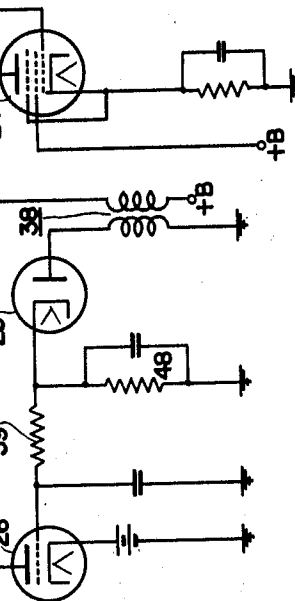
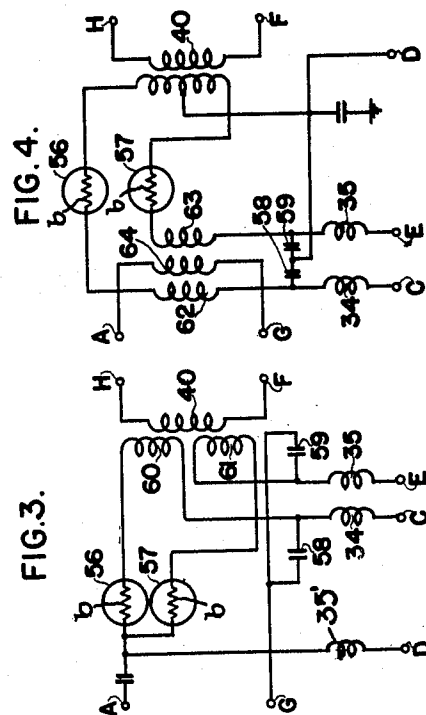
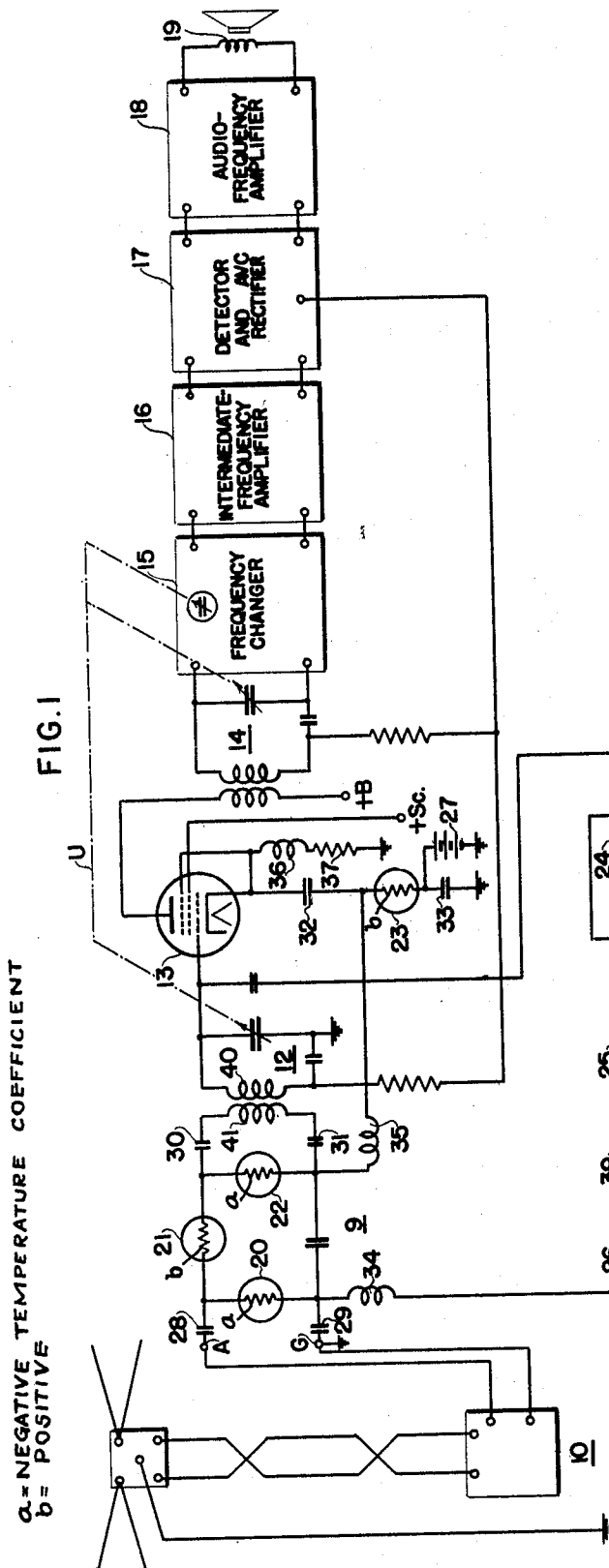


Dec. 5, 1939.

H. A. WHEELER
ATTENUATING NETWORK
Filed June 23, 1937

2,182,329

2 Sheets-Sheet 1



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Dec. 5, 1939.

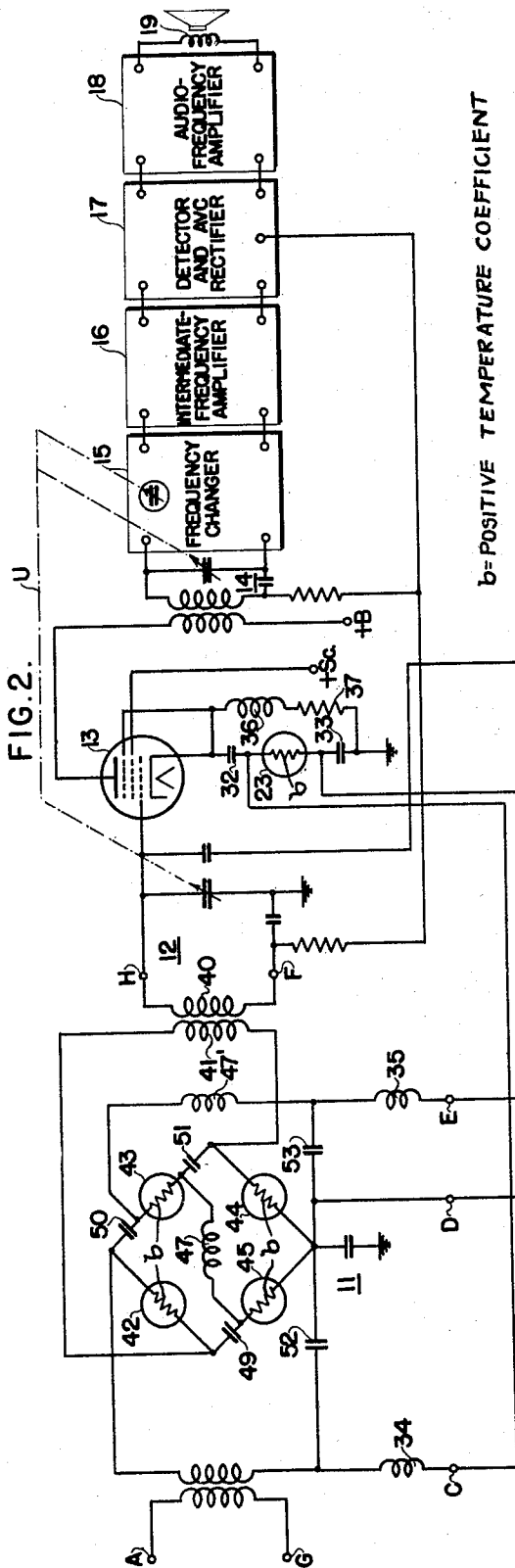
H. A. WHEELER

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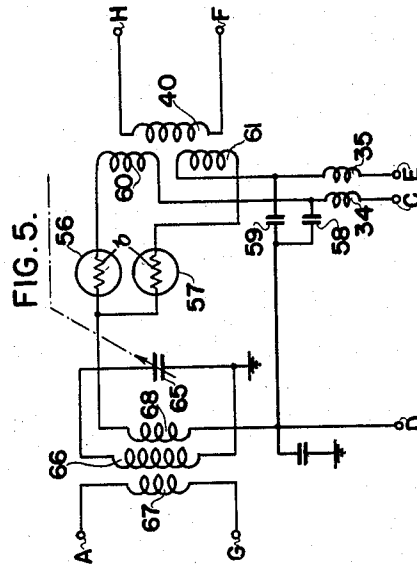
ATTENUATING NETWORK

Filed June 23, 1937

2 Sheets-Sheet 2



b= POSITIVE TEMPERATURE COEFFICIENT



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UNITED STATES PATENT OFFICE

2,182,329

ATTENUATING NETWORK

Harold A. Wheeler, Great Neck, N. Y., assignor
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Application June 23, 1937, Serial No. 149,795

18 Claims. (Cl. 179—171)

This invention relates to modulated-carrier signal receivers and, more particularly, to an arrangement for reducing the maximum amplitude and the range of amplitude variation of the input to the first repeater stage of the receiver.

Under normal operating conditions, a modulated-carrier signal receiver is subject to the reception of signals of amplitudes varying within very wide limits. As a result, the input to the first repeater stage of the receiver normally has a correspondingly wide range of variation. For weak signals, it is desirable to maintain the gain from the antenna to the first repeater stage of the receiver at a maximum in order to raise the signal substantially above the noise level and thus to procure the maximum useful sensitivity of the receiver. However, as the strength of the desired received signal increases to such an extent that the swing of the grid of the first repeater stage includes a substantial nonlinear portion of the characteristic curve of the repeater, distortion of the desired signal-modulation envelope and cross modulation of the desired signal carrier by strong undesired signals may result. This is particularly true in the case of receivers provided with automatic amplification control by which strong signals cause the grid to be biased toward that portion of its characteristic which is most nonlinear. Undesired signals, as well as desired signals, which reach the input electrodes of the first repeater stage have the effect of increasing the grid swing to such an extent that these disturbing effects result. It is well known that such envelope distortion and cross modulation are effects which cannot be filtered out by succeeding selective circuits.

In general, the preselector of the receiver should be selective to pass a band of desired modulation frequencies sufficiently wide to provide the desired fidelity of reproduction. Generally speaking, if an attempt is made to decrease the input to the first repeater stage by attenuating the undesired signals passed by the selector by adjusting its band width, the fidelity of reproduction is impaired to an intolerable degree. Furthermore, this does not remove the envelope distortion of abnormally strong desired signals.

Various expedients have been proposed for automatically and adjustably attenuating the input to the first repeater stage in order to eliminate the disturbing effects described above. In certain arrangements, adjustable impedance elements, such as vacuum tubes, have been connected in circuit with the preselector circuits of the receiver adjustably to damp such circuits,

thereby adjustably to attenuate the input to the first repeater. This type of element, however, is usually inherently of high impedance, which restricts its application to a parallel connection with other elements of the preselector circuit. As thus connected, such an adjustable impedance generally has an undesirable effect on the selectivity or the band-pass characteristic of the preselector with which it is associated. In addition, both desired and undesired signals may be present with amplitudes sufficient to cause nonlinear fluctuation of the vacuum-tube shunt conductance, with resulting envelope distortion of the desired signal and cross modulation thereof by an undesired signal. Furthermore, the inter-electrode capacitance of such element incidentally influences the resonant frequency of the circuit with which it is connected. This effect is undesirable in radio-frequency preselector circuits which are tunable over a range of frequencies, both because it tends to restrict the tuning range and because its detuning effect may vary with adjustments in its attenuation effect.

It is an object of the invention, therefore, to provide an improved, simple, and economical arrangement which may be easily adjusted to control the sensitivity of a modulated-carrier signal receiver in such a manner as to eliminate the effects described above.

It is a further object of the invention to provide an arrangement for adjustably attenuating the input to a repeater stage of a modulated-carrier signal receiver with freedom from undesired cross modulation of the desired signal carrier by strong undesired signals on nearby frequencies.

It is a further object of the invention to provide an arrangement of the type described which secures the desired result without affecting the selectivity of a radio-frequency selector with which it is associated.

Briefly, the above objects are attained in accordance with the present invention by providing effectively in circuit with each of certain of the selector circuits included in the radio-frequency channel of a modulated-carrier signal receiver, a resistance element having no substantial fluctuation of resistance at either radio or audio frequencies, but a considerable variation of resistance with respect to temperature. More specifically, resistance elements having a substantial current coefficient of resistance are used and, by means of adjustable heating currents, are caused to vary the attenuation of the several circuits with which they are associated. The invention contemplates in particular the use of

such a device in the first radio-frequency selector circuit of the receiver for increasing the attenuation from the antenna to the first repeater during reception of strong signals which tend to produce distortion and cross modulation effects. In the preferred arrangement, the attenuation control is in accordance with the amplitude of both desired and undesired signal input to the first repeater. A tungsten filament incandescent lamp is one form of resistance element having the desired characteristic.

The novel features which are believed to be characteristic of this invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with further objects thereof will best be understood by reference to the specification taken in connection with the accompanying drawings, in which Fig. 1 illustrates one form of the improved attenuation control as applied to a radio broadcast receiver of the superheterodyne type; while Figs. 2, 3, 4, and 5 illustrate modifications of the attenuator system included in Fig. 1.

Referring to Fig. 1 of the drawings, there is shown a circuit diagram of a complete modulated-carrier signal receiver of the superheterodyne type embodying the invention, in which certain conventional portions are indicated schematically since they, per se, form no part of the invention. This receiver comprises, in cascade, an antenna circuit 10, a preattenuating circuit 9, a tunable radio-frequency selector 12, a radio-frequency amplifier 13, a tunable radio-frequency selector 14, a tunable frequency changer 15, an intermediate-frequency amplifier 16 of one or more stages, a detector and A. V. C. rectifier 17, an audio-frequency amplifier 18 of one or more stages, and a loud-speaker 19. Automatic amplification control is secured in a well-known manner by applying a unidirectional voltage derived from the detector and A. V. C. rectifier 17 to the control electrodes of one or more of the tubes included in the radio-frequency and intermediate-frequency channels, as shown in the drawings.

Antenna circuit 10 is coupled to selector 12 by means of an attenuating circuit, indicated generally at 9, which is adjustable to vary the effective coupling between antenna circuit 10 and selector circuit 12. Suitable operating potentials are supplied to amplifier 13 from sources indicated as +Sc and +B.

Neglecting for the present the operation of the preattenuating means, the apparatus just described constitutes, in general, a conventional superheterodyne radio receiver, the operation of which is well understood in the art. In brief, signals intercepted by antenna circuit 10 are selectively amplified by selector 12 and amplifier 13, are further selected in selector 14, and are converted to an intermediate-frequency signal in frequency changer 15. The intermediate-frequency signals are amplified in intermediate-frequency amplifier 16 and are delivered to rectifier 17, wherein the audio-frequency signals and the A. V. C. biasing potential are derived. These signals are, in turn, amplified by audio-frequency amplifier 18 and supplied to loud-speaker 19 for reproduction. The automatic amplification control is effective to maintain the signal output of the receiver within narrow limits for a wide range of received signal intensities.

Referring now more particularly to the preattenuating system for controlling the input to

amplifier 13, the arrangement comprises, in general, means for controlling the preattenuator circuit 9 coupled to the selector 12 by means of inductively coupled windings 40, 41 and means for simultaneously controlling the grid bias of amplifier 13 to reduce the effective signal input to amplifier 13, both in accordance with the magnitude of the total signal input to amplifier 13. The means for adjusting the input of amplifier 13 comprises resistors 20 and 22, connected in shunt to the antenna circuit 10, each having a negative temperature coefficient of resistance, and a resistor 21 effectively in series in the circuit 9 and interposed between resistors 20 and 22 and having a positive coefficient. A resistor 23 included in the cathode circuit of tube 13, also having a positive coefficient, provides a controllable degeneration of this tube. Incandescent lamps having a carbon filament have been found to be satisfactory for resistors 20 and 22 and incandescent lamps having a tungsten filament have been found to be satisfactory for resistors 21 and 23. These resistors are selected so that they have a considerable variation of resistance with respect to temperature, but a substantial thermal inertia; that is, neither radio-frequency nor audio-frequency currents produce any appreciable fluctuation of temperature or resistance.

In order to vary the temperature and, therefore, the resistance of resistors 20-23, inclusive, there is provided a control circuit substantially less frequency-selective than selector 12 and including, in series, the resistors 20-23, inclusive, the space current path of a direct current amplifier 26, and a source of space current, such as a battery 27. There is also provided a control tube 24, preferably of the pentode type, having its input electrodes coupled to the input circuit of amplifier 13 and its output electrodes coupled through coupling transformer 38 to a diode rectifier 25 having a load circuit 48 across which is developed a unidirectional voltage proportional to the total signal input to the amplifier 13. The voltage across the load circuit 48 is impressed upon the control grid of direct current amplifier 26 through coupling resistor 39. Direct current is prevented from flowing in other parts of the signal channel by suitable blocking condensers 28-33, inclusive, while choke coils 34 and 35 in the control circuit just described prevent the dissipation of radio-frequency currents in the direct current circuit. A direct current path for the space current of tube 13 is provided by radio-frequency choke coil 36 and resistor 37 connected between its cathode and ground.

In coupling a circuit, such as preattenuator 9, into a receiver circuit, it is known that there is a tendency for the impedance of the attenuating circuit to be reflected in some degree into the tuned circuits to which it is coupled and in this way alter the selectivity of the receiver. In order to minimize this tendency, preattenuator 9 is so designed that antenna circuit 10 and selector circuit 12 are respectively coupled to preattenuator 9 in such manner that each of the circuits is terminated approximately in its image impedance. This terminating impedance, comprising preattenuator 9, does not vary materially as the resistances of resistors 20, 21, and 22 are varied by the control circuit, due to the fact that the values of resistors 20 and 22 are varied in opposite sense to that of resistor 21. The antenna circuit 10 is preferably constructed in accordance with the disclosure of United States

Letters Patent No. 2,064,774, granted December 15, 1936, on an application of Harold A. Wheeler, and has an approximately uniform resistive image impedance over its operating frequency range.

In considering the operation of the system described above, it will be seen that the input to amplifier 13 is also applied to tube 24 and, through rectifier 25 and direct current amplifier 26, produces current through resistors 20—23, inclusive, which varies in accordance with the intensity of both desired and undesired signal input to amplifier 13. As the control current increases in response to increasing signal inputs, the resistance of series resistor 21 increases and that of shunt resistors 20 and 22 decreases, progressively attenuating the input to the amplifier 13, that is, resistor 21 and either of resistors 20 and 22 are so connected that a variation thereof in a given sense would be effective to vary the selectivity of the coupling system 9 in the same sense and to vary its coupling in opposite senses. At the same time, as the control current increases, the resistance of resistor 23 increases and, since it is unby-passed, increases the degeneration of amplifier 13. However, it will be understood that resistor 23 can be omitted from the circuit or used alone to attenuate the input to amplifier 13, if desired. Tube 24 may be of the sharp cutoff type and may be biased beyond its cutoff value in the absence of a received carrier, so that the action of the control circuit is not effective until the amplitude of the input has reached a predetermined value. The preattenuation just described is effective over a wide range of signal inputs to prevent cross modulation and distortion in the signal receiver.

The arrangement of Fig. 2 differs from that shown in Fig. 1 primarily in the circuit arrangement of attenuators 9 and 11 of Fig. 1 and Fig. 2, respectively, and in the method of controlling the current therein. Resistors 42—45, inclusive, of attenuator 11 are similar to resistor 21 of Fig. 1, in that each has a positive temperature coefficient of resistance and are connected, as shown, in a conventional Wheatstone bridge circuit with the antenna circuit A, G connected across one diagonal and the selector circuit 12 effectively coupled across the conjugate diagonal through transformer 40, 41. The control current path for resistors 43 and 45 includes choke coils 47 and 47' to prevent the dissipation of radio-frequency energy in this circuit, while condensers 49—53, inclusive, serve to block the flow of direct current from the radio-frequency circuits. The means for controlling the flow of direct current in the resistors 42—45, inclusive, is such that the current increases in resistors 42 and 44 and simultaneously decreases in resistors 43 and 45, while the values of the resistors are preferably chosen so that the maximum value of resistors 42 and 44 is somewhat less than the maximum value of resistors 43 and 45 over the operating range of the attenuator.

A preferred means of producing the desired controlling currents through the resistors 42—45, inclusive, is by the use of a pentode 46, the third grid or suppressor of which is controlled by the voltage across the load circuit 48 of diode rectifier 25. Proper operating potentials for the remaining electrodes of the tube 46 are supplied from a suitable source, such as a battery 54 and a voltage divider comprising resistors 71, 72, and 73, the portion 71 of the voltage divider providing a constant grid bias for the tube 46 and serv-

ing to maintain its total space current substantially constant. The potential variations of the suppressor grid of amplifier 46 cause a division of the constant space current between the anode and the screen of the tube in a manner fully described in United States Letters Patent No. 1,997,665, granted April 16, 1935, on an application of Harold A. Wheeler. Since the total space current is substantially constant, an advantageous arrangement is obtained if the cathode resistor 55 comprises the field winding of loudspeaker 19.

In considering the operation of the embodiment of the invention illustrated in Fig. 2, it will be assumed that, in the absence of a signal or in the presence of a weak signal, the bridge circuit is considerably unbalanced so that the signal input to selector 12 is a maximum. An increase in the amplitude of the signal input to amplifier 13 causes a decrease in the anode current of tube 46 and an increase in its screen current. As a result, the resistances of resistors 42 and 44 are increased, thus tending to vary the selectivity of the receiver in one sense, while the resistances of resistors 43 and 45 are decreased, thus tending to vary the selectivity of the receiver in the opposite sense. This change in the resistances of resistors 42—45, inclusive, tends to bring the bridge into balance, reducing the voltage across its output diagonal to a value approaching zero and resulting in an attenuation of the input to amplifier 13. As in the modification shown in Fig. 1, attenuator 11 of Fig. 2 is designed to terminate the antenna circuit 10 and selector 12 in their image impedances. Since the total resistance of the bridge across each of its diagonals is not substantially changed as the resistances of its arms are varied as described, the selectivity of the receiver is not substantially varied.

Fig. 3 illustrates a further modification of the coupling circuit 11 of Fig. 2 and terminals A, C, D, E, F, G, and H are appropriately marked to indicate the manner of connecting the attenuator of Fig. 3 in the circuit of the receiver illustrated in Fig. 2. In this embodiment, the bridge circuit comprises resistors 56 and 57 and primary windings 60 and 61 of a transformer, the secondary winding 40 of which is connected to output terminals H, F. Resistors 56 and 57 are similar to resistors 42—45, inclusive, of Fig. 2 in that they have positive temperature coefficients of resistance. Blocking condensers 58 and 59 restrict the flow of direct current to the portion of the signal channel including the resistors. The windings 60 and 61 have the same number of turns and equal inductive couplings with winding 40. A choke 35' is included in series with terminal D in this embodiment of the invention.

In considering the operation of the preattenuator of Fig. 3, it will be assumed that the values of resistors 56 and 57 are so proportioned that, when receiving no signals or signals of low amplitude, the bridge is unbalanced to a maximum degree and the attenuation is a minimum, the circuit comprising winding 61 having the lesser coupling effect. The direct current in resistor 56, and, therefore, its resistance, is caused to increase as the intensity of the input to amplifier 13 increases, while the direct current in resistor 57 and its resistance decrease under the same conditions, thus tending to balance the bridge and increase the attenuation of the system. If the resistances of resistors 56 and 57 became equal, the bridge would be completely balanced 75

and the signal output would be reduced to zero, since equal windings 60 and 61 are equally coupled to winding 40 with opposite polarity. The minimum value of resistor 57 is, therefore, chosen to be slightly greater than the maximum value of resistor 56, within the operating range of the preattenuator. An increase in input to amplifier 13, therefore, increases the attenuation of the preattenuator, while the selectivity of the receiver is not substantially changed, due to the fact that the total resistance of the circuit remains substantially unchanged.

The form of the invention shown in Fig. 4 differs from that shown in Fig. 3, only in that the preattenuator is coupled to the input circuit A, G through a transformer comprising a primary winding 64 and secondary windings 62 and 63 in series with resistors 56 and 57, respectively. The operation is substantially similar to that of Fig. 3.

An attenuating selector circuit is illustrated in the embodiment of the invention shown in Fig. 5, which is similar to the arrangement of Fig. 3, except that the input circuit of the attenuator is coupled to the terminals A, G through a transformer 67, 68 having a tertiary winding 66 tuned by an adjustable condenser 65 which may be ganged for unicontrol with the tuning elements shown in Figs. 1 and 2. The method of operation is similar to that of Fig. 3, but the arrangement provides an additional selective circuit.

While there have been described what are at present considered to be the preferred embodiments of this 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 it is, therefore, 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 coupling system for adjustably coupling an input circuit to a vacuum-tube repeater comprising a signal selector coupled between said input circuit and said repeater, a cathode resistor for said repeater effective to produce degeneration at carrier frequencies, a pair of variable resistive impedance means so connected in circuit with said selector that a variation thereof in a given sense would cause them to vary the selectivity of said selector in the same sense and vary the coupling to said repeater in opposite senses, and means for varying said resistor and one of said impedance means in one sense and for simultaneously varying the other impedance means in the opposite sense, thereby effectively to attenuate the input to said repeater.

2. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input circuit to a vacuum-tube repeater comprising a signal selector coupled between said input circuit and said repeater, a cathode resistor for said repeater effective to produce degeneration at carrier frequencies, a pair of variable resistive impedance means so connected in circuit with said selector that a variation thereof in a given sense would cause them to vary the selectivity of said selector in the same sense and vary the coupling to said repeater in opposite senses, and means responsive to a received carrier for varying said resistor and one of said impedance means directly, and for simultaneously varying the other of said impedance means inversely, in accordance with the amplitude of said received

carrier thereby effectively to attenuate the input to said repeater.

3. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input circuit to a vacuum-tube repeater comprising a signal selector coupled between said input circuit and said repeater, a cathode resistor for said repeater effective to produce degeneration at carrier frequencies and having a substantial current coefficient of resistance, a pair of variable resistive impedance means having substantial current coefficients of resistance of opposite signs so connected in circuit with said selector that a variation thereof in the same sense would cause them to vary the selectivity of said selector in a given sense and vary the coupling to said repeater in opposite senses, a direct current circuit including said resistor and said impedance means, and means for varying the current in said direct current circuit, thereby effectively to attenuate the input to said repeater.

4. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input circuit to a vacuum-tube repeater comprising a selector circuit coupled between said input circuit and said repeater, a cathode resistor for said repeater effective to produce degeneration at carrier frequencies and having a substantial current coefficient of resistance, a pair of variable resistive impedance means having a substantial current coefficient of resistance of the same sign as said resistor so connected in circuit with said selector that a variation thereof in a given sense would cause them to vary the selectivity of said selector in the same sense and vary the coupling to said repeater in opposite senses, and means to pass a variable current through said resistor and one of said impedance means and simultaneously to pass a current varying inversely to said variable current through the other of said impedance means, thereby effectively to attenuate the input to said repeater.

5. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input circuit to a vacuum-tube repeater, comprising a signal selector coupled between said input circuit and said repeater, a cathode resistor for said repeater effective to produce degeneration at carrier frequencies and having a substantial current coefficient of resistance, a pair of variable resistive impedance means having substantial current coefficients of resistance so connected in circuit with said selector that a variation thereof in a given sense would cause them to vary the selectivity of said selector in the same sense and vary the coupling to said repeater in opposite senses, and means responsive to a received carrier for producing a controlling current in each of said impedance means and said resistor variable in accordance with the amplitude of said received carrier, thereby effectively to attenuate the input to said repeater.

6. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input circuit to a vacuum-tube repeater, comprising a signal selector coupled between said input circuit and said repeater, a pair of variable resistive impedance means so connected in circuit with said selector that a variation thereof in a given sense would cause them to vary the selectivity of said selector in the same sense and the coupling to said repeater in opposite senses, and means responsive to the amplitude of the total signal input to said repeater for simultaneously varying said impedance means in opposite senses

thereby variably to attenuate the input to said repeater.

7. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input circuit to a vacuum-tube repeater, comprising a signal selector tunable over a range of frequencies and coupled between said input circuit and said repeater, a pair of variable resistive impedance means so connected in circuit with said selector that a variation thereof in a given sense would cause them to vary the selectivity of said selector in the same sense and the coupling to said repeater in opposite senses, a control circuit coupled to said selector, said control circuit and its coupling to said selector being nonselectively responsive over said frequency range, and means controlled by said control circuit for simultaneously varying said impedance means in opposite senses thereby variably to attenuate the input to said repeater.

8. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input circuit to a vacuum-tube repeater, comprising a signal selector coupled between said input circuit and said repeater, a pair of resistive impedance means having a substantial current coefficient of resistance so connected in circuit with said selector that a variation thereof in a given sense would cause them to vary the selectivity of said selector in the same sense and the coupling to said repeater in opposite senses, and means responsive to a received carrier to pass through one of said impedance means a current varying directly, and to pass through the other of said impedance means a current varying inversely, in accordance with the amplitude of said received carrier, thereby to attenuate the input to said repeater.

9. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input circuit to a vacuum-tube repeater, comprising a signal selector coupled between said input circuit and said repeater, means for reducing the effective signal input to said repeater comprising a cathode resistor for said repeater having a substantial thermal inertia and effective to produce degeneration at carrier frequencies, and means responsive to the amplitude of the input to said repeater for varying said resistor.

10. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input circuit to a vacuum-tube repeater, comprising a signal selector coupled between said input circuit and said repeater, means for reducing the effective signal input to said repeater comprising a cathode resistor for said repeater having a substantial thermal inertia and effective to produce degeneration at carrier frequencies and having a substantial current coefficient of resistance, and means responsive to the amplitude of the input to said repeater for varying the average current in said resistor in accordance with the amplitude of said input, thereby effectively to attenuate the input of said repeater.

11. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input circuit to a vacuum-tube repeater, comprising a signal selector coupled between said input circuit and said repeater, a bridge circuit having at least two resistive arms having a substantial thermal inertia, said input circuit and said repeater being coupled respectively to conjugate diagonals of said bridge, and means responsive to the amplitude of the total signal input to said repeater for varying the resistances of said resistive arms

of said bridge inversely to each other to vary the attenuation to said repeater.

12. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input circuit to a vacuum-tube repeater, comprising a signal selector coupled between said input circuit and said repeater, a bridge circuit having two adjacent resistive arms having a substantial thermal inertia, said input circuit and said repeater being coupled respectively to conjugate diagonals of said bridge, and means responsive to the amplitude of the total signal input to said repeater for varying the resistances of said resistive arms of said bridge inversely to each other to vary the attenuation to said repeater.

13. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input circuit to a vacuum tube repeater, comprising a signal selector coupled between said input circuit and said repeater, a bridge circuit having two resistive arms having a substantial thermal inertia and two inductive arms, said input circuit and said repeater being effectively coupled respectively to conjugate diagonals of said bridge, and means responsive to the amplitude of the total signal input to said repeater for varying the resistances of said resistive arms of said bridge inversely to each other to vary the attenuation to said repeater.

14. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input circuit to a vacuum-tube repeater, comprising a signal selector coupled between said input circuit and said repeater, a bridge circuit having two resistive arms having a substantial thermal inertia and two inductive arms, said repeater being inductively coupled to said inductive arms with opposite polarity and said input circuit being connected to a conjugate diagonal of said bridge, and means responsive to the amplitude of the total signal input to said repeater for varying the resistances of said resistive arms of said bridge inversely to each other to vary the attenuation to said repeater.

15. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input circuit to a vacuum-tube repeater, comprising a signal selector coupled between said input circuit and said repeater, a resistance bridge having a substantial thermal inertia, said input circuit and said repeater being coupled respectively to conjugate diagonals of said bridge, and additional means responsive to the amplitude of the total signal input to said repeater for varying the resistance of adjacent arms of said bridge inversely to each other to vary the attenuation to said input terminals.

16. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input circuit to a vacuum-tube repeater, comprising a signal selector and a nonselective network coupled in succession between said input circuit and said repeater, said network including at least one resistor having a substantial temperature coefficient of resistance and a substantial thermal inertia, and control means coupled to the output of said system for adjusting the temperature of said resistor to reduce the coupling through said network with increasing signal strength, said control means being less selective than said selector and, therefore, responsive to the total of desired and undesired signals traversing said system.

17. In a modulated-carrier signal receiver, a coupling system for adjustably coupling an input

circuit to a vacuum-tube repeater, comprising two signal-selector networks coupled between said input circuit and said repeater, a non-selective attenuator between said networks including at least one resistor having a substantial temperature coefficient of resistance and a substantial thermal inertia, and control means coupled to the output of said network for adjusting the temperature of said resistor to reduce the coupling through said network with increasing signal strength, said control means being less selective than said selector and, therefore, responsive to the total of desired and undesired signals traversing said system.

18. In a modulated-carrier signal receiver, a coupling system tunable over a range of frequencies for adjustably coupling to a vacuum-tube repeater an input circuit having an impedance which is approximately a uniform resistance over said frequency range, comprising a

signal selector and a nonselective attenuator coupled in succession between said input circuit and said repeater, said attenuator comprising at least two resistors having substantial temperature coefficients of resistance and substantial thermal inertias, said attenuator being of a type in which opposite variations of said resistors maintain the image impedance thereof approximately constant and so proportioned that said image impedance is equal to said input circuit impedance, and control means coupled to the output of said system for adjusting the temperatures of said resistors to cause opposite variations thereof to reduce the coupling through said system with increasing signal strength, said control means being less selective than said selector and, therefore, responsive to desired and undesired signals traversing said selector.

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