March 14, 1950 P. F. G. HOLST 2,500,493

STUDIO TONE CONTROL

Filed Feb. 19, 1949

Fig. 1

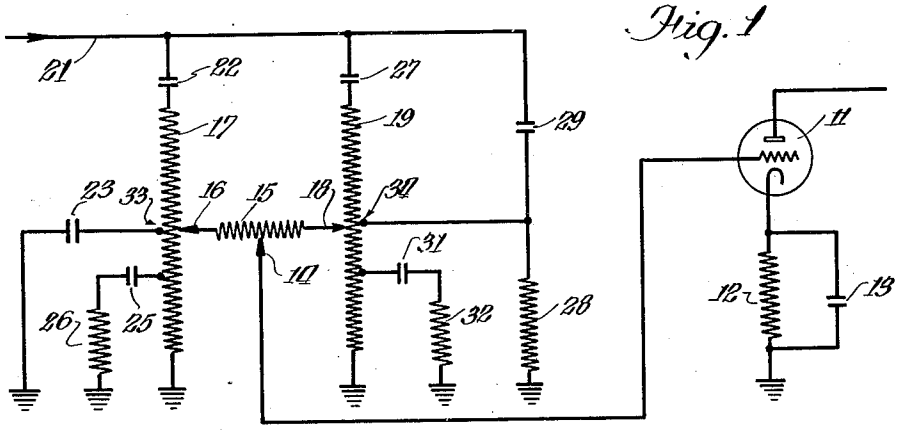


Fig. 2

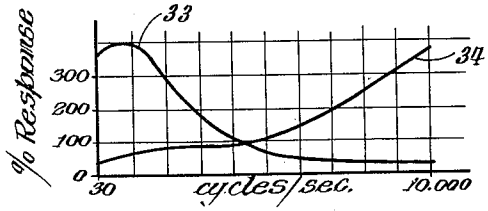


Fig. 3

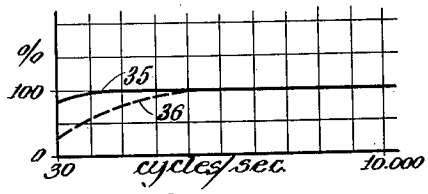


Fig. 4

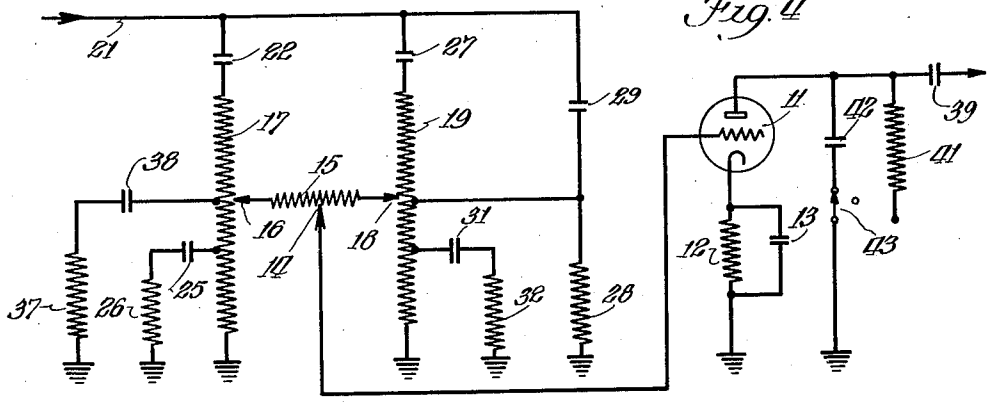


Fig. 5

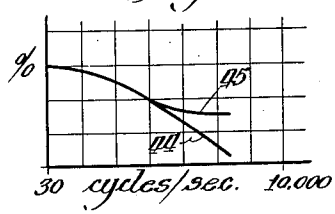
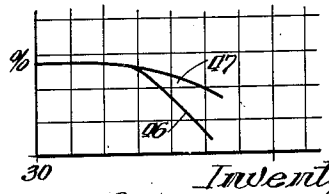


Fig. 6



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STUDIO TONE CONTROL

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7 Claims. (Cl. 178—44)

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The present invention relates to tone controls and more particularly to a wide range tone control particularly suited for radio receivers for producing certain compensating effects at different audio sound levels.

It is well known that a great difference exists between the audio sound level of a person speaking in a broadcasting studio and the audio sound level of a symphony orchestra. The level of transmission as indicated by the depth of modulation radiated by the broadcasting station, however, does not correspondingly vary. It of course is known that the radio station operators "ride the gain control" so that the transmitted variations in sound level are kept within a certain range. Quite obviously no compensation is provided for at the radio receiver. Thus the reproduction usually is at a sound level quite different from the level of sound from the original source. According to the authority Fletcher a change of the sound level of the reproduced sound when compared with the original or normal level of sound from the source produces on the listener an effect of an apparent change in tonal characteristic.

It of course has been observed by many individuals having radio receivers that when it is desired to set the volume level at a particular value it sometimes is necessary to adjust the tone control in order to make the reproduction more pleasing and natural. The tone control provided in the average radio receiver, however, is incapable of providing sufficient compensation to overcome the apparent change in tonal characteristic referred to by Fletcher.

It, therefore, is apparent that it would be desirable to provide an improved tone control having a relatively wide range which could be adjusted so as to provide the desired compensation for any volume level of reproduction so that the tonal characteristic would more nearly correspond to the tonal characteristic of the sound from the original source.

It, therefore, is an object of the present invention to provide an improved wide range tone control for sound reproducing circuits.

Another object of the present invention is to provide a wide range tone control which maintains the output level constant independent of the volume control setting.

Still another object of the present invention is to provide a tone control for compensating at the receiver for variations in broadcasting studio audio sound level.

Still another object of the present invention is

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to provide in a wide range tone control an additional control of the high audio frequency range independent of the adjustable or variable tone control.

Other and further objects of the present invention subsequently will become apparent by reference to the following description taken in conjunction with the accompanying drawings wherein:

Fig. 1 is a circuit diagram of one embodiment of the present invention;

Fig. 2 is a graphical representation of the approximate characteristics obtained at certain points in the circuit of Fig. 1;

Fig. 3 is another graphical representation of the approximate characteristics obtained at certain other points in the circuit of Fig. 1;

Fig. 4 is a circuit diagram of another embodiment of the present invention;

Fig. 5 is a graphical representation of certain characteristics obtained by the circuit of Fig. 4; and

Fig. 6 is a graphical representation illustrating certain other characteristics of the operation of the circuit of Fig. 4.

Referring to Fig. 1 of the drawing there is shown a vacuum tube 11 having a cathode bias resistor 12 and a bypass capacitor 13. This representation of a tube 11 is intended to denote the first stage of an audio frequency amplifier. The present invention consists of a circuit interposed between the first audio frequency amplifier and the audio input thereto which in a radio receiver is obtained from the detector tube. While it has been mentioned that the present invention is particularly suited for producing certain compensating effects because of the difference in transmission of the levels of sound from a radio station, it of course will be appreciated that the circuit likewise may be used for compensation in the reproduction of phonograph records particularly where such records are to be reproduced at certain desired sound levels.

The grid of the first audio amplifier tube 11 is connected to the adjustable contact 14 of a variable resistor 15 which is of the potentiometer type. One terminal of the resistor 15 is connected to an adjustable contact 16 of a resistor 17. The other terminal of the resistor 15 is connected to another adjustable or movable contact 18 of a resistor 19.

The resistor 17 is connected between ground and the input conductor 21 through a coupling capacitor 22. At an intermediate point on the resistor 17 a tap is provided for the connection

of a capacitor 23 which in turn is connected to ground.

At a point intermediate the grounded terminal of the resistor 17 and the point at which the capacitor 23 was connected to the resistor there is provided another tap which is connected to a capacitor 25 which is connected through the resistor 26 to ground. The circuit including a relatively large capacitor 22, the resistor 17, the capacitors 23 and 25 and the resistor 26 is designed to be predominantly responsive to the low frequencies of the audio frequency range. This circuit may be so designed that the response characteristic thereof is satisfactory for the reception and reproduction of a symphony orchestra or it may be so designed that the low frequency response obtained is slightly greater than that which would normally be required.

The other circuit which includes the resistor 19 connected between ground and the conductor 21 by means of a capacitor 27 is designed to be predominantly responsive to the higher frequencies of the audio frequency range. The resistor 19 at an intermediate point is also provided with a tap 34 which is connected through a resistor 28 to ground. The resistor 28 is also connected to a capacitor 29 which in turn is connected to the conductor 21. At a point intermediate the first mentioned tap on the resistor 19 and ground there is provided a second tap which is connected to a capacitor 31 which in turn is connected through a resistor 32 to ground. This combination of a capacitor and resistor serves the same purpose as the capacitor 25 and resistor 26 connected to the low frequency resistor 17.

This high frequency circuit may be so arranged as to provide adequate high frequency response or even an over-emphasis of the higher frequencies. The low frequency response of the high frequency circuit may be so arranged as to be satisfactory for the reproduction of speech.

It now will become apparent to those skilled in the art that the first control which includes the resistor 17 is supplied from the audio frequency input conductor 21 by a relatively large capacitor so as to insure a good low frequency response across the entire resistor 17. The intermediate tap point on the resistor 17 is loaded with a capacitor 23 or with the combination of a resistor and capacitor in series so that the impedance of this branch is designed to be low compared to the impedance of the control resistor 17. The response of the control circuit at the first tap point will be substantially the same as the frequency response characteristic of the impedance of the shunting network represented by the capacitor 23. Since this impedance has been selected so as to be high at the low frequency, the low frequency response of the circuit obtained when the adjustable contact is in the proximity of the first mentioned tap will be one which is relatively high.

The second shunting network represented by the capacitor 25 and the resistor 26 serves to further increase the low frequency response at still lower levels of reproduction.

In the second control which includes the resistor 19 the coupling capacitor 27 is relatively small so as to attenuate the low frequency response. The bypass capacitor 29 which is in shunt to the upper portion of the resistor 19 bypasses the high frequencies thereby creating a condition where high frequencies are prominent at the first tap. Since the first tap is loaded by the resistor 28 no accentuation of any low frequencies occurs there. The second tap point on the resistor 19 which includes the capacitor 31 and the resistor 32 as a shunt circuit, is provided for the lower levels of reproduction.

By adjusting the contact 16 and 18 simultaneously a change in the volume level is obtained. A change in the accentuation of the higher frequencies or lower frequencies is obtained by adjusting the position of the contact 14 on the resistor 15.

Thus it will be seen that I have provided, for use in combination with a source of audio frequency signals, a novel studio tone control which comprises a parallel pair of potentiometers (22, 17 and 27, 19) connected across the terminals (21, ground) of said source, each of said potentiometers having a sliding connection terminal (16 or 18) between its end terminals, one of said potentiometers (22, 17) having impedance characteristics which favor the low frequency components of the audio frequency signals and discriminate against the high frequency components, the other of said potentiometers (27, 19) having impedance characteristics which favor the high frequency components and discriminate against the low frequency components, a third potentiometer comprising a sliding connection terminal 14 and a resistor 15 connected between the sliding connection terminals (16, 18) of said first and second potentiometers. This tone control is shown in association with an amplifier stage 11 which has an input (grid-cathode) circuit connected to the output circuit formed by the sliding connection terminals 14 of the third potentiometer and the low potential terminal (ground) of the source. The third slide connection terminal 14 is adjustable to vary the relative intensities of the high and low frequency components of the signals applied to the amplifier stage 11. The first 16 and second 18 sliding connection terminals are adjustable in unison to vary the level of said signals. A series resistor-capacitor bass boost network (26, 25) is connected between the lower potential tap on potentiometer 17 and the low potential end terminal (ground). A series resistor-capacitor bass boost network (31, 32) is connected between the lower potential tap on potentiometer 19 and its low potential end terminal (ground). A series treble boost network comprising capacitor 29 and resistor 28 is also provided. It comprises a capacitor which is connected between the high potential tap on potentiometer 19 and the high potential end terminal of the potentiometer circuit (27, 19). It also comprises a resistor 28 connected between the tap 34 and the low potential end terminal (ground).

Referring to Fig. 2 there is shown in graphical representation the approximate characteristic to be expected at various taps on the resistors 17 and 19. The curve 33 shows the response to be obtained at the first tap on the resistor 17. Curve 34 shows the response at the first tap on resistor 19. The representation in Fig. 2 illustrates the percentage of response as compared to the frequency as expressed in cycles per second.

Fig. 3 shows an approximate characteristic curve 35 indicating the response to be obtained at the top of the resistor 17. In a similar manner the curve 36 indicates the response to be obtained at the top of the resistor 19.

In order to further assist those skilled in the art typical values for the components employed in Fig. 1 in one installation will be enumerated. The resistors 17 and 19 are four megohm resistors

tapped at one and two megohms from the lower extremity. The resistor 15 is a two megohm variable resistor. The resistors 17 and 19 are contained in a dual volume control resistor. The resistors 26, 28 and 32 are each 100,000 ohms.

The coupling capacitor 22 is 5,000 mmf., and the coupling capacitor 27 is 560 mmf. The capacitors 25 and 31 are each 3300 mmf. The circuit loading capacitor 23 is 2500 mmf. The bypass capacitor 29 is 82 mmf. As has been previously stated the circuit shown in Fig. 1 may have selected characteristics and hence the values given for the different components are not to be considered limitations but merely an explanation of the values encountered in a typical embodiment.

While the circuit illustrated in Fig. 1 has been found entirely satisfactory there are certain times when it would be desirable to have some kind of high frequency control which is independent of the action of the control illustrated in the circuit of Fig. 1. Such an arrangement is particularly useful where two different types of operation are desired as in the one instance a maximum low frequency response with additional high frequency response and in the other instance a maximum high frequency response with a less extreme high frequency response. It will be noted that similar reference characters have been applied to similar components in Fig. 4 and that only minor changes have been made. It will be noted that the tap on the resistor 17 is connected through a resistor 37 to a capacitor 38. The resistor 37 in this instance had a value of 60,000 ohms and the capacitor had a value of 2700 mmf.

The anode of the first audio vacuum tube 11 has the usual coupling capacitor 39 and anode resistor 41. Interposed between the anode and these elements is a connection to a capacitor 42 which is connected to one switch contact of an electrical switch 43 having its contact arm connected to ground.

The change in the shunt circuit connected to the first tap on resistor 17 changed the response characteristic from the curve 44 in Fig. 5 to curve 45. The provision of the capacitor 42 and the selector switch 43 at the anode of the vacuum tube 11 provides a selection between curves 46 and 47 of Fig. 5. Thus it will be appreciated that the switch 43 may be used to provide a greater or lesser amount of the higher audio frequencies without adjustment of the movable contact 14.

While for the purpose of illustrating and describing the present invention certain preferred circuit arrangements have been disclosed in the drawings, it is to be understood that the invention is not to be limited thereby since such variations in the circuit and in the components employed are contemplated as may be commensurate with the spirit and scope of the invention as defined in the accompanying claims.

What I desire to protect by United States Letter Patent is claimed as follows:

1. The combination of a source of audio frequency signals having high frequency and low frequency components, a parallel pair of potentiometers connected across the terminals of said source, each of said potentiometers consisting of a capacitor connected to the high-potential source terminal and a resistor connected between the capacitor and the low-potential source terminal, and each of said potentiometers having an adjustable connection terminal contacting its resistor between its end terminals, one of said potentiometers having impedance characteristics

which favor said low frequency components and discriminate against said high frequency components, the other of said potentiometers having impedance characteristics which favor said high frequency components and discriminate against said low frequency components, a third potentiometer comprising an adjustable connection terminal and a resistor connected between the adjustable connection terminals of said first and second potentiometers, and an amplifier stage having an input circuit connected to the output circuit formed by the adjustable connection terminal of the third potentiometer and the low potential terminal of said source, the third adjustable connection terminal being positioned to vary the relative intensities of the high and low frequency components of the signals applied to said amplifier stage, the first and second adjustable connection terminals being positioned in unison to vary the level of said signals.

2. The combination of a source of audio frequency signals having high frequency and low frequency components, a parallel pair of potentiometers connected across the terminals of said source, each of said potentiometers having a sliding connection terminal between its end terminals, said potentiometers having different frequency-response characteristics, a third potentiometer comprising a sliding connection terminal and a resistor connected between the sliding connection terminals of said first and second potentiometers, and an amplifier stage having an input circuit connected to the output circuit formed by the sliding connection terminal of the third potentiometer and the low potential terminal of said source, the third sliding connection terminal being adjustable to vary the relative intensities of the high and low frequency components of the signals applied to said amplifier stage, the first and second sliding connection terminals being adjustable in unison to vary the level of said signals.

3. The combination of a parallel pair of potentiometers connected across common input terminals, each of said potentiometers having a sliding connection terminal between its end terminals, one of said potentiometers having such impedance characteristics that it favors the low frequency components of an audio signal applied to said input terminals and discriminates against the high frequency components, the other of said potentiometers having such impedance characteristics that it favors said high frequency components and discriminates against said low frequency components, and a third potentiometer comprising a sliding connection terminal and a resistor connected between the sliding connection terminals of said first and second potentiometers, an output circuit being formed by the sliding connection terminal of the third potentiometer and the low potential input terminal, the third sliding connection terminal being adjustable to vary the relative intensities of the high and low frequency components of the signals appearing in said output circuit, the first and second sliding connection terminals being adjustable in unison to vary the level of said signals.

4. The combination of a parallel pair of potentiometers connected across common input terminals, each of said potentiometers having a tap and a sliding connection terminal between its end terminals, one of said potentiometers having such impedance characteristics that it favors the low frequency components of an audio signal applied to said input terminals and discriminates

against the high frequency components, the other of said potentiometers having such impedance characteristics that it favors said high frequency components and discriminates against said low frequency components, a third potentiometer comprising a sliding connection terminal and a resistor connected between the sliding connection terminals of said first and second potentiometers, an output circuit being formed by the sliding connection terminal of the third potentiometer and the low potential input terminal, the third sliding connection terminal being adjustable to vary the relative intensities of the high and low frequency components of the signals appearing in said output circuit, the first and second sliding connection terminals being adjustable in unison to vary the level of said signals, and a pair of series resistor-capacitor bass boost networks individually connected between each tap and the low potential end terminal of the associated potentiometer.

5. The combination of a parallel pair of potentiometers connected across common input terminals, each of said potentiometers having a pair of taps and a sliding connection terminal between its end terminals, one of said potentiometers having such impedance characteristics that it favors the low frequency components of an audio signal applied to said input terminals and discriminates against the high frequency components, the other of said potentiometers having such impedance characteristics that it favors said high frequency components and discriminates against said low frequency components, a third potentiometer comprising a sliding connection terminal and a resistor connected between the sliding connection terminals of said first and second potentiometers, an output circuit being formed by the sliding connection terminal of the third potentiometer and the low potential input terminal, the third sliding connection terminal being adjustable to vary the relative intensities of the high and low frequency components of the signals appearing in said output circuit, the first and second sliding connection terminals being adjustable in unison to vary the level of said signals, three series resistor-capacitor bass boost networks, two of which are individually connected between each tap on said one potentiometer and its low-potential end terminal, the remaining network being connected between the low-potential end terminal of said other potentiometer and its nearer tap.

6. The combination of a parallel pair of potentiometers connected across common input terminals, each of said potentiometers having a sliding connection terminal between its end terminals, one of said potentiometers having such impedance characteristics that it favors the low frequency components of an audio signal applied to said input terminals and discriminates against the high frequency components, the other of said potentiometers having such impedance characteristics that it favors said high frequency components and discriminates against said low frequency components, a third potentiometer comprising a sliding connection terminal and a resistor connected between the sliding connection terminals of said first and second potentiometers, an output circuit being formed by the sliding connection terminal of the third potentiometer and the low potential input terminal, the third sliding connection terminal being adjustable to vary the relative intensities of the high and low frequency components of the signals appearing in said output circuit, the first and second sliding connection terminals being adjustable in unison to vary the level of said signals, three series resistor-capacitor bass boost networks, two of which are individually connected between each tap on said one potentiometer and its low-potential end terminal, the remaining network being connected between the low-potential end terminal of said other potentiometer and its nearer tap, and a series treble boost network comprising a capacitor between the remaining tap and end terminal of said other potentiometer and a resistor between said remaining tap and its low-potential end terminal.

7. The combination in accordance with claim 6 and means including a series combination of switch and capacitor selectively effectively coupled in shunt with said output circuit to discriminate against the high-frequency components of said signals.

PAUL F. G. HOLST.

REFERENCES CITED

The following references are of record in the file of this patent:

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