Sept. 16, 1941. W. L. CARLSON 2,256,073

VARIABLE SELECTIVITY DEVICE

Filed Nov. 3, 1934 2 Sheets-Sheet 1

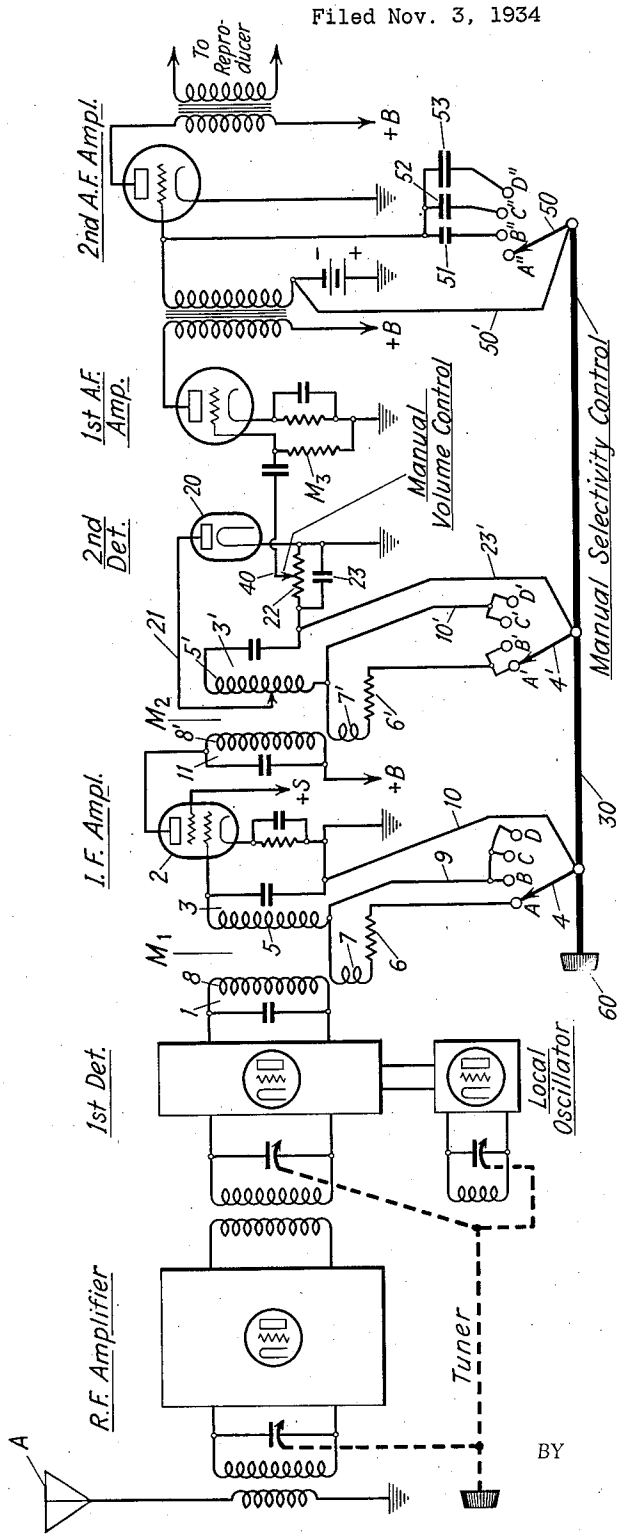


Fig. 1

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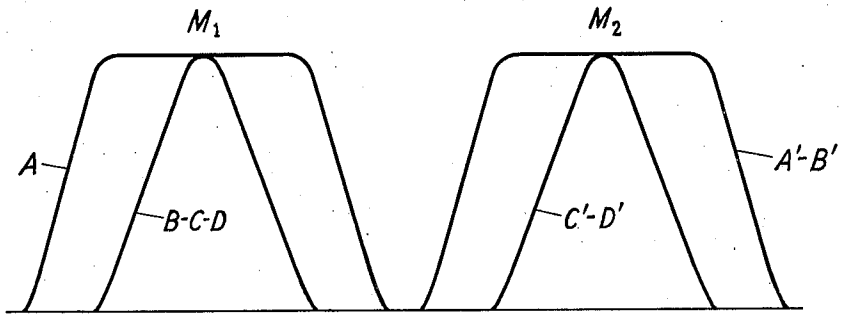


Fig. 2

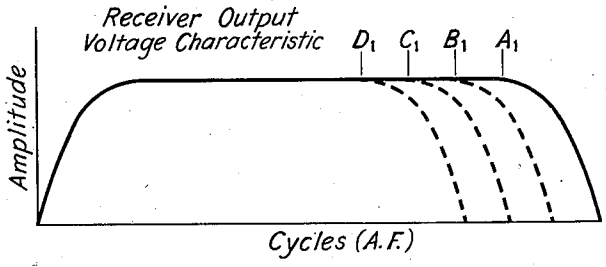


Fig. 3

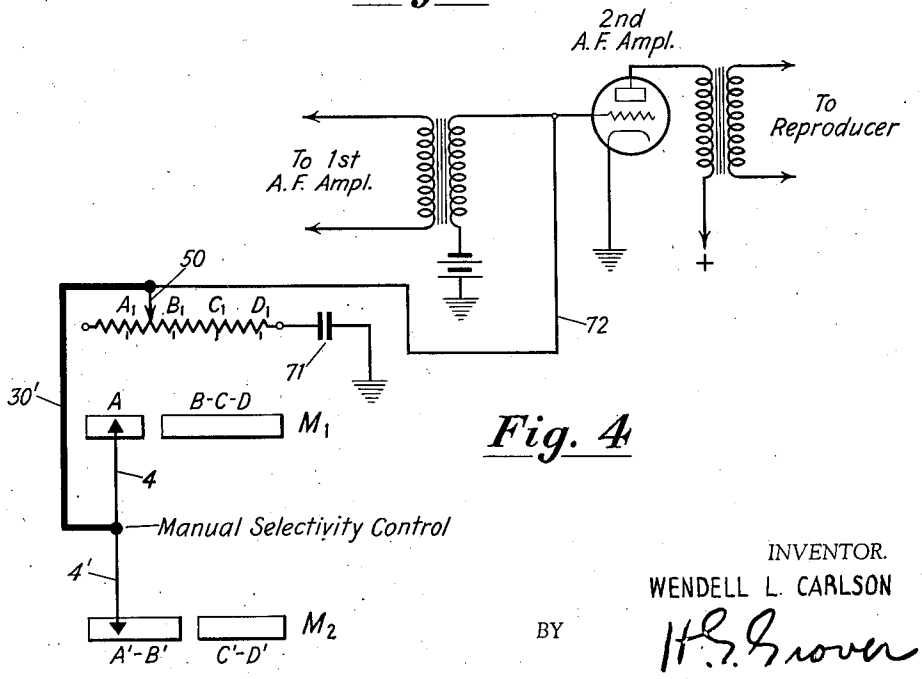


Fig. 4

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UNITED STATES PATENT OFFICE

2,256,073

VARIABLE SELECTIVITY DEVICE

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Application November 3, 1934, Serial No. 751,305

8 Claims. (Cl. 250—20)

My present invention relates to selectivity adjustment devices for radio broadcast receivers, and more particularly to an improved device for readily adjusting a broadcast receiver to operate either with a high degree of fidelity or with a high degree of selectivity.

One of the main objects of the present invention is to provide an improved variable selectivity device which is capable of adjusting the degree of selectivity of a radio broadcast receiver, and which selectivity device additionally includes means for regulating the audio frequency transmission band of the receiver whereby the receiver output audio frequency characteristic is changed when the degree of selectivity of the receiver is adjusted.

Another important object of the invention is to provide in a radio broadcast receiver which has a substantially flat output voltage characteristic over a wide audio frequency range, a variable selectivity device which is capable of adjusting the receiver so as to operate with a high degree of fidelity or with a high degree of selectivity, the selectivity device having operatively associated with it an audio frequency transmission control element which is adapted to attenuate the transmission of the higher audio frequencies when the selectivity device is adjusted to increase the degree of selectivity of the receiver.

Another object of the invention is to provide an adjustable selectivity control for a radio receiver, which control is independent of the tuning of the receiver, the selectivity control being adapted to operate at different rates in successive tuned networks of the receiver, and additionally including a tone control element for varying the attenuation of the higher audio frequencies during selectivity adjustment.

Still other objects of the invention are to improve generally the efficiency of variable selectivity devices for high fidelity radio broadcast receivers, and more particularly to provide selectivity control arrangements for receivers which are not only reliable in operation, but economically constructed and assembled in the radio receiver.

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, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawings in which I have indicated diagrammatically several circuit organizations whereby my invention may be carried into effect.

In the drawings:

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

Fig. 2 graphically shows the characteristics of the radio frequency networks when radio frequency selectivity is varied,

Fig. 3 shows the output voltage characteristic when selectivity is varied,

Fig. 4 shows a modified form of the invention.

Referring now to the accompanying drawings, wherein like reference characters in the different figures designate similar circuit elements, there is shown in Fig. 1 a superheterodyne receiver of conventional type, the various networks being schematically designated since those skilled in the art are fully aware of the constructional detail of the networks shown.

The receiver embodies the usual signal collector A, which is shown as a grounded antenna circuit, the signal collector being coupled to the tunable input circuit of a radio frequency amplifier. This amplifier may embody one, or more, stages of tunable radio frequency amplification, and the amplifier stages may employ electron discharge tubes of any type adapted for such purposes and well known in the art. The amplified radio frequency signal energy is then impressed upon a first detector which has a tunable input circuit, and there is impressed upon the first detector locally produced oscillations from the usual local oscillator. The tuning of the local oscillator is varied simultaneously with the tuning of the first detector and the radio frequency amplifier. Of course, those skilled in the art are fully aware of combined first detector-local oscillator networks wherein a single tube can be employed for performing the functions of the separate local oscillator and first detector. The legend "Tuner" designates the uni-control tuning element which mechanically couples the rotors of the various variable tuning condensers which have been described.

The intermediate frequency energy produced in the tuned output circuit 1 of the first detector is impressed upon the tuned input circuit of the following intermediate frequency amplifier tube 2. The reference letter M_1 designates the coupling network between the first detector and the intermediate frequency amplifier 2. The tuned secondary circuit of the coupling network M_1 is designated by the numeral 3, and it is to be understood that circuits 1 and 3 are not only maintained fixedly tuned to the operating in-

termediate frequency, which may be of the order of 175 kilocycles, but they are also magnetically coupled. The amplifier 2 is shown as of the screen grid type, but it will be understood that any other type of tube may be used, such as the pentode tube. There is provided in the input circuit 3 of the tube 2 a selectivity adjustment device.

This selectivity adjustment device comprises an adjustable tap element 4 which is adapted to contact with any one of four contact elements designated by the reference letters A—B—C—D. The contact A is connected to the coil 5 of the input circuit 3 through a path including a resistor 6 and a coil 7. The coil 7 is closely coupled to the coil 8 of the tuned output circuit 1 of the first detector. Coils 8 and 5 are relatively loosely coupled. Contacts B, C and D are connected together, and contact B is connected by lead 9 to the low alternating potential side of coil 5. The adjustable tap 4 is connected by lead 10 to the grounded side of the tuning condenser of circuit 3.

The plate circuit of amplifier tube 2 includes a tuned output circuit 11 which is fixedly tuned to the operating intermediate frequency. The degree of selectivity of the receiving system is effectively adjusted to operate either with a high degree of fidelity or with a high degree of selectivity by changing the position of tap 4 from contact A to either of the contacts B—C—D. This general type of variable selectivity device has been described and claimed in my U. S. Patent No. 1,871,405 of August 9, 1932. It is pointed out in the patent that when broadcast stations are operated at frequencies set apart by 10 kilocycles it is difficult to operate receiving apparatus with high quality and sharp selectivity without reverting to single side band transmission. It is, also, shown in the patent that the best quality of reception is obtained with a high fidelity adjustment for local reception, and with a relatively poor fidelity and high selectivity adjustment for distance reception through interference. There was, therefore, provided the device shown operatively associated with coupling network M_1 for imparting to the coupling network M_1 a substantially band pass characteristic when the tap 4 is connected to contact A. This arises by virtue of the relatively close coupling between coil 8 and the auxiliary coupling coil 7.

Fig. 2 shows the type of resonance curve characteristic secured when tap 4 is connected to contact A. The resonance curve characteristic with such a setting is broad, and has a width of substantially 10 kilocycles with a substantially flat top. The modulation side bands are included within this width, and the resistor 6 is so chosen as to equalize the response at different frequencies within the receiving range. When the tap 4 is connected to the contact B, or contacts C—D, the resonance curve characteristic of network M_1 is changed to that shown in Fig. 2. It will be observed that the resonance curve characteristic is now relatively narrow, and that the higher modulation side band frequencies have been attenuated. The receiver, in other words, has been made highly selective at the expense of the higher modulation side band frequencies. This is of value in receiving weak, or distant, stations through interference. Furthermore, the noise frequencies, which are in the higher audio frequency range, have been considerably minimized. It will be understood that the relatively loose coupling between coils 8 and 5 provides the changed resonance curve characteristic. Connection of tap 4 to contact B results in open circuiting of coil 7 and resistor 6, and for this reason the width of the resonance curve is narrowed.

Additional investigation along the lines of my aforementioned patented disclosure has shown that more efficient and smoother operation of selectivity change is secured when a second selectivity adjustment device is utilized, as shown in connection with the succeeding coupling network M_2. This coupling network comprises the tuned output circuit 11 including coil 8', the coil being relatively loosely coupled to the coil 5' of the tuned input circuit 3' of the second detector tube 20. The second detector tube is shown as of the diode type, the anode of the diode being connected by an adjustable lead 21 to an intermediate point on input coil 5' so as to give less load from the diode.

The coil 5' is connected to the grounded cathode of diode 20 through a path which includes the tuning condenser of circuit 3' and the load resistor 22, the latter being shunted by a radio frequency by-pass condenser 23.

The coil 8' is relatively tightly coupled to auxiliary coupling coil 7', and contacts A' and B' are connected to the low alternating voltage side of coil 7' through the resistor 6'. Contacts C' and D' are connected to the low alternating voltage side of coil 5' through lead 10', and the adjustable tap 4' is connected by lead 23' to resistor 22; the tap is arranged to be connected with any of the contacts associated therewith. It will be observed that the adjustable taps 4 and 4' are arranged upon a common, mechanical adjusting element 30 so that they can be operated conjointly, and it is to be understood that the contact elements A—B—C—D of each of the selectivity adjusting devices may be arranged upon any circular supporting element in such a manner that the adjustable tap 4 may readily make contact in succession with each of the contact elements.

The two resonance characteristic curves in the right hand side of Fig. 2 show the resonance curves of coupling network M_2 when the tap 4' is in contact with either of contact members A' or B'; and when the tap is in contact with either of members C' or D'. It will be observed that the resonance curve for coupling network M_2 is the same as the resonance curve of coupling network M_1 when tap 4' is on either of contact members A' or B'. In other words, while the tap 4 has been adjusted to contact B to vary the selectivity of the receiver, the tap 4', being in contact with member B', imparts a relatively broad characteristic to the receiver. It is not until tap 4 contacts with member C that network M_2 possesses the same characteristic as that of network M_1. In this way the selectivity transition is made more gradual and smoother.

It has been found that such an overlapping selectivity control device is desirable in high fidelity broadcast radio receivers. The shaft 30 is made of insulation material, and it is to be understood that adjacent taps 4' and 4 are not conductively connected through the shaft. The contacts A—B—C—D are preferably arranged on a circular disc, and the contacts A'—B'—C'—D' are arranged on another disc; the shaft 30 may pass through the center of both discs, and the latter may be parallel. The shaft 30 is adjusted independently of the "Tuner," and at any desired setting of the latter may be varied to regulate

the degree of selectivity of the networks M_1—M_2.

The audio component of rectified signal voltage across resistor 22 is transmitted to the first audio amplifier. The audio coupling network M_3 may be of any desired type; it is here shown as a resistance-capacity coupling. A manual volume control device 40 is disposed in the network feeding the audio amplifier. An automatic volume control circuit, utilizing the direct current voltage component across resistor 22 if desired, can also be used; in that case the variable voltage would be used to regulate the gain of the radio frequency amplifiers in a manner well known to the prior art. The AVC network is not shown to preserve simplicity of disclosure, but the various other receiver control devices (Tuner; Manual volume control; AVC) are referred to in order to distinguish them from the manual selectivity device of this application.

The amplified audio energy is further amplified in a second amplifier; the output of the latter may be again amplified, or reproduced by any well known type of reproducer. Regardless of the type of audio frequency network used subsequent to the second detector, it is to be understood that the network is constructed to give an output voltage characteristic to the receiver which is substantially flat up to about 8000 cycles. This type of characteristic is graphically represented in Fig. 3 by the full line curve A1. The curves in Fig. 3 are purely pictorial, and are to be considered as such.

In operating the variable selectivity device of this invention it is desirable to simultaneously adjust the transmission of the higher audio frequencies through the audio network. The effect of such desired adjustment is represented in Fig. 3 by the dotted line curves B_1—C_1—D_1. It will be seen that the receiver output voltage characteristic is cut off at varying frequency points as the degree of selectivity is changed. Cut-off point B_1 may be, for example, 6000 cycles; point C_1 may be 4000 cycles, and point D_1 may be at 3000 cycles. This means that there will be a gradual change of selectivity; beginning first at the radio and audio points of the receiver, and ending with audio adjustment between points C_1 and D_1.

This is accomplished by providing a third tap 50 on shaft 30, the tap 50 being insulated from the other taps 4 and 4', and arranging contacts A''—B''—C''—D'' to be engaged by tap 50. Contact A'' is free; contact B'' is connected to the grid of the second audio amplifier through condenser 51; contact C'' connects to the grid through condenser 52; contact D'' connects to the audio amplifier grid through condenser 53. The three condensers are of such relative size and arrangement that the cut-off points B_1—C_1—D_1 will result when tap 50 engages contacts B''—C''—D'' respectively. In other words audio frequencies from 3000 to 8000 cycles are substantially attenuated when tap 50 engages contact D''; this corresponds to the D and D' positions of taps 4 and 4' respectively. Audio frequencies above point C_1 are attenuated when tap 50 engages contact C'', and this corresponds to the C—C' positions of taps 4—4'. When taps 4—4' engage contacts B—B', then audio frequencies above point B_1 are attenuated by tap 50 engaging contact B''.

The utility and advantage of varying the transmission frequency characteristics of both audio and radio circuits simultaneously, or nearly simultaneously, will now be explained. The overall audio fidelity transmission characteristic is a function of both radio frequency and audio frequency characteristics. To eliminate high audio heterodyne beat interference from side bands of adjacent channel stations which is called "monkey chatter," and to reduce interference from static, hiss, etc., it is desirable to sharply attenuate the over-all characteristic response above a predetermined desired frequency range. This may be accomplished all in one part in either the audio or radio circuit, or it may be accomplished simultaneously in two, or more, parts of the receiver circuit. The first method would require an additional band pass circuit network involving considerable cost to obtain the desired attenuation. The second method as described in this application accomplishes the desired result with few extra circuit parts, and consequently lower cost.

There is another type of interference known as "cross talk" from adjacent channel stations which is distinguished from "monkey chatter" by the fact that interfering side bands and carrier appear on the audio detector in sufficient magnitude to rectify and produce an intelligible audio response independent of the desired signal. This type of interference can only be eliminated by attenuating the undesired signal before it reaches the audio detector, that is, by restricting the radio frequency transmission band.

Another factor to be considered is the unavoidable high frequency distortion which may be created at the input end of the audio circuits, for instance, at the detector. These distortion frequencies could be attenuated by restricting the audio frequency range of transmission to approximately the same frequency range that the radio frequency circuits efficiently pass when the receiver over-all band width is reduced to avoid cross-talk, monkey chatter, or to produce the tone quality desired by the listener.

For different reasons as stated above, the radio frequency and audio frequency transmission bands should both be restricted whenever it is desired to restrict the over-all transmission frequency band of the receiver. This amounts to saying that the control of the over-all transmission frequency band should operate simultaneously on the radio and audio circuits. In a practical design the control may operate in small degrees alternately on the radio and audio circuits, but in a manner such that it would be substantially simultaneous. For example, the switching mechanism in Fig. 1 might consist of six contacts instead of four as shown, and arranged so as to alternately change the transmission frequency band of radio and audio circuits for adjacent switch positions.

The tap 50 is connected by lead 50' to the low potential side of the grid circuit of the second audio amplifier. The shaft section between taps 4' and 50 is made of insulation material. The contacts and tap of the tone control device can be constructed as in the case of the preceding contacts and taps. The shaft 30 may terminate in a knob 90 which protrudes from the receiver operating panel; this knob can be adjusted to receive strong or weak stations; local or distant stations; or to cut out interference from strong adjacent channels. In other words, the selectivity control is used wherever it is desired to change from good fidelity when receiving strong signals with little interference to high selectivity when receiving weak signals through much interference.

In Fig. 4 is shown another variable selectivity control device construction which may be employed in place of that shown in Fig. 1. In place of separate contacts A—B—C—D, two strips are employed. One strip is used as the A position of tap 4, the other strip is used for the B—C—D positions of tap 4. Similarly, two strips replace contacts A'—B'—C'—D'. One strip is used for the A'—B' positions of tap 4'; the other strip is used for the C'—D' positions of the tap. Tap 50 slides over a resistor 70, and movement along the resistor varies the flow of the higher audio frequency currents through the path including resistor 70 and condenser 71.

The tap 50 is connected by lead 72 to the grid of the audio amplifier; the condenser 71 is grounded. A common mechanical element 30' is arranged to simultaneously vary taps 4, 4' and 50 in the same manner as in Fig. 1. The extreme A_1 to D_1 positions on resistor 70 are shown; the movement of tap 50 beyond point D_1 on resistor 70 results in a further by-passing of the audio frequencies. The circuit connections to the pairs of strips are believed obvious from Fig. 1, and are, therefore, not shown. The mechanical assembly of resistor 70, the pairs of strips and taps 50, 4, 4' can be compact, and may assume different forms.

It will be understood that the invention is not limited to a superheterodyne type of receiver; it may be applied to the radio frequency and audio frequency networks of a T. R. F. type of receiver. Again, a multi-function tube of the 55 type, or 2B7 type, may be used to perform the functions of the diode 20 and the first audio amplifier.

While I have indicated and described several systems 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 forth in the appended claims.

What I claim is:

1. In combination with a radio receiver of the type including a radio frequency signal transmission network and an audio frequency signal transmission network, means for adjusting the degree of selectivity of said radio frequency network, means for adjusting the transmission of the higher audio frequencies through the audio network, means for varying both said adjusting means, said adjusting means being constructed and arranged in such a manner that said varying means is adapted to vary both adjusting means for a portion of the varying means adjusting range and solely said audio adjusting means for another portion of said range.

2. In a system of the type defined in claim 1, means for tuning said radio frequency network through a desired signal frequency range, and said varying means being adjustable independent of said tuning means.

3. In a receiver of the superheterodyne type which includes an intermediate frequency transmission network, a second detector and an audio frequency transmission network, means for adjusting the resonance curve characteristic of said intermediate frequency network, means for varying the audio frequency transmission efficiency through said audio network, means for simultaneously varying both said adjusting means, said intermediate frequency network including at least two cascaded band pass circuits, said resonance curve adjusting means including a selectivity controlled device operatively associated with each band pass circuit and constructed and arranged to vary the sharpness of tuning of said band pass circuits in overlapping relation.

4. In a receiver of the superheterodyne type which includes an intermediate frequency transmission network, a second detector and an audio frequency transmission network, means for adjusting the resonance curve characteristic of said intermediate frequency network, means for adjusting the audio frequency transmisison efficiency through said audo network, and a common means for varying said adjusting means, said both adjusting means being constructed and arranged to permit the common means concurrently to vary them for a portion of the varying means adjusting range and solely said audio adjusting means for another portion of said range said audio transmission adjusting means being constructed to vary the transmission of the higher audio frequencies through said audio network, and said resonance curve adjusting means being constructed to change the width of the resonance curve characteristic in a predetermined sense with a change in transmission of the higher audio frequencies.

5. In a superheterodyne receiver of the type including a pair of coupled resonant circuits, each circuit being tuned to the operating intermediate frequency, a succeeding pair of coupled resonant circuits similarly tuned to the operating intermediate frequency, a second detector of the diode type having its anode connected to an intermediate point on the coil of the second tuned circuit of the succeeding pair of coupled circuits, an audio amplifier following the second detector, means including an adjustable element for varying the by-passing of audio frequencies from said audio amplifier, a variable selectivity control device operatively associated with one of the tuned circuits of said first pair of coupled circuits and including an adjustable element for changing the degree of selectivity of said coupled circuits, a similar selectivity control device operatively associated with said succeeding pair of coupled circuits and including an adjustable element arranged to change the degree of selectivity of the second pair of circuits in an overlapping relation with respect to the selectivity adjustment of the first pair of coupled circuits, and a common mechanical adjusting means operatively associated with the adjustable elements of said selectivity control devices and said audio amplifier adjustable element, said audio frequency bypassing means including a resistor and condenser in series across the input circuit of said audio amplifier, and said adjustable element of the bypassing means being slidably engaged with the resistor.

6. In a superheterodyne receiver of the type including a pair of coupled resonant circuits, each circuit being tuned to the operating intermediate frequency, a succeeding pair of coupled resonant circuits similarly tuned to the operating intermediate frequency, means for successively varying the co-efficient of coupling in each pair of coupled circuits for regulating the selectivity of the circuits, a second detector of the diode type having its anode connected to an intermediate point on the coil of the second tuned circuit of the succeeding pair of coupled circuits, said point being chosen to lessen the loading effect of the diode on the second tuned circuit.

7. In a radio receiver of the type provided with at least two cascaded radio frequency networks, a detector and an audio network, the improvement which comprises each of said radio networks consisting of a pair of reactively coupled tuned circuits each resonated to a common carrier frequency, the coupled pairs of tuned circuits having like selective resonance curves, a separate auxiliary reactive coupling device operatively associated with each pair of coupled tuned circuits to provide a less selective resonance curve, a switch connected with the auxiliary coupling device of the first pair of tuned circuits, said switch including an adjustable element constructed to have a plurality of adjustment positions, solely the first of the positions corresponding to coupling connection of said first auxiliary coupling device, a second switch connected with the auxiliary coupling device of the second pair of tuned circuits, the second switch including an adjustable element constructed to have a plurality of adjustment positions, the first of the second switch positions, and at least one position subsequent thereto, corresponding to coupling connection of the second auxiliary coupling device, a common actuating means for concurrently adjusting the adjustable elements of both switches whereby said resonance curves are of different sharpness upon adjustment of said switch elements from said first positions to the succeeding position.

8. In a radio receiver of the type provided with at least two cascaded radio frequency networks, a detector and an audio network, the improvement which comprises each of said radio networks consisting of a pair of reactively coupled tuned circuits each resonated to a common carrier frequency, the coupled pairs of tuned circuits having like selective resonance curves, a separate auxiliary reactive coupling device operatively associated with each pair of coupled tuned circuits to provide a less selective resonance curve, a switch connected with the auxiliary coupling device of the first pair of tuned circuits, said switch including an adjustable element constructed to have a plurality of adjustment positions, solely the first of the positions corresponding to coupling connection of said first auxiliary coupling device, a second switch connected with the auxiliary coupling device of the second pair of tuned circuits, the second switch including an adjustable element constructed to have a plurality of adjustment positions, the first of the second switch positions, and at least one position subsequent thereto, corresponding to coupling connection of the second auxiliary coupling device, a common actuating means for concurrently adjusting the adjustable elements of both switches whereby said resonance curves are of different sharpness upon adjustment of said switch elements from said first positions to the succeeding position, an audio tone control device operatively associated with the audio network, said tone control comprising a series resistor-condenser path shunted across the network to bypass high audio frequency components, means for adjusting the effective resistance in said path, said adjusting means having adjustment positions to correspond to the positions of the adjustable elements of said two switches, said adjusting means being coupled to said common actuating means, and said adjusting means being constructed to provide additional bypassing of high audio frequency components subsequent to the last positions of said adjustable elements.

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