Dec. 14, 1937. L. E. BARTON 2,101,832

VOLUME CONTROL CIRCUITS

Filed May 12, 1934

Fig. 1.

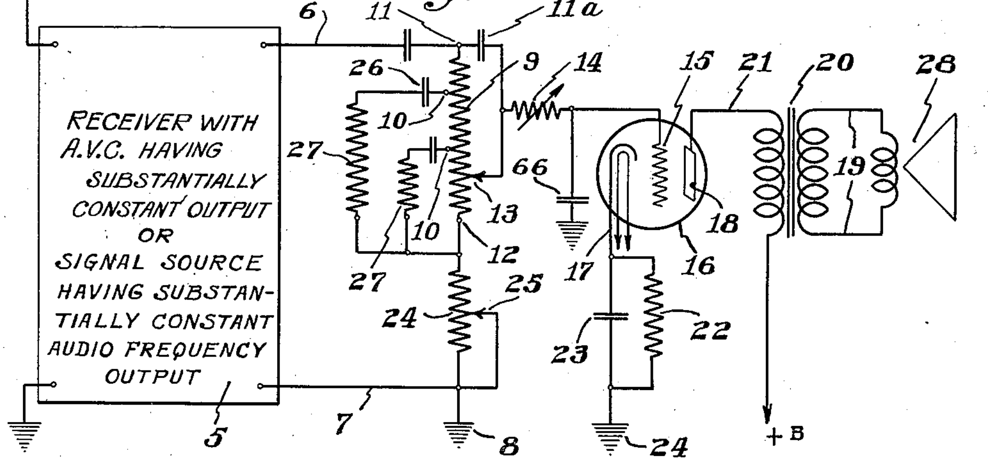


Fig. 4.

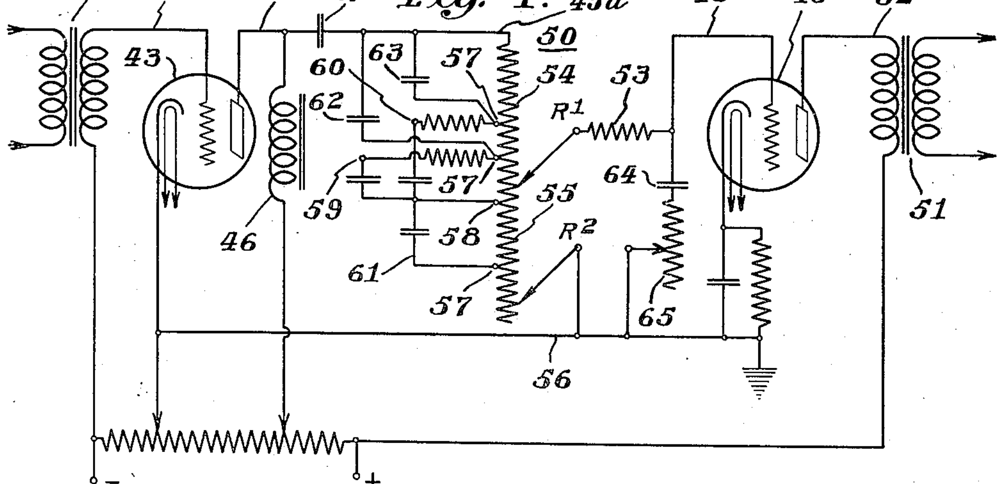


Fig. 3.

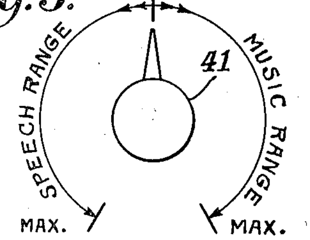
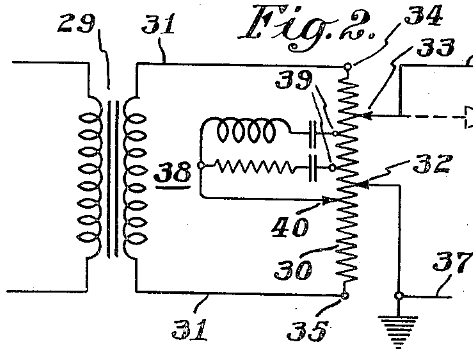


Fig. 2.



INVENTOR:
Loy E. Barton,
BY R. Goldsborough
ATTORNEY.

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2,101,832

VOLUME CONTROL CIRCUITS

Loy E. Barton, Collingswood, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application May 12, 1934, Serial No. 725,272

20 Claims. (Cl. 178—44)

The present invention relates to electrical sound amplification and reproduction, and more particularly to volume control circuits for controlling the sound output of radio receiving apparatus and the like. A volume control circuit of the acoustically compensated type includes both tone and volume control means simultaneously adjustable, thereby to control both the amplitude and the frequency characteristic of signals transmitted through a circuit in predetermined mutual relationship.

A system of that character for audio frequency volume and tone control is shown and described in my Patent No. 2,037,753, issued April 21, 1936, entitled Amplifier, being a division of my prior application, Serial No. 589,846, filed January 30, 1932, entitled Amplifier, both applications being assigned to the same assignee as this application.

For a further understanding of the purposes of compensated volume or sound output control reference may be made to the patent to Stevenson, 1,788,035, as pointed out in that patent, the ear is more sensitive to signals near the center of the audible range of frequencies than to those near the frequency limits of audibility.

Stating in other words, it is known that the human ear is less responsive to both high and low frequency sounds than it is to sounds in the middle register of the audio frequency range when the volume of such sounds is at a low level. It is also commonly observed that there is usually some degree of loudness or sound output level at which certain sounds, such as reproduced music or speech from a radio receiver or from phonograph records, are most pleasant to listen to. The general effect is that music loses its body when reproduced at lower than original volume, and speech sounds acoustically heavy or preponderant in bass frequency components when reproduced at higher than original volume. The cause for this effect can be traced to the variable frequency response charactertistic of the ear to tones or sounds of different intensity, as pointed out in the patent to Stevenson above referred to.

In my copending applications, above designated, I have provided an improved volume control circuit which is acoustically compensated to attenuate a certain portion of the audio frequency signal band as the signal level is reduced. Specifically, the system includes a tone and volume control electrical network, including a potentiometer resistor having one or more tap points thereon, to which are connected frequency discriminating circuits for variably loading the audio frequency transmission circuit at different volume adjustments of the potentiometer resistor, thereby to provide uniform and gradual control of volume from maximum to zero without appreciably affecting the frequency characteristic of reproduced sounds on the ear.

For the reason that music occurring in the useful audio frequency range from below 100 cycles to above 5,000 cycles, is usually reproduced at lower sound levels than the original, such acoustic compensation cooperating with volume control in reproducing apparatus is desirable, a greater degree of compensation or tone control being required in order to cause music to sound natural throughout the audio frequency range at low volume levels.

Speech, however, occurring below 2,000 cycles, in a usual range from about 100 cycles to 1,500 cycles or slightly higher, is usually reproduced at the same or higher sound or volume levels than the original and, therefore, requires less acoustic compensation in connection with the volume control means in sound reproducing apparatus, for example, if a radio announcer is talking at low volume levels, the voice sounds low pitched and unnatural, if the volume at the radio receiver is controlled by an acoustically compensated volume control means of the type above referred to, or, if the voice is reproduced at a level appreciably higher than the original.

Stated in other words, if speech is to sound natural and like the original, and the volume level is required to be above that of the original, the low frequency components of the sound are preferably reduced in amplitude or attenuated to a greater extent than the remainder of the audio frequency range. However, if the reproduction is below the original volume level for speech fidelity, the low frequency components of the sound to be reproduced are preferably amplified or increased in amplitude.

It is, therefore, desirable to provide, in a volume control circuit, not only acoustic compensation, but also a predetermined mutual relationship between the degree of attenuation effected by and the transmission efficiency characteristic of the audio frequency transmission circuit to provide for the proper reproduction of speech as compared to the reproduction of music, and this is primarily for the reason that speech is usually reproduced at a higher than the original sound level and music is reproduced at a lower than the original sound level.

It is, therefore, an object of the present invention to provide an improved acoustically compensated volume control circuit for radio receiving apparatus and the like, which is particularly adapted for adjustment to compensate for speech reproduction with improved fidelity, and which at the same time, is provided with compensating means for reproduction of music with fidelity at low sound levels.

It is a further object of the present invention to provide an audio frequency volume control system for controlling the signal attenuation effected in and the frequency transmission characteristic of an audio frequency signal circuit in predetermined mutual relationship and for adjusting said relationship.

It is a still further object of the present invention to provide a volume control circuit for a radio receiving system adapted to acoustically compensate signals throughout the audio frequency range for low sound levels, and for compensating for speech reproduction, that is, in the range below 2000 cycles, to restore the natural or original characteristic thereof at any sound level.

It is also an object of the present invention to provide an improved acoustically compensated audio frequency volume control signal network adapted for adjustment to provide high fidelity in speech transmission and reproduction.

In accordance with the invention, a combined tone and volume control potentiometer is included in circuit with variable impedance means for varying the degree of tone or acoustic compensation for any predetermined adjustment of the volume level, thereby to provide pleasing and natural speech reproduction from radio receiving apparatus and the like. Both the compensated volume control and speech compensating control means are preferably independently or selectively adjustable, and are further preferably associated in the same signal attenuating and control network in the circuit or system to which the compensation is applied.

In accordance with one embodiment of my invention, two audio frequency volume control devices are provided, one device being compensated acoustically, that is, to attenuate signals in a predetermined portion of the audio frequency range, such as the mid-frequency range of the audio frequency band, more rapidly than signals throughout the remainder of the audio frequency band. The other volume control device provides control of volume only, or compensation in the reverse direction, whereby, as the volume is increased, signals in the low frequency range are increased from a normal value at low volume adjustment at a much lower rate than signals in the remainder of the audio frequency range.

The invention will, however, be better understood from the following description when considered in connection with the accompanying drawing, and its scope will be pointed out in the appended claims. In the drawing:

Figure 1 is a schematic circuit diagram of a radio receiving system including an audio frequency amplifier circuit provided with a compensated volume control circuit embodying the invention;

Fig. 2 is a circuit diagram illustrating a modification of the volume control circuit of Figure 1, also embodying the invention;

Fig. 3 is a front view of a panel control knob for the volume control circuit of Fig. 2 showing the operating range thereof; and

Fig. 4 is a circuit diagram of an audio frequency amplifier provided with a compensated audio frequency volume control circuit embodying the invention and illustrating a further modification of the circuit of Fig. 1.

Referring to Fig. 1, 5 is a radio receiver provided with automatic volume control means adapted to maintain substantially constant signal amplitude in the audio frequency transmission circuit of the receiver indicated by the leads 6 and 7, the latter being the low potential side of the circuit and being preferably grounded as indicated at 8. It is obvious that any other source of audio frequency signals may be used provided the signal level is essentially constant at a predetermined level.

Connected across the audio frequency transmission circuit, 6—7 is a potentiometer device comprising a tapped resistor element 9 having a plurality of fixed taps 10 between its terminal ends 11 and 12, and a variable tap 13.

The tap 13 is connected through a variable resistor 14 with the input or control grid 15 of an audio frequency amplifier device 16. The amplifier may be of any suitable type, and is provided with a cathode 17 and an anode 18, the latter being connected with an audio frequency output circuit 19 through a coupling transformer 20 in the anode circuit 21 having connection with any suitable positive potential supply source (not shown). The cathode is provided with a self-bias resistor 22 and a by-pass condenser 23 therefor, and is connected to ground, as indicated at 24. The grid 15 is connected through the potentiometer device 9—13 with the negative end of the bias resistor 22 through the resistor element 24 of a second potentiometer device in series between the ground 8 and the volume control potentiometer element 9 in connection with the low potential terminal 12.

The potentiometer device 24 is provided with a movable tap 25, by which its impedance value is adjusted, and the tap is connected also with the ground connection 8 and circuit lead 7 whereby it serves to short circuit that portion of the element 24 included between the tap 25 and the lead 7. Any suitable impedance device may, however, be provided in place of the device 24, if suitably variable and connected in circuit with the volume control device 9 to vary its electrical effect across the audio frequency circuit.

Each of the spaced tap points 10 is provided with an acoustic compensating circuit terminating with the low potential end or terminal 12 of the impedance 9 being thereby in shunt with differing portions of the resistor or impedance 9 at the low potential end thereof. In the present example, each circuit includes a tone compensating condenser 26 and a current limiting resistor 27 in series therewith.

The operation is as follows:

The receiver 5 serves to supply to the audio frequency circuit 6—7 substantially constant output potentials at audio frequency, that is plural frequency sound representing electric oscillations of substantially constant average amplitude. The impedance network across the circuit including the tapped volume control device 9, having shunt compensating circuits, operates to attenuate to a greater degree signals in certain portions of the audio frequency range, thereby to correct for the audio frequency response characteristic of the ear at the lower volume levels.

When the sounds to be reproduced are lower in level than the original, the speech compensating volume control device 24—25 is reduced to zero, the contact 25 being moved in the drawing upwardly to the limit of the resistor 24, whereby the impedance 24 is reduced to zero. The volume control contact 13 is then adjusted for the desired volume, and compensation for frequency characteristic is applied automatically by the impedance network circuit more adjacent to the contact 13 in its adjusted position.

When the volume or sound level of the reproduced sounds are substantially the same or higher than the original, the contact 13 may be moved in a downward direction, as viewed in the drawing to reduce the volume, and the contact 25 is then moved also in a downward direction, as viewed in the drawing, to restore the volume with reduced compensation of the acoustic type.

By properly adjusting the compensated volume control device 9—13, and the speech compensating volume control device 24—25, a frequency balance may be obtained in the audio frequency transmission circuit to provide electric currents or oscillations representing sounds, which may be reproduced as signals, which sound like or approach the original in fidelity, although the sound level or volume of the reproduced signals may be substantially at or above the level of the original.

As the volume of the sound level of the reproduced signals is reduced to subnormal values, a balance is gradually effected between the two volume control devices whereby the compensated volume control device may assume a greater control effect and the speech compensating volume control a less control effect, or vice versa.

It will be noted, from an inspection of the drawing, that the dual volume control circuit or network includes two variable impedance devices in series across an audio frequency transmission circuit, and that the shunt compensating circuits for the compensated volume control device are connected with spaced tap points on the compensated volume control device and the terminal end to which the second volume control device is connected. The compensating circuits are returned in common to a point at the low potential end of said volume control device and between said device and the speech compensating volume control device. The latter device therefore is adjacent to the low potential side of the audio frequency circuit.

In the present example, the signal output from the dual volume control network is applied to an audio frequency amplifier device represented by the amplifier tube 16, and the audio frequency output therefrom is applied to the output circuit 19, as hereinbefore pointed out. For example, a loud speaker device may be connected thereto as indicated at 28 for the reproduction of signals applied to the circuit 19. It should be noted that the degree of reverse compensation for speech depends upon the relative values of the impedance 24 and the impedance of the network 9.

With the main volume control contact 13 at the minimum volume position adjacent to the terminal 12, the effect of the network is to permit more high frequency signals to pass through the circuit as the second or speech volume control contact 25 is varied to provide the desired volume or signal output level.

In any case, it is desirable that the impedance of the network in shunt to the audio frequency circuit, including the speech control device, be relatively high with respect to the source of signals or input end of the circuit. In this manner, the tone compensating network does not appreciably load the audio frequency input circuit 6—7.

Referring now to Fig. 2, an audio frequency coupling transformer 29 is provided with a volume control potentiometer resistor 30 connected in shunt to the secondary or audio frequency circuit 31. The volume control resistor is provided with an adjustable midtap 32 and a movable or variable volume control tap 33 which may be moved past and on either side of the tap 32 between the terminal ends 34 and 35 of the volume control potentiometer resistor. An output signal circuit 36—37 is connected to the taps 32 and 33 as shown and the output volume is zero or minimum when the two taps are together. The volume is increased as the tap 33 is moved toward either of the terminal ends 34 and 35.

The midtap 32 and the output circuit lead 37 are preferably connected to ground or chassis as indicated.

The volume control potentiometer resistor 30 is provided with acoustic compensating means or shunt tone compensating circuits 38 connected to fixed spaced taps 39 and an adjustable tap 40 movable to positions to and on either side of the center or ground tap 32. The tone compensating network or circuit may thereby be included only in one portion of the volume control potentiometer or may be included in a portion of the resistor on the opposite side of the ground or center tap.

Having adjusted the zero volume center tap 32, the volume control adjustments of the volume control contact 33 are compensated for tone on one side or the other of the tap 32 and compensated to a lesser degree or in a reverse direction i. e. increased high frequency response instead of low frequency response with reduced or low volume by adjustment of the tone compensating tap 40, thereby to attain good fidelity for music on one side of the tap 32 and speech on the other.

The volume for both music and speech may therefore be adjusted or controlled by one movable element or contact 33 and may be controlled by one control knob indicated at 41, the volume being zero when the tap 33 is moved to a position on the resistor 30 at which the ground or low potential output tap 32 is connected.

The operating ranges for the knob 41 are indicated in Fig. 3, the knob being rotatable between the "Min" position for zero or minimum volume and "Max" or full volume in either direction. The two ranges for speech and music correspond to the ranges between the tap point 32 and the terminals 35 and 34 respectively of Fig. 2 for movement of the volume control contact 33.

By adjusting the contact 40, the degree of tone or acoustic compensation may be adjusted; that is, the relation between the volume or signal output level and the frequency response characteristic of the system for a position of volume adjustment may be varied. The signal attenuation and efficiency of frequency transmission or degree of compensation may be adjusted to provide improved music and speech response.

Referring now to Fig. 4, a tone compensating network for acoustic compensation in accordance with the invention, is shown between two stages of an audio frequency amplifier. The amplifier is provided with an input transformer 42, and a first stage electric discharge amplifier device 43, the input circuit 44 of which is connected to the transformer 42, and the output circuit 45 of which is connected through an output coupling impedance or choke coil 46 and condenser 47. The input circuit 48 of the second stage electric discharge device 49 is connected with the output circuit 45 through a variable coupling network 50.

The device **49** is provided with an output transformer **51** connected with its output circuit **52**.

The network **50** is also connected with the input circuit **48** of the second stage amplifier device **49** through a series radio frequency attenuator or resistor **53**. The bias potential path of the input circuit **48** is completed through a tapped potentiometer device **54** and a second potentiometer device or variable resistor **55** to a grounded cathode return lead **56**. The circuit arrangement is such that the devices **54** and **55** are in series across the output circuit of the first stage amplifier device represented by the leads **56** and **45*a***.

The volume control device **54**, and, if desired, the device **55**, are provided with taps **57** between the terminal ends, and tone compensating circuits are connected between the various tap points and a junction point **58** of the said series connected devices **54** and **55**, whereby compensation is applied to the low potential end of the device **54**, and the high potential end of the device **55** if compensation is provided on the latter device.

With the above described circuit arrangement, compensation is applied in reverse order in the one volume control device with respect to the other. The compensating circuits are designated at **59**, **60** and **61**. Additional high frequency compensation may be provided by condensers **62** and **63** connected between the high potential side **45** of the audio frequency circuit and the tap points **57**. As the specific form of compensating circuits used in the volume control network does not concern the invention further description is believed to be unnecessary.

In general, the operation of the circuit shown is the same as Fig. 1, the volume control network including two variable volume control variable impedances or resistors in series across the circuit, the one being "acoustically" compensated, and the other providing compensation in reverse order, or speech compensation when the other volume control device is effectively in circuit and in a position to offer tone or acoustic compensation.

Briefly stated, the volume control network includes two variable tone and volume controlling impedance devices, the one providing predetermined acoustic compensation, and the other providing means for changing the effect of the compensation, provided by the other, whereby speech compensation may be effected. The circuit further includes high frequency tone compensating means such as the condensers **62** and **63**, and the condenser **64** and series variable limiting resistor **65** in shunt across the input circuit **48**. The condenser **64** is of such value that it reduces the high frequency response as the resistor **65** is reduced in value.

The volume control network, therefore, includes compensated volume control and speech fidelity control means, each being independently variable. The attenuation of audio frequency signals effected by and the transmission frequency characteristic of the network may not only be controlled in predetermined mutual relationship, but the relationship may be adjusted and the frequency transmission characteristic may also be further adjusted in the high frequency range all independently, the one from the other in a volume control network embodying the invention.

In the embodiment of Figs. 2 and 3, the control is provided by a single variable means including both speech and music compensation for high fidelity in the reproduction of signal currents corresponding to sounds. Furthermore, it should be noted in connection with the circuit, shown in Fig. 2, that the audio frequency circuit, which is the secondary circuit of the transformer **29**, may be ungrounded whereby both sides of the circuit may be at potential above or below ground, as is advantageous in certain receiving systems. The output circuit, however, may be grounded as shown and, in the present example, the center or adjustable center tap **32** is connected to ground whereby the terminals of the volume control impedance may operate at other than ground potentials.

In accordance with the invention, therefore, predetermined mutual relationship between signal attenuation or volume control and transmission frequency characteristic or tone control for the reproduction of music with good fidelity may thus be varied in suitable manner, independently, to compensate the system for good fidelity in the reproduction of speech.

I claim as my invention:

1. The combination with an audio frequency signal transmission circuit, of a volume control potentiometer resistor connected in shunt thereto, means providing a variable center tap output connection therewith, means providing a second output tap connection therewith movable substantially throughout the length of said resistor on either side of said center tap connection, means providing a tone compensating network having connection with said resistor between the center tap and one terminal thereof, and means providing an input circuit connection with the terminals of said resistor.

2. The combination with an audio frequency circuit, of a volume control device comprising a continuously variable volume control potentiometer resistor connected in shunt therewith, a plurality of fixed spaced taps on said resistor between and spaced from the ends thereof, tone compensating means connected with said taps, at least one signal output tap movable along said resistor successively past said taps to provide a variable connection with said resistor, and at least one signal output tap movable along said resistor outside the tapped portion thereof and the range of operation of the first named tap.

3. In an audio frequency volume control circuit, a single volume control potentiometer and tone control reactance means in shunt with a portion of said potentiometer at the low volume end thereof for attenuating signals within certain portions of the audio frequency range with variation in volume in a control range adjacent said end, and a single impedance element comprising a variable resistor in series with said low volume end of said potentiometer.

4. In an audio frequency volume control circuit to which signals of substantially constant average amplitude are applied, variable volume control means comprising two series impedance elements connected in shunt relation with said circuit, tone compensating means in circuit with one of said impedance elements only, for attenuating signals within certain portions of the audio frequency range with variation in signal volume, and means for varying the signal volume including a variable output tap connection with each of said impedance elements.

5. In an audio frequency volume control circuit, a volume control potentiometer device having a resistance element provided with high potential and low potential input terminals at its ends, a tap continuously movable along said element between said ends, a signal output circuit

connected with said movable tap and the low potential terminal, a signal input circuit connected with said high and low potential terminals, said element having a series of taps spaced from said high potential terminal and from each other, a tone compensating network connected between each of said last named taps and the low potential terminal of said first named element, and a variable tone compensating impedance element connected between one of said circuits and the low potential terminal.

6. In an audio frequency volume control system, a volume control device including a shunt impedance element, at least one tone compensating impedance means connected in shunt relation to a fixed portion of said element, means providing a continuously variable output connection with said element along and including said fixed portion, and means providing a second variable output connection therewith over a limited range substantially excluding said fixed portion.

7. In an audio frequency volume control system, an audio frequency transmission circuit, a volume control device having a resistor element connected in shunt to said circuit, at least one tone compensating means connected in shunt relation to a fixed portion of said element less than the whole, a volume control tap continuously movable along a portion of said resistor element including the fixed shunted portion, an output circuit connected between one terminal of said resistor element and said variable tap, and means for varying the resistance between said terminal and said shunted portion.

8. In a radio receiving apparatus, a circuit providing substantially constant audio frequency signal output, a volume control network in said circuit including a potentiometer volume control device having a resistor element comprising two resistance sections and a tap connection between said sections, tone compensating reactance means connected with said tap connection across one section of said resistor element, a signal output circuit, a variable signal output contact element for said potentiometer device connected with said circuit for controlling the signal level in said circuit and the load applied to said circuit by said reactance means in predetermined mutual relationship, and a second contact for said circuit movable in connection with the other portion of said resistor element to vary said relationship.

9. In an audio frequency volume control system, a volume control device having an impedance element, a volume control contact member movable in connection with said impedance element, frequency discriminating impedance means connected directly in shunt with a fixed portion of said element, a second volume control contact movable in connection with said impedance element over a portion of said element outside the limits of said fixed portion, a signal output circuit connected with said contacts, and means for supplying signals to the terminals of said impedance element.

10. In an audio frequency volume control system, a control device having an impedance element, a contact member movable in connection with said impedance element, frequency discriminating impedance means connected directly in shunt with a fixed portion of said element independently of said contact element, an output circuit connected with one end of the last named portion of the impedance element and with said contact member, a single impedance element constituted by a variable resistor in said last named connection, and a signal supply circuit connected across said impedance element and resistor in series.

11. I an audio frequency volume control system, a tapped volume control potentiometer device comprising a resistor element having at least two resistor sections, means providing a fixed tap connection between said sections, a separate variable contact movable along and in connection with each of said sections, frequency discriminating impedance means connected in shunt with one of said sections through said tap connection, and an output circuit therefor connected with said variable contacts.

12. In an audio frequency volume control system, a tapped volume control potentiometer device comprising a resistor element having at least two resistor sections, means providing a variable tap ground connection between said sections, a reactance network connected in shunt with one of said sections through said tap connection, an audio frequency transformer having a secondary winding connected across the resistor element, variable contacts independently movable along each of said sections, and a signal output circuit connected with said contacts.

13. In a radio receiving apparatus, the combination of a circuit having substantially constant audio frequency signal output, an audio frequency signal transmission circuit following said circuit for receiving said substantially constant signal output therefrom, a volume control network between said circuits including signal attenuating reactance means, a potentiometer volume control device, said reactance means being connected in shunt relation to said circuits and to a fixed portion of said potentiometer device, whereby said device is operable to gradually control the signal volume transmitted through said network and the degree of attenuation provided by said reactance means, and whereby said circuit may variably be loaded by said means to compensate certain portions of the audio frequency range of said signals at predetermined signal volume levels, and a single impedance means in circuit with said potentiometer device, said last named means being variable for changing the degree of attenuation and load.

14. In an audio frequency volume control system, a control device including a shunt impedance element, at least one frequency discriminating signal attenuating means connected directly in shunt to a fixed portion of said element, and means providing two independently variable output connections with said element, the one including and the other excluding, said fixed portion.

15. In an audio frequency volume control system, an audio frequency transmission circuit, a volume control device having a resistive element connected in shunt to said circuit, a tone compensating reactance network connected in shunt relation to a fixed portion of said element less than the hole, means providing a variable tap connection continuously along and with said element as a whole, and an output circuit connected with a tap point between and substantially spaced from the terminals of said resistive element.

16. The combination with a source of plural frequency sound-representing electric oscillations, of an adjustable attenuating system therefor comprising a resistive voltage-dividing circuit, means for applying said oscillations thereacross, reactive means fixedly bridged across a portion of said circuit, output connections from said circuit,

means for controlling the attenuation effected by and the transmission-frequency characteristic of said system in predetermined mutual relationship, said means consisting in a single contact selectively movable over said circuit to a plurality of positions within and to a plurality of positions without said bridged portion thereof, said contact forming one of said output connections, and a second variable contact forming one of said output connections for varying said relationship.

17. The combination with a source of plural frequency sound-representing electric oscillations, of an adjustable attenuating system therefor comprising a potentiometer including a resistive element, said element having a high potential end and a low potential end, a fixed tap thereon, and a contact movable thereover to any of a plurality of positions on each side of said tap, a series circuit, including at least one reactance and resistance connected between said tap and an extremity of said resistive element, means for applying said oscillations across said resistive element, means for transmitting oscillations appearing between said extremity of said element and said movable contact, whereby adjustment of said contact simultaneously controls the attenuation effected by and the transmission-frequency characteristic of said system in predetermined mutual relationship, and variable means in circuit with the resistive element at the low potential end thereof for varying said relationship.

18. In an audio frequency volume control circuit, a volume control potentiometer device having a resistance element provided with high potential and low potential input terminals at its ends, a tap continuously movable along said element between said ends, a signal output circuit connected with said movable tap and the low potential terminal, a signal input circuit connected with said high and low potential terminals, said element having a series of taps spaced from said high potential terminal and from each other, a tone compensating network connected between each of said last named taps and the low potential terminal of said first named element, and a variable tone compensating impedance element connected between one of said circuits and the low potential terminal, said tone compensating network including elements for effecting tone compensation over a relatively wide frequency range and said variable tone compensating impedance element being effective to provide a desired tone compensation in a frequency range for speech reproduction.

19. In an audio frequency volume control system, an audio frequency transmission circuit, a volume control device having a resistive element connected in shunt to said circuit, a tone compensating reactance network connected in shunt relation to a fixed portion of said element less than the whole, means providing a variable tap connection continuously along and with said element as a whole, an output circuit connected with a tap point between and substantially spaced from the terminals of said resistive element, said tone compensating reactance network being effective to provide an improved frequency response for the reproduction of music over a relatively wide audio frequency range when said variable tap connection is included within the fixed portion of the resistive element, and means for indicating the position of said variable tap connection with respect to said last named tap point, whereby the volume control device may provide adjustment of volume within and without the compensating range and an indication of the response range within which it is adjusted.

20. In an audio frequency volume control system, an audio frequency transmission circuit, a volume control device having a resistive element connected in shunt to said circuit, a tone compensating reactance network connected in shunt relation to a fixed portion of said element less than the whole, means providing a variable tap connection continuously along and with said element as a whole, an output circuit connected with a tap point between and substantially spaced from the terminals of said resistive element, a control knob for manually adjusting said variable tap connection, and means providing indicia associated with said knob for indicating the selected adjustment range of operation of said variable tap with respect to said last named tap point.

LOY E. BARTON.