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QUIET AUTOMATIC VOLUME CONTROL SYSTEM

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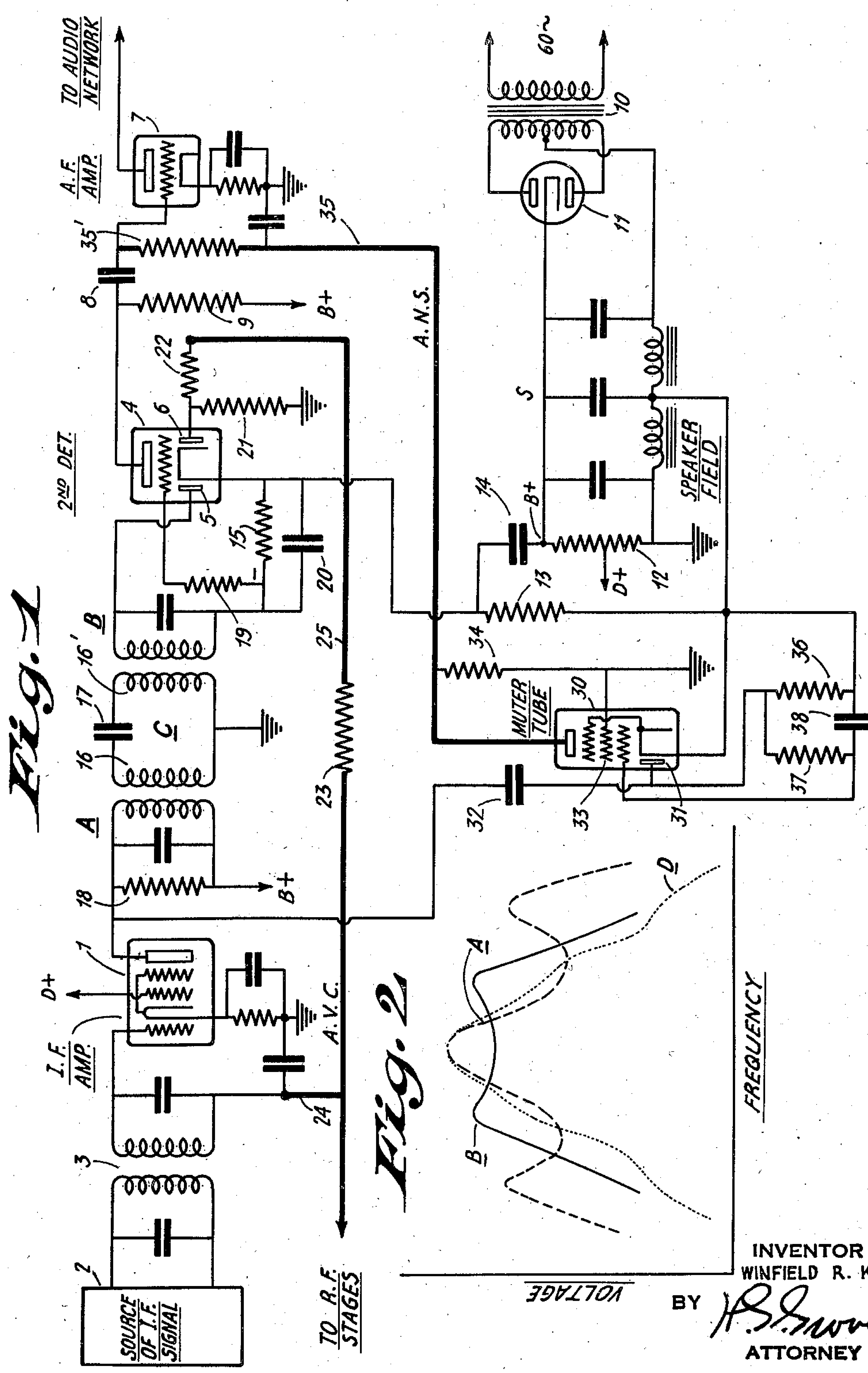

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QUIET AUTOMATIC VOLUME CONTROL SYSTEM

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5 Claims. (Cl. 250—20)

My present invention relates to automatic volume control circuits, and more particularly to an improved type of quiet automatic volume control system.

One of the main objects of my present invention is to provide an automatic volume control arrangement for a radio receiver, the volume control arrangement having its action supplemented by a quieting, or muting, device adapted to render the transmission of signal energy through the receiver inefficient whenever the amplitude of the signal waves impressed upon the receiver decreases below a predetermined intensity level, and the muting device deriving its signal energy input from a point in the signal receiver which has a sharper selectivity characteristic than the point in the receiver from which the automatic volume control arrangement derives its signal energy.

Another important object of the invention is to provide in a radio receiver an automatic volume control circuit and a supplementing muting circuit, the automatic volume control circuit being provided with a signal input network having a resonance curve characteristic of the band pass type, and the muting circuit being provided with a signal input circuit which has a relatively sharper resonance curve characteristic, whereby the action of the muting circuit is eliminated only when a signal of sufficient intensity is tuned to the mid-peak frequency of the muting circuit characteristic.

Still another object of the present invention is to provide in a superheterodyne receiver an intermediate frequency transmission network between the second detector and a preceding stage of intermediate frequency amplification, the transmission network comprising a plurality of resonant circuits tuned to the operating intermediate frequency, the receiver additionally including an automatic volume control circuit arranged to be fed by the last resonant circuit of the said transmission network, there being additionally provided a noise suppressor tube arranged to be fed with signal energy from the input of said transmission network, and said noise suppressor tube functioning to render the audio amplifier of the receiver operable only when a signal of sufficient intensity is tuned in and the signal frequency corresponds to the middle peak of the selectivity curve of the first of said resonant circuits, and this middle peak corresponding to the mid-frequency of the relatively broader resonance curve of the transmission network.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, will best be understood by reference to the following description, taken in connection with the drawing, in which I have indicated diagrammatically a circuit organization whereby my invention may be carried into effect.

In the drawing:—

Fig. 1 diagrammatically shows a superheterodyne receiver embodying the present invention,

Fig. 2 graphically illustrates the resonance curve characteristics of the intermediate frequency coupling network in Fig. 1.

Referring now to the accompanying drawing, there is shown in Fig. 1, in purely diagrammatic manner, that portion of a superheterodyne receiver associated with my present invention. Only the last stage of intermediate frequency amplification, the second detector and the first stage of audio frequency amplification are shown, because all other elements of the receiving system are sufficiently well known to those skilled in the art. For this reason, the network preceding the intermediate frequency amplifier tube **1** has been conventionally represented, and it will be understood that the numeral **2** designates any well known source of intermediate frequency signal energy. Such a source, for example, may include the usual tuned radio frequency amplifier network followed by a local oscillator and first detector tube, or a combined detector-oscillator tube, the output of the mixing circuit being followed by one or more stages of intermediate frequency amplification.

In any case, the numeral **3** denotes the intermediate frequency coupling transformer, whose primary and secondary windings are each tuned to the operating intermediate frequency, commonly disposed between the input electrodes of the last intermediate frequency amplifier tube **1** and the next preceding tube.

The numeral **4** designates an electron discharge tube of the 55 type, also known as a duplex diode triode, and those skilled in the art are well acquainted with the fact that the tube comprises, in addition to the usual cathode control grid and plate, a pair of diode anodes 5 and 6. The electron stream between the cathode and both diode anodes, and the electron stream between the cathode, grid and plate are independent. The audio amplifier tube 7 has its control grid connected to the plate of tube 4 through a coupling condenser 8, a resistor 9 being disposed in the plate voltage supply lead of tube 4.

The operating potentials for the various electrodes of the receiver tubes are supplied from a power supply network generally denoted by the reference letter S. This supply network includes the customary transformer 10 whose primary is connected to the alternating current supply, and whose secondary is connected between the anodes of the full wave rectifier tube 11. The usual filter network S has its input terminals connected between an intermediate tap on the secondary of the transformer 10 and the cathode of the rectifier 11; a bleeder resistor 12 being connected across the output terminals of the network S. The grounded side of the filter network includes the usual series chokes, and if desired one of these chokes may also function as the field coil of the loud speaker of the system. A plurality of shunt condensers are connected across the bleeder resistor 12, and the cathode of tube 4 is connected to a point intermediate the series chokes of filter S through a resistor 13. A condenser 14 is connected between the cathode side of resistor 13 and the positive potential side of bleeder resistor 12.

As is well known to those skilled in the art, the various electrodes of the tubes used in the receiving system may be connected to appropriate points along the bleeder resistor 12, and it will be noted that the plates of tubes 1 and 4 are connected to the +B terminal of the bleeder resistor, while the screen grid of tube 1, for example, would be connected to the point +D on the bleeder resistor.

The intermediate frequency signal energy is impressed between the signal grid and cathode of tube 1, the amplified output of the tube is transmitted through a coupling network comprising a tuned circuit A, a tuned circuit B, and a tuned circuit C coupling the circuits A and B. Each of these three circuits is individually tuned to the operating intermediate frequency, and it will be noted that the tuned circuit A is connected in the plate circuit of tube 1, while the tuned circuit B is connected in a series path between the diode anode 5 and the cathode of tube 4, the series path including the tuned circuit and a load resistor 15. The tuned circuit C includes a coil 16 magnetically coupled to the tuned circuit A and a coil 16′ magnetically coupled to the circuit B, both these coils being connected in series with a condenser 17. The low alternating potential side of circuit C is grounded, and a resistor 18 is connected across the tuned circuit A. The function of resistor 18 is to control the damping of network A—C—B. The diode demodulator also has some effect on the damping.

The grid of tube 4 is connected to the negative side of resistor 15 through a resistor 19, and a radio frequency by-pass condenser 20 is connected in shunt with resistor 15. Any small radio frequency voltages existing across condenser 20 are attenuated by this resistor 19, in combination with the input capacity of the tube 4, so that these voltages will not reach the grid of the tube in any appreciable amount.

The diode anode 6 is connected to lead 25, also designated by the reference letters A. V. C. to denote the automatic volume control connection; the anode 6 being connected to ground through a resistor 21, and a resistor 22 being included between the lead 25 and the anode 6. A direct voltage filter resistor 23 is included in lead 25, and it will be understood that the lead 25 is to be connected to the grid circuits of the various high frequency amplifier stages, one such connection of the grid circuit of intermediate frequency amplifier 1 being designated by the numeral 24. Both resistors 22, 23 function to filter the audio component from the direct voltage component; only one resistor may be used if desired.

The numeral 30 denotes the muter, or noise suppressor, tube which may be of the 2B7 type. This tube includes at least one diode anode 31 connected through a signal energy by-pass condenser 32 to the plate circuit of the intermediate frequency amplifier tube 1. It will be noted that the diode anode 31 is disposed adjacent a portion of the cathode of tube 30, and that the electron stream from the cathode to this diode anode is independent of the electron stream flowing from the cathode to the plate through the interposed three grids. The grid 33, disposed between the signal grid and the suppressor grid, is maintained at ground potential, and is also connected to the plate of tube 30 through the resistor 34. The plate side of resistor 34 is connected through a path which includes lead 35 and resistor 35′ to the signal grid of audio amplifier tube 7. This lead 35 is also designated by the reference letters A. N. S. to denote that this is the automatic noise suppressor path, and that this connection controls the effective bias on the grid of audio amplifier tube 7.

The cathode of tube 30 is connected through lead 36 to the negative side of resistor 13. A resistor 36 is connected between the diode anode 31 and the cathode of the muter tube, a path including series arranged resistor 37 and condenser 38 being connected in shunt across resistor 36. The grid immediately adjacent the cathode of tube 30 is connected to the condenser side of resistor 37. The latter resistor filters the audio and radio frequency voltage from the bias voltage, so that the pentode portion of tube 30 works only at a sub-audible rate. The drop across the resistor furnishes the bias for the pentode portion of tube 30. In other words, it serves as a leak for charges on condenser 32.

In order to clearly understand the operation of the present receiving arrangement, it is pointed out that in Fig. 2 there is shown the resonance curve characteristics of the coupling network A, C, B at circuit A and at circuit B. It will be observed that the dotted line curve A represents the characteristic at circuit A. In laboratory measurements the outside peaks of the selectivity curve A were found to be separated from the middle peak, which middle peak is located at the operating frequency of the system, sufficiently in frequency so that the selectivity of the rest of the receiver prevents any response to these outside peak frequencies. The side peaks of this curve A would be completely eliminated by the selectivity of the preceding I. F. transformer 3, which would have a curve of the same general shape as B. Assuming that it would have the same curve as B, there is shown a selectivity curve D between the source 2 and the diode 31 of tube 30 without side peaks. The selectivity at circuit B may be either double or triple peaked, and in Fig. 2 it is shown double peaked, depending on the resistance 18 across the primary circuit A.

Through the action of the automatic volume control, the selectivity of the receiver, and the selectivity of the coupling system disclosed, the noise suppressor can be made to render the audio amplifier 7 operable only when a signal of sufficient intensity is tuned to the middle peak of the selectivity curve A, which, as stated before, is the center of the band selected by the receiver. The selectivity of the three coupled circuits is substantially flat topped, as shown in Fig. 2, and the voltage across the primary circuit A will tend to be quite selective. The automatic volume control arrangement is operated from the output of the three coupled circuits, while the noise suppressor, or muter, network is operated from the input of the three coupled circuits. This mode of operation of the two control circuits insures an accurate tuning of the receiver, since the muting action will not be eliminated until the receiver is tuned to the desired signal frequency. Of course, the variable tuning means commonly disposed in the network 2 ahead of the intermediate frequency amplifier has not been shown, since those skilled in the art are well acquainted with such devices.

Considering the precise operation of the automatic volume control and muter networks, it is first pointed out that the noise suppressor tube 30 utilizes the voltage drop across the speaker field as screen and plate voltages, by virtue of the connection of these two electrodes to the ground side of bleeder 12. When the receiver is tuned to the desired signal frequency, intermediate frequency energy is impressed upon tuned circuit A, and such energy is transmitted through condenser 32 and is impressed between the diode anode 31 and the cathode of tube 30. The diode system of the muter tube rectifies the impressed signal voltage and biases off the pentode portion of the tube 30. This results in a decrease in the flow of current through the plate circuit of tube 30, which reduces the normal cut-off bias applied through lead 35 and resistor 35' to the grid of audio amplifier tube 7. In other words, when signal voltage is not impressed upon circuit A, the flow of plate current through lead 35 is at a maximum and this results in a cut-off bias being applied to the signal grid of amplifier 7.

With respect to the operation of the automatic volume control network of the receiver, it is pointed out that this network operates in the following manner: A signal on the diode 5 causes a voltage drop across resistor 15. This voltage is impressed on the grid of the triode portion of the tube 4, making the grid more negative. The resulting decrease in plate current reduces the voltage drop across resistor 13, making the cathode of tube 4 go from a positive voltage to a negative voltage with respect to ground. Diode 6 is maintained at ground potential by resistor 21 until the cathode becomes negative, and current flows through the diode-cathode path. When this occurs, diode 6 and the grids of the controlled tubes follow very closely the cathode voltage of tube 4. The stronger the signal, the more negative this cathode becomes, and because the grids of the amplifiers become more negative the less will be the gain in the controlled tubes.

While I have indicated and described a system for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organizations shown and described but that many modifications may be made without departing from the scope of my invention, as set worth in the appended claims.

What I claim is:

1. In combination with a high frequency amplifier and an automatic volume control network for regulating the gain of the amplifier in response to variations in the amplitude of signals impressed on the amplifier, a coupling network connected between the amplifier and the automatic volume control arrangement, a signal transmission tube having its input electrodes coupled to the output of said coupling network, a muter tube having an output electrode connected to the input circuit of said signal transmission tube, the muter tube having a maximum flow of space current when signals below a predetermined amplitude are impressed upon said high frequency amplifier, a signal path connecting an input electrode of said muter tube to the input of said coupling network, and said coupling network including a plurality of resonant circuits tuned to an operating signal frequency, said coupling network being constructed in such a manner that the resonance curve characteristic at the output of the coupling network is substantially broader than the resonance curve characteristic at the input of said network.

2. In a system as defined in claim 1, said coupling network consisting of three coupled resonant circuits tuned to the said operating signal frequency, the resonance curve characteristic of the coupling network at the last resonant circuit being of the band pass type, and the resonance curve characteristic at the first of said resonant circuits being relatively more selective and having a sharp peak located at the mid-frequency of said band pass characteristic.

3. In a system as defined in claim 1, said muter tube including at least one diode anode disposed adjacent its cathode, the diode anode and cathode including a load impedance whereby a diode rectifier circuit is provided, and said signal path connecting said diode anode to the input of said coupling network.

4. In a superheterodyne receiver of a type including an intermediate frequency amplifier, a second detector, an audio frequency amplifier, and an automatic volume control circuit electrically associated with the second detector and the grid circuit of said intermediate frequency amplifier, a coupling network connected between the plate circuit of said intermediate frequency amplifier and the second detector, a muter tube having an input electrode coupled to the input of said coupling network and an output electrode directly connected to the grid circuit of said audio amplifier, said coupling network including a sufficient number of circuits tuned to the operating intermediate frequency to impart a relatively broad resonance curve characteristic to the circuit feeding said second detector, and the circuit feeding said muter tube having a resonance curve characteristic characterized by a relatively sharp peak located at the mid-band frequency of said first characteristic.

5. In a radio receiver of the superheterodyne type, an intermediate frequency transmission network including a plurality of tuned circuits arranged in cascade, a demodulator coupled to the

last of the cascaded circuits, an audio frequency transmission network arranged to receive demodulated signal energy from the demodulator, means responsive to signal amplitude variations at the demodulator input for automatically regulating the efficiency of signal transmission through the intermediate frequency network, means, responsive to signal amplitude variations at a point in the intermediate frequency network preceding said last of the cascaded circuits, for automatically regulating the efficiency of signal transmission through the audio network, the resonance curve characteristic of the intermediate network at said last circuit being substantially broader than the characteristic at said preceding point in the network.

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