frequency amplifier and frequency changer 49. The intermediate-frequency signals are transmitted by the selector system 44 to the intermediate-frequency amplifier 43 wherein they are further selected and amplified and from which they are delivered to the rectifier 46, whereby the audio-frequency signals are derived. The audio-frequency signals are transmitted to the audio-frequency system 47 wherein these signals are amplified and supplied in the usual manner to a loudspeaker for reproduction.

The selector system 44 in this embodiment of the invention is similar in many respects to the embodiment shown in Fig. 3, and only its distinguishing features, therefore, will be described. A single tuning condenser 13 is employed for the circuit II but is equivalent to the two corresponding condensers of Fig. 3. Control vacuum tubes 16 and 17, corresponding to the tubes 16 and 17 in Fig. 3, are here shown as triodes, although the same type of tubes as used in the other embodiment may, of course, also be employed here. The tubes 48 and 49 are connected and operate substantially in the same manner as the control tubes of Fig. 3, excepting that here the control
electrodes of the respective tubes are connected, for automatic control, with the output circuit of the rectifier 46 as will presently be described.

The selective coupling network 45 is a broad band coupling and may comprise an intermediate-frequency transformer including a primary winding 50, which is tuned to the intermediate frequency by a condenser 51 and is coupled to the output of the last stage of the intermediate-frequency amplifier 43, and a secondary winding 52, which is tuned to the intermediate frequency by an adjustable condenser 61, and applied to the grid of the rectifier 46. The windings 50 and 52 are coupled sufficiently to provide the desired broad band transmission characteristic when the winding 52 is properly terminated.

The rectifier 46 is a diode having connected between its cathode and anode a load circuit which includes series-connected resistors 54, 55, 56 and 57, the resistors 54 and 55 being shunted by a high-frequency by-pass condenser 58 and the resistors 56 and 57 being shunted by a similar condenser 59. The resistors 55 and 56 are also shunted respectively by high-frequency by-pass condensers 60 and 61, respectively. The common junction between the condensers 58 and 59 and 60 and 61 and the resistors 55 and 56 is grounded. The unidirectional voltage developed across the resistor 55 is applied negatively through the lead 63 by a large time constant filter including series resistor 63 and shunt condenser 64 to the control electrode of one or more of the tubes of the intermediate-frequency amplifier 43 and to the control grid of the tube 48 of the selector system 44. A further filter including series resistor 65 and shunt condenser 66 is also included in the lead 62 to the grid of tube 48. The unidirectional voltage simultaneously developed across the resistor 56 is applied positively through the lead 67 by a large time constant circuit including a series resistor 68 and shunt condenser 69 to the control grid of the tube 49. The audio-frequency voltage developed by the load circuit is transmitted by means of connection 70 to the audio-frequency system, as shown.

The control of the selectivity is accomplished in this embodiment automatically in accordance with the amplitude of both the desired and undesired signal input to the receiver. The amplification in the intermediate-frequency amplifier 43 is controlled in accordance with the amplitude of the desired signal input to the rectifier 48 by means of the biasing voltage developed across resistor 55 and applied to the grids of one or more of the tubes of the intermediate-frequency amplifier as above described. The selectivity of the selector system 44 is also controlled by the biasing voltage developed across resistors 55 and 56 which are proportionally to the desired signal input amplitude to the amplifier 43.

To procure selectivity control of the selector 44 by the undesired signals, an auxiliary broad band intermediate-frequency amplifier 71 is connected to the output of the radio-frequency amplifier and frequency changer 40, and the output of the amplifier 71 is, in turn, connected to an automatic amplification control, or first AVC rectifier, 72. The radio-frequency amplifier 40 is designed to pass a band of frequencies which is at least as wide as the fully explicable band of the intermediate-frequency amplifier 43 and the selectivity of the selector system 44. The amplification of the undesired signal carrier input to the intermediate-frequency amplifier 43 is the factor which directly determines the degree of amplification therein and the band

stantially wider than that of the radio-frequency amplifier; that is, it passes and amplifies not only the desired signal but also the undesired signals which are passed by the radio-frequency amplifier and frequency changer 40 and which have sufficient amplitude to be capable of causing interference or overloading the frequency changer.

The rectifier 72 is designed and operated in conventional manner to develop a unidirectional biasing voltage proportional to the amplitude of the signal input thereto. The biasing voltage thus developed is applied negatively to the control grids of one or more of the tubes of the radio-frequency amplifier and frequency changer 40 to control the amplification therein inversely in accordance with the amplitude of the input to the rectifier 72.

Hence, in the presence of interfering signals, the desired carrier input amplitude to the intermediate-frequency amplifier 43 is reduced, with the resultant contraction of the band by the selector 44, as previously explained.

Since, as before mentioned, the undesired signals which produce the interference are those on carriers adjacent the desired signal carrier and separated therefrom by about 10 kilocycles in the standard American broadcast system, the intermediate-frequency amplifier 71 in the preferred embodiment of the invention is designed to have a characteristic such as is illustrated by the curve of Fig. 5a. In that figure relative gain in decibels is plotted against frequency difference in kilocycles from the intermediate frequency indicated as O. Thus, the amplifier 71 is designed to be more responsive to adjacent carrier frequencies than to the desired carrier frequencies or other frequencies. Hence, by virtue of this characteristic, the adjacent undesired signals have relatively a substantially increased effect; that is, a relatively greater contraction of the bandwidth is effected by these signals than by desired signals or other signals. The construction and operation of amplifiers having a characteristic curve such as that shown in Fig. 5a is well understood by those skilled in the art and a detailed description thereof is deemed unnecessary.

The rectifier 72 together with the rectifier 46 also provide double automatic volume control, the control by rectifier 72 serving to keep the signal level well below the overload level in the first part of the receiver and the control provided by the rectifier 46 serving, as above described, to maintain the amplitude of the output of the amplifier 43 substantially uniform. By thus avoiding overloading of the receiver, distortion of the desired signal and cross-modulation of the desired signal by undesired signals will be obviated.

The amplification of the intermediate-frequency amplifier 43 is controlled not only by the application of the biasing voltage applied to the control electrodes thereof from the rectifier 46, as above mentioned, but may also be controlled to a certain extent, by action of the selector 44.

Reviewing briefly, then, the general operation of the receiver shown in Fig. 5, it is noted that an increase in the bias voltage developed by the rectifier 46 has the effect of controlling both the amplification of the intermediate-frequency amplifier 43 and the selectivity of the selector system 44. The amplification of the desired signal carrier input to the intermediate-frequency amplifier 43 is the factor which directly determines the degree of amplification therein and the band...
width of the selected band. In the absence of undesired signals this general relation is sufficient for satisfactory reproduction and no other type of control is needed. When, however, there is present an undesired signal on a frequency near the desired signal carrier frequency and of sufficient amplitude to be capable of causing interference, this signal is passed by the broad band intermediate-frequency amplifier to the rectifier and the control biasing voltage developed by this rectifier is utilized to control the radio-frequency amplifier and thereby effect a reduction of the desired signal input amplitude to the intermediate-frequency amplifier. Since the rectifier is responsive to the output of the amplifier regardless of whether the amplitude thereof has been varied in response to desired or undesired signals, the undesired signals will thus indirectly effect a contraction of the frequency band passed by the selector.

In summary, therefore, the circuit arrangement of Fig. 5 provides, in a radio receiving system, a plurality of cascade-coupled amplifiers and including means for controlling the selectivity thereof in accordance with the relative amplitude of the potential derived by the rectifier from electrical energy in a limited range of frequencies and passed by selector and from the potential derived by rectifier from electrical energy in frequency bands adjacent to the limited range passed by amplifier. The selectivity-controlling means comprises at least one coupling device for the two amplifiers and the coupling device includes tuned circuits and III connected with the amplifiers respectively and a link circuit II for coupling the tuned circuits I and III. The circuit of Fig. 5 additionally includes means responsive to the relative amplitudes of the control potentials for varying the effectiveness of the link circuit II in coupling the tuned circuits I and III.

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

What is claimed is:
1. An electric circuit arrangement for controlling the selectivity of a modulated-carrier signal band-pass selector comprising input and output terminal circuits and an intermediate circuit reactively coupling said terminal circuits, each of said circuits being a resonant circuit tuned to a selected carrier frequency, resistive impedance means effectively in circuit with said intermediate circuit and adjustable over a range including a minimum value providing a power factor for said intermediate circuit which is substantially less than the coefficient of coupling between said intermediate circuit and each of said terminal circuits and a maximum value providing a power factor for said intermediate circuit which is substantially greater than the coefficient of coupling, and means for adjusting said impedance means over said range, thereby substantially to adjust the width of the frequency band passed by said selector.
2. A carrier-frequency band-pass selector system comprising input and output terminal circuits and an intermediate circuit coupling said terminal circuits, each of said circuits being a resonant circuit tuned to a selected carrier frequency, resistive impedance means effectively in circuit with said intermediate circuit and adjustable over a range including a minimum value providing a power factor for said intermediate circuit which is substantially less than the coefficient of coupling between said intermediate circuit and each of said terminal circuits and a maximum value providing a power factor for said intermediate circuit which is substantially greater than the coefficient of coupling, and means for adjusting said impedance means over said range, thereby substantially to adjust the width of the frequency band passed by said selector.
6. A carrier-frequency band-pass selector system comprising three resonant circuits individually tuned to a selected carrier frequency and including input and output circuits and an intermediate circuit, said circuits being reactively coupled to pass a band of frequencies between desired frequencies of maximum separation, resistive impedance means effectively in circuit with said intermediate circuit and adjustable over a range including a minimum value providing a power factor for said intermediate circuit which is substantially less than the coefficient of coupling between said intermediate circuit and each of said terminal circuits and a maximum value providing a power factor for said intermediate circuit which is of the order of ten times the value of said coefficient of coupling, and means for adjusting said impedance means over said range, thereby substantially to adjust the width of the frequency band passed by said system.

7. A carrier-frequency band-pass selector system comprising three resonant circuits individually tuned to a selected carrier frequency, including input and output terminal circuits and an intermediate circuit, said terminal circuits being reactively coupled to said intermediate circuit to a predetermined extent and said intermediate circuit and one of said terminal circuits normally having power factors of substantially zero, whereby said circuits will pass a band of frequencies between desired frequencies of maximum separation, adjustable resistive impedance means effectively in circuit with said intermediate circuit and normally having negligible effect on the power factor thereof, and means for adjusting said resistive impedance means to increase the power factor of said intermediate circuit and thereby decrease the width of the band of frequencies passed by said system.

8. A carrier-frequency band-pass selector system comprising input and output terminal circuits and an intermediate circuit coupling said terminal circuits, each of said circuits being a resonant circuit tuned to a selected carrier frequency, said intermediate circuit and one of said terminal circuits normally having power factors of substantially zero, whereby said circuits will pass a band of frequencies between desired frequencies of maximum separation, adjustable resistive impedance means effectively in circuit with said intermediate circuit and normally having negligible effect on the power factor thereof, adjustable resistive impedance means effectively in circuit with said other of the terminal circuits and normally adjusted to provide a predetermined maximum power factor therefor to effect a proper termination impedance for said selector, and means for simultaneously adjusting said impedance means to increase the power factor of said intermediate circuit and thereby decrease the width of the frequency band passed by said system and to decrease the power factor of said other termination circuit to provide a proper termination impedance for said selector at all band-width adjustments.

9. A radio receiving system having a plurality of cascade-coupled amplifiers and including means for controlling the selectivity thereof in accordance with the relative amplitude of potentials derived respectively from electrical energy in a limited range of frequencies and from electrical energy in frequency bands adjacent to said limited range, in which said means comprise at least one coupling device for at least two of said amplifiers, said coupling device including tuned circuits connected with each of said amplifiers and a link circuit for coupling said tuned circuits, and means responsive to the relative amplitude of said potentials for varying the effectiveness of said link circuit in coupling said tuned circuits.

10. In a modulated-carrier signal receiver, a band-pass selector, for selecting a desired signal comprising a carrier and a band of modulation frequencies, including input and output terminal circuits and a link circuit reactively coupling said terminal circuits, and means responsive to the amplitude of an undesired signal on a carrier-frequency near the desired signal-carrier frequency for varying the effectiveness of said link circuit in coupling said terminal circuits to adjust the width of the band of frequencies passed by said selector inversely in accordance with said undesired signal amplitude.

11. 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, including input and output terminal circuits and a link circuit reactively coupling said terminal circuits, means for varying the effectiveness of said link circuit in coupling said terminal circuits to adjust the width of said band of frequencies passed by said selector, means responsive to the amplitude of an undesired signal on a carrier frequency near the desired signal carrier frequency for automatically controlling said adjusting means to adjust said band width inversely in accordance with the input amplitude of said undesired signal.

JOHN F. FARRINGTON.