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BAND WIDTH AND TONE CONTROL CIRCUIT

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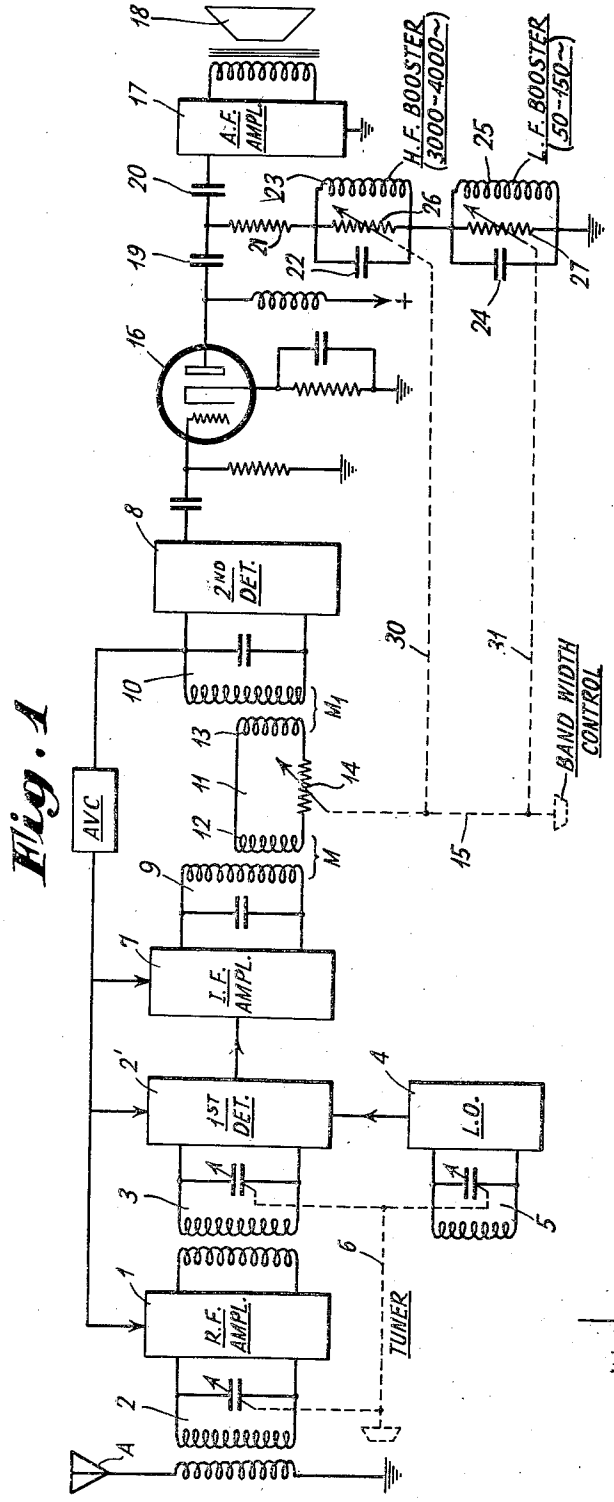


Fig. 1

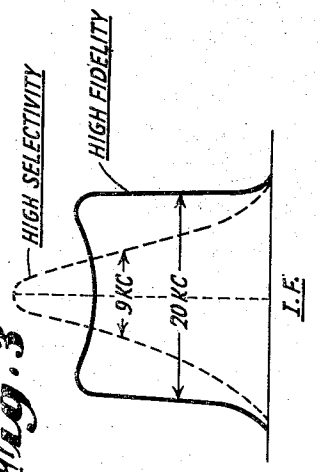


Fig. 3

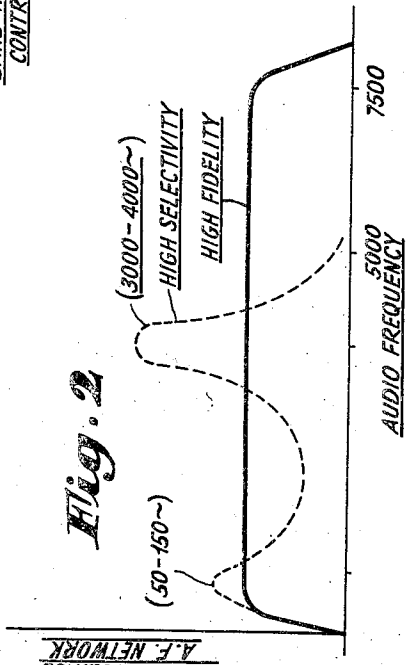


Fig. 2

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BAND WIDTH AND TONE CONTROL CIRCUIT

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7 Claims. (Cl. 250—20)

My present invention relates to tone control circuits for radio receivers, and more particularly to combined band width and tone control circuits for radio receivers of the high fidelity type.

In the past it has been customary, in radio receivers, to diminish the reproduction of the higher audio frequencies. Generally, tone control circuits have been employed for this purpose, and such circuits have comprised series resistor-condenser networks shunted across the audio amplifier circuit, the resistor usually being adjustable to produce a gradual diminution in the high audio frequency voltage supplied to the loud speaker. Unless the receiver is of the high fidelity type, the loud speaker employed usually has a sound output characteristic which is generally dish-shaped, and has peaks at about 80 cycles and 2000–3000 cycles, assuming a constant applied voltage to the audio network. What is most interesting about this type of characteristic is that there is generally a high peak in the vicinity of 2000–3000 cycles, with a sharp falling off in sound output thereafter and with negligible output above 5000 cycles.

The result of this peak is to produce brilliancy in the sound output, and to increase the intelligibility of speech. Thus, when a tone control device of the type described above is used with a loud speaker having the aforesaid characteristic, the peak in the speaker characteristic tends to sustain the brilliancy, or intelligibility, of the sound output even though the tone control device cuts down the high audio frequencies fed to the loud speaker. Low frequency boosting is used to improve the "balance" of high and low frequencies in the sound output, when a peak is inserted in the high frequency range. When the latter is done, an effect of insufficient bass, or a "thin" quality, would be apparent in the reproduction of music, if the low frequency end of the response curve were not raised also.

In high fidelity radio receivers, the loud speaker which is employed generally has a more uniform characteristic covering a wider frequency range, usually to about 7500 cycles. Receivers of the high fidelity type have as their object the faithful reproduction of the audio modulation side bands. More faithful reproduction is secured through the wide frequency range, and it is undesirable to resort to a peak in the speaker characteristic at 3000 cycles in order to secure added brilliancy in the sound output, as would be the case with loud speakers having a 5000 cycle cut-off. Such a peak would impair the faithfulness of reproduction when the full audio modulation band is supplied to the loud speaker.

However, receivers of the high fidelity type are usually provided with a device for restricting its acceptance band. For example, when receiving distant, or weak, stations, it is desirable to increase the radio frequency selectivity of the receiver. This is usually done by employing an adjustable band width control circuit which acts to widen or narrow the resonance curve characteristic of at least one of the signal selector networks. When using a band width control device, the audio frequency band supplied to the loud speaker may be limited to 4000 or 5000 cycles. The character of the sound output from a high fidelity, or flat response, loud speaker, supplied with a uniform audio frequency band limited to only 4000 or 5000 cycles, is not nearly as pleasing to the ear as that of a loud speaker output having a dish-shaped characteristic of the type described above, when the latter is supplied with a similarly limited band of frequencies.

Accordingly, it may be stated that it is one of the main objects of my present invention to provide a tone control circuit for a radio receiver of the high fidelity type, and which receiver embodies a variable band width control arrangement, the tone control circuit being constructed and arranged in such a manner that a broad peak may be introduced at a desired audio frequency region as the receiver selectivity is sharpened for receiving distant, or weak, stations.

Another important object of my invention may be stated to reside in the provision of a method of controlling the tonal characteristic of a receiver of the high fidelity type, wherein the brilliancy and intelligibility of the audio output is maintained throughout different conditions of signal reception; the method including the accentuation of the high frequency part of the audio characteristic simultaneously as the transmitted radio frequency band is progressively restricted by means of a variable selectivity device.

Another object of the invention may be stated to reside in the provision of a combined adjustable band width control device and audio tone control circuit for a radio receiver of the type having a normally flat audio response when receiving signals of maximum carrier strength; the tone control circuit functioning in a manner such as to accentuate a low audio frequency portion and a high audio frequency portion of the audio characteristic when the band width is restricted for weak signal reception.

Still another object of the invention may be

stated to reside in the provision of a radio receiver of the high fidelity type, which receiver includes a tone control circuit for providing peaks in the normally flat audio response characteristic when the radio frequency selectivity of the receiver is increased for weak signal reception; the peaks being disposed at 50–150 cycles and 3000–4000 cycles.

Still other objects of my invention are generally to improve the efficiency and reproduction of receivers of the high fidelity type, and more particularly to provide such a receiver so that it will function in a desirable manner, and be economically manufactured and assembled.

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 drawing in which I have indicated diagrammatically a circuit organization whereby my invention may be carried into effect.

In the drawing:

Fig. 1 schematically shows a radio receiver embodying the present invention,

Fig. 2 is an audio characteristic illustrating the operation of the invention,

Fig. 3 graphically shows the functioning of the band width control device.

Referring now to the accompanying drawing, in Fig. 1 there is shown a radio receiving system which is to be understood as being of the high fidelity type. That is to say, the radio frequency circuits up to the demodulator are all designed to transmit the audio modulation side bands with maximum efficiency and with uniform response. The resonant circuits will, therefore, have band pass characteristics. The audio amplifier network in such a receiver has a substantially flat response up to the limits of the audio range desired to be reproduced; the loud speaker employed will utilize a substantially flat audio response characteristic. Since the receiver can be of any well known type, it is believed only necessary to describe the various networks employed in a general manner.

The signal collector A is shown as of the grounded antenna circuit type; of course, a radio frequency distribution line, a loop collector, or even a collector used on a mobile structure may be employed. The collected signals are impressed on a radio frequency amplifier 1 which is provided with a tunable selector circuit 2. The amplified radio frequency signals are fed to a first detector 2'; the latter having a tunable selector circuit 3. The local oscillator 4 is provided with a tunable tank circuit 5, and the locally produced oscillations are impressed in any desired manner upon the first detector 2'. The dotted lines 6 indicate the usual "tuner" which is employed to vary the rotors of the variable tuning condensers in a simultaneous manner. Circuits 2 and 3 are tuned to the common signal carrier frequency in the desired frequency range, and the latter may comprise the broadcast band of 500 to 1500 kc.; whereas, the tank circuit 5 is tunable to a frequency range which differs from the signal range by the operating intermediate frequency, and the latter I. F. may be chosen from a range of 75 to 450 kc.

The I. F. energy delivered by the first detector 2' will be fed through an I. F. transformer, not shown, to an I. F. amplifier 7, and the amplified I. F. energy is then transmitted through another I. F. network to the second detector 8. Of course, the receiver need not be of the superheterodyne type, but can be of the tuned radio frequency amplifier type. In the latter case, the demodulator 8 will be preceded by a plurality of cascaded resonant radio frequency amplifiers each tunable to a common carrier frequency in the desired signal frequency range.

The network between I. F. amplifier 7 and the second detector 8 employs a band width control device. The latter may be of any desired type; the specific device shown is purely illustrative, and acts to vary the accepted band width in a desirable manner. The primary circuit 9 is coupled to the secondary circuit 10 by means of a link coupling network 11; the circuits 10 and 9 are each fixedly tuned to the operating I. F. Coil 12 of link coupling circuit 11 is magnetically coupled, as at M, to the circuit 9; coil 13 is magnetically coupled, as at M_1 to the circuit 10. The magnitudes of coupling reactances M—M_1 are chosen so that circuits 9–10 are coupled with optimum coupling; the latter produces the full line curve of Fig. 3. Such a curve is a band-pass curve, the modulation side bands are transmitted to the demodulator with uniform response and the band width is 20 kc. thereby passing all audio modulation frequencies up to 10,000 cycles.

The resistor 14 is inserted in series with coils 12 and 13; the resistor is variable in magnitude so as to adjust the coupling reactance value between circuits 9 and 10. When the resistor 14 has a maximum value, then the circuits 9 and 10 are loosely coupled; in that case the broken line selectivity characteristic of Fig. 3 results. This characteristic is employed for high selectivity transmission of signals to the demodulator; for example, the accepted band of frequencies may be about 9 kc. wide. The "high selectivity" curve need not be sharply single peaked as shown; the full line curve could be narrowed in width to pass a narrow band of frequencies and yet retain the band-pass characteristic. Of course, when the resistor 14 is adjusted to zero, or minimum, value, then the "high fidelity" curve of Fig. 3 results.

The control element 15, shown in broken line in Fig. 1 and designated "band width control", serves to vary the value of resistor 14. The demodulator 8 feeds the audio signals to an audio amplifier network comprising tube 16 whose input electrodes are coupled across the detector output circuit. The plate of amplifier tube 16 is coupled to the input of amplifier 17 through a path including series connected condensers 19–20. The junction of condensers 19 and 20 is connected to ground through a path comprising three series connected impedances.

The series impedances comprise resistor 21, a high audio frequency booster network which includes condenser 22 and coil 23, and a low frequency booster network which includes condenser 24 and coil 25. The network 22—23 is resonant broadly to a frequency at which a peak is desired in the high audio frequency region, as for example 3000–4000 cycles. The variable resistor 26 is connected in shunt with the reactive elements of the parallel resonant circuit 22—23. The variable resistor 27 is connected in shunt with the reactive elements of the parallel resonant network 24—25. The low frequency booster network 24—25 is tuned to a frequency at which a peak is desired in the low audio frequency region, as for example 50–150 cycles. The greater the magnitude of each of resistors 26 and 27, the more pronounced is the boosting

effect of the two resonant circuits. On the contrary when the resistors 26 and 27 have a low magnitude, then the two booster circuits are in effect short-circuited and no boosting results. The dotted lines 30 and 31 are to be understood as designating mechanical couplings between the control element 15 and the adjustable elements of variable resistors 26 and 27. Of course the mechanical coupling 31 may be omitted, and, in that case, only the high frequency booster network 22—26—23 will be employed with the band width control device 15.

The remaining elements of the audio transmission network are purely conventional. The amplifier 17 may be the usual power output stage. The loud speaker 18 is of the flat audio response type, such as are commonly employed in receivers of the high fidelity type. In Fig. 2, there are graphically shown the characteristic curves of the audio system of the receiver shown in Fig. 1, for the two conditions of high fidelity and high selectivity reception. The full line curve, designated "high fidelity", depicts the flat audio response of the audio transmission network, and it is shown that the response is flat up to substantially 7500 cycles. This is the audio characteristic when the band width element 15 varies the magnitude of resistor 14 so as to impart to the selector circuits the full line characteristic curve shown in Fig. 3. When the magnitude of resistor 14 is a minimum, then the magnitudes of resistors 26 and 27 are also a minimum.

On the other hand when the resistor 14 is adjusted so as to increase the selectivity so that distant, or weak, stations can be properly received, then the coupling elements 30 and 31 are simultaneously actuated to increase the magnitude of resistors 26 and 27 so that boosting occurs at the low and high audio frequency portions of the accepted audio range. The dotted line curve in Fig. 2 shows the boosting effect desired when the selectivity of the receiver is changed from broad to sharp condition. Of course the curves in Figs. 2 and 3 are purely pictorial, and those skilled in the art can readily derive the exact relations. It is to be noted that the mechanical adjusting elements 15, 30 and 31 are linked, in any well known and desired manner, so that the resistors 14, 26 and 27 are conjointly adjustable in a continuous manner from the full line curves to the dotted line curves of both Figs. 2 and 3.

It may be pointed out that the audio characteristic pictured by the broken line curve of Fig. 2 produces the best condition for listening to a high fidelity receiver when the band width control has been adjusted to restrict the modulation frequencies to a narrow band. The peak at the higher audio frequencies creates to some extent the impression of the brilliancy which exists when wide band reception is used, yet without the necessity for having decreased I. F. selectivity. Low frequency boosting is used to improve the "balance" of high and low frequencies in the sound output, when a peak is inserted in the high frequency range. When the latter is done, an effect of insufficient bass, or a "thin" quality, would be apparent in the reproduction of music, if the low frequency end of the response curve were not raised also. The carrier amplitude at the input circuit 10 of the demodulator 8 may be maintained substantially uniform by employing a conventional automatic volume control (A. V. C.).

As those skilled in the art fully know, such an A. V. C. circuit uses the I. F. energy for rectification, as in a separate rectifier. The direct current voltage component of rectified I. F. energy is employed to decrease the gain of each of the R. F. amplifier 1, the first detector 2', and I. F. amplifier 7. The decrease in gain is produced with an increase in carrier amplitude and at a rate such that the carrier amplitude at the input circuit 10 is substantially uniform, regardless of the variation of the carrier amplitude at the collector A. It will be clearly understood that the band width control device and the audio tone control networks are purely illustrative in nature; various other devices can be used in place of the specific ones illustrated. However, in any case, it is desired to correlate the band width control element and the audio tone control circuit in the manner described above.

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 organization 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. A method of operating a radio receiver of the type including a signal selector network and an audio network of the type having a normally flat audio response; the method including the steps of transmitting signals through said selector network with uniform response and over a wide audio range for strong signals, transmitting weak signals through the selector network over a limited audio range, and simultaneously accentuating low and high portions of the limited range.

2. In a receiver of the type employing a signal selector network of the variable band pass type and an audio amplifier having a flat audio response over a wide audio range; the method of reception including simultaneously restricting the band width passed by said network, for weak signal reception, and accentuating low and high portions of the restricted audio range corresponding to the restricted band width.

3. In a radio receiver of the high fidelity type comprising a band pass network, a demodulator and an audio system normally of a flat audio response; means for varying the width of the band passed by said network thereby to restrict the audio band delivered to said audio system, means for providing peaks adjacent low and high frequency ends of the restricted audio band, and control means for simultaneously adjusting said two means.

4. In a radio receiver of the high fidelity type comprising a band pass network, a demodulator and an audio system normally of a flat audio response; means for varying the width of the band passed by said network thereby to restrict the audio band delivered to said audio system, means for providing a peak adjacent the high frequency end of the restricted audio band, and control means for simultaneously adjusting said two means, and auxiliary means, responsive to the control means, for providing a peak adjacent the low frequency end of the audio band.

5. In a radio receiver of the type comprising a radio frequency amplifier, detector and audio amplifier; means for varying the selectivity of the radio amplifier between high and low limits; means for controlling the response of the audio amplifier; and a unitary device for adjusting said two means in a sense such that for high selec-

tivity the audio amplifier response is peaked in a region of 3000–4000 cycles, and additional means for peaking the audio response in a region of 50–150 cycles, in response to adjustment of the unitary device to high selectivity.

6. In a radio receiver, a high frequency portion provided with a band pass network, said network being adjustable to selectively transmit signals with high fidelity or high selectivity, an audio frequency portion designed to have a uniform frequency response characteristic over a comparatively wide range when receiving signals with high fidelity adjustment of the band pass network and a uniform frequency response over a narrower range due to attenuation of the higher audio frequencies when receiving signals with high selectivity adjustment of the band pass network, and means for improving the response characteristic of the audio frequency portion when receiving signals with the latter adjustment of the band pass network, said means consisting of a tone control circuit which accentuates the frequencies at the low and high frequency ends of said narrower range.

7. The invention according to claim 6 wherein the tone control circuit comprises a pair of serially connected resonant circuits, each shunted by a variable resistance, said resistances being conjointly controlled with adjustment of the selectivity control of the band pass network.

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