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G. MOUNTJOY ET AL

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TONE CONTROL SYSTEM

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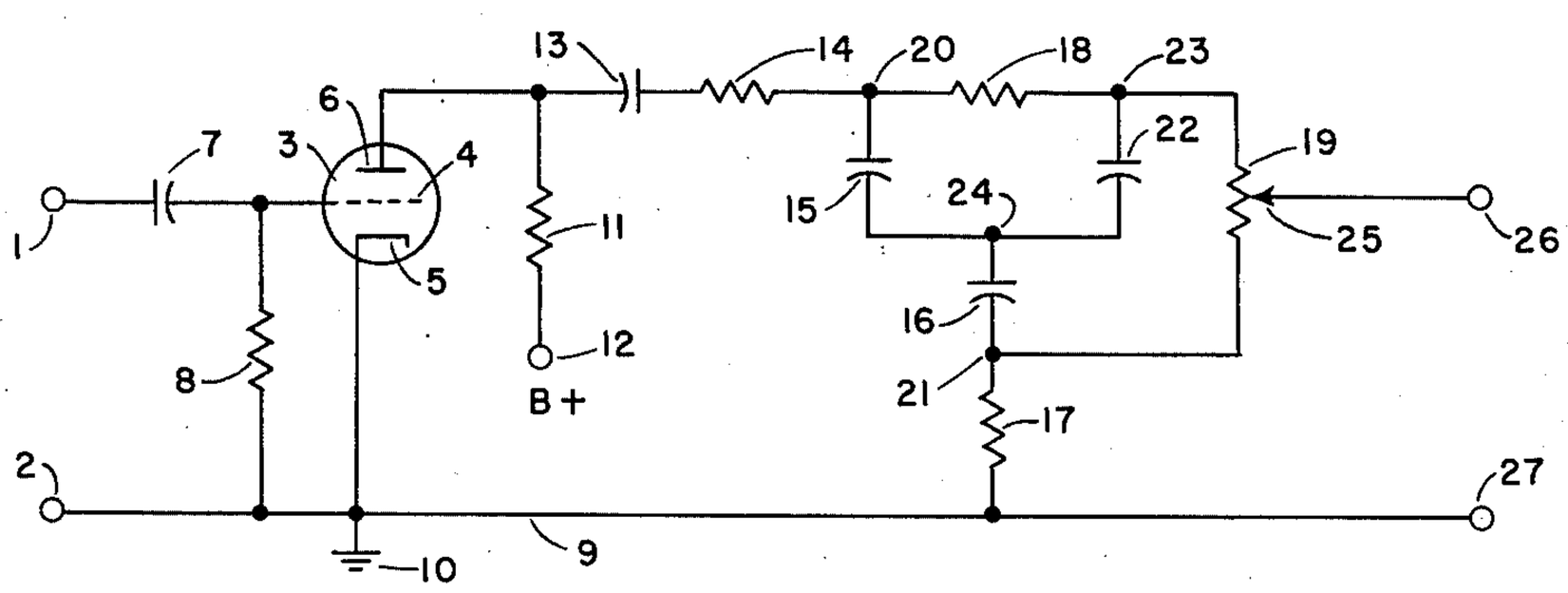

FIG. 1

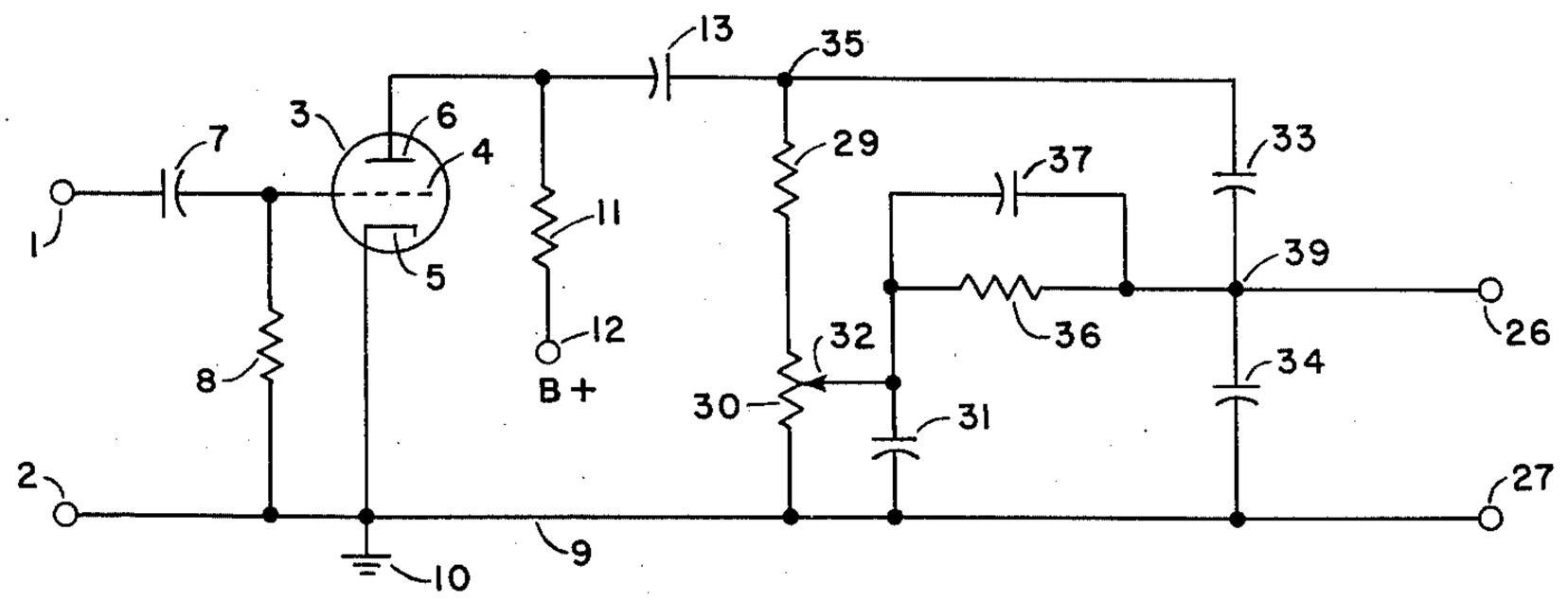

FIG. 2

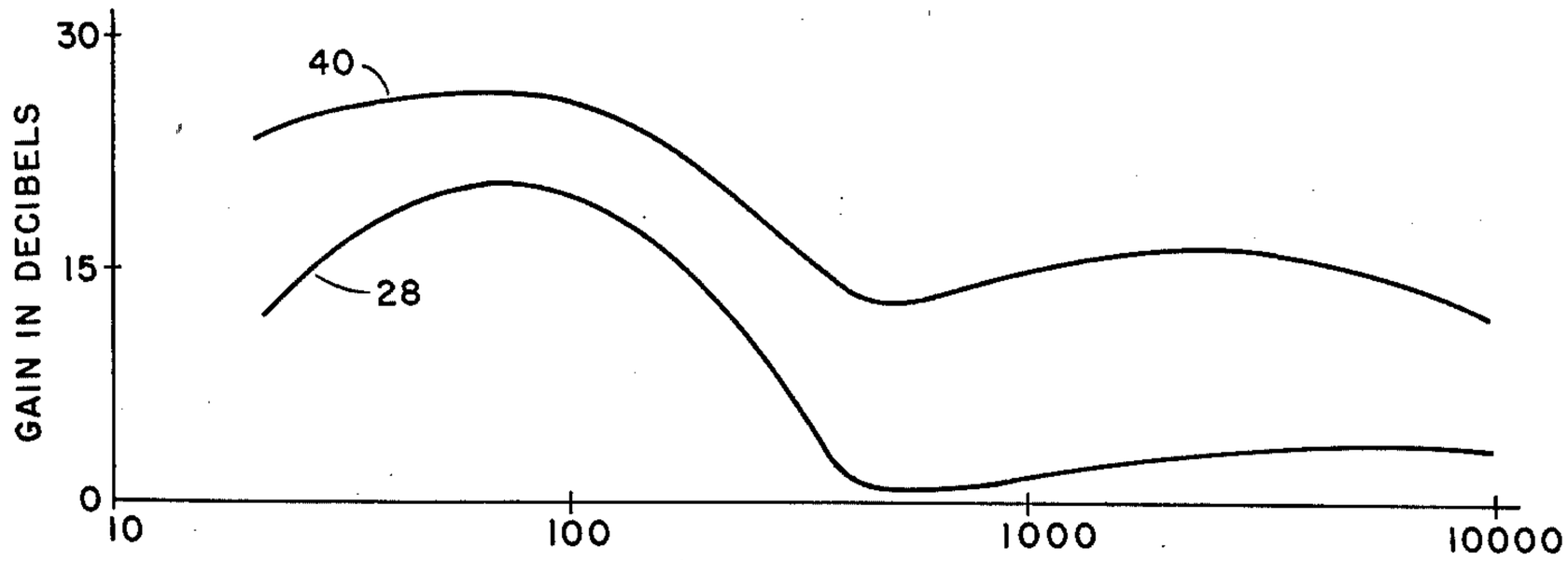

FIG. 3

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TONE CONTROL SYSTEM

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2 Claims. (Cl. 178—44)

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The present invention relates to a tone control system, and more particularly to such a system especially adapted for use in a radio broadcast receiver or in a sound system.

It has been found that reproduction of music by a radio receiver or other sound amplifying system is enhanced if the bass portion of the audio-frequency spectrum is accentuated relatively to the middle and treble portions of the musical scale. In general, however, accentuation of the bass portion of the frequency spectrum tends to render reproduction of speech "boomy" and sometimes practically unintelligible.

One solution of this problem is to provide a relatively rapid transition from a high bass level to a substantially lower level for the middle and treble portions of the frequency spectrum. The simplest type of circuit arrangement for securing relative accentuation of the bass frequencies utilizes a combination of resistance and capacitance. This arrangement is not entirely satisfactory, however, since the response curve obtained with it has a gradual slope downward from the bass level to the level of the middle and treble portions of the frequency spectrum.

It is an object of the present invention, therefore, to provide an improved tone control system in which the transition from the bass level to the level of the middle and treble portions of the frequency spectrum is relatively sudden.

It is another object of the present invention to provide a tone control system which is capable of attenuating the upper and middle portions of the frequency spectrum without a substantial effect upon the lower portion thereof.

An additional object of the present invention is to provide an improved tone control system of simple and inexpensive construction, which is capable of substantially enhancing the reproduction of musical program matter without any deleterious effect upon the reproduction or intelligibility of speech.

The above and other objects are realized in accordance with present invention by providing a source of signals extending over a wide band of frequencies. Means are provided for transmitting the upper portion of this frequency band with substantial attenuation, and for transmitting the lower portion of the frequency band without appreciable attenuation. Means are also provided for transmitting the portion of the frequency band intermediate the upper and lower portions in such a manner as to provide a relatively sudden transition from the level of the lower portion to the level of the upper portion.

By way of example, let it be assumed that the frequency spectrum to be covered extends from 30 to 10,000 cycles per second. In order to secure improved musical reproduction, it is desirable to substantially accentuate the frequencies in

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the region between 80 and 100 cycles per second with respect to the frequencies above this range. If unsatisfactory reproduction of speech is to be avoided, however, the relative accentuation of the bass frequencies should lie entirely below approximately 300 cycles per second. Such performance is readily obtained with the arrangements in accordance with the present invention.

The above and other objects and features of the present invention will be better understood by referring to the following description taken in connection with the accompanying drawing, in which like components are designated by like reference numerals, and in which:

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

Fig. 2 represents schematically a modified embodiment of the present invention; and

Fig. 3 shows graphically the performance realized with the embodiments of Figs. 1 and 2.

Referring to Fig. 1 of the drawing, there is shown a tone control system comprising input terminals 1 and 2 and an electron discharge device 3 having a control electrode 4, a cathode 5, and an anode 6. Input terminal 1 is coupled to control electrode 4 by a capacitor 7. A resistor 8 is connected between control electrode 4 and line 9, which is connected to input terminal 2 and which may be grounded as indicated at 10. Cathode 5 is connected to line 9. Anode 6 is connected through a load resistor 11 to a suitable source of positive potential, as indicated at 12.

Connected between anode 6 and line 9 is a series network comprising a capacitor 13, a resistor 14, capacitors 15 and 16, and a resistor 17. A resistor 18 and a potentiometer 19 are connected in series between the junction 20 of resistor 14 and capacitor 15, and junction 21 of capacitor 16 and resistor 17. A capacitor 22 is connected between junction 23 of resistor 18 and potentiometer 19, and junction 24 of capacitors 15 and 16. The movable arm or slider 25 of potentiometer 19 is connected to a first output terminal 26, the second output terminal 27 being connected to line 9.

In operation, resistors 14 and 18 and capacitors 15 and 22 form a T network. This network by itself would provide a response curve which would accentuate the bass portion of the frequency spectrum relative to the remaining frequencies, but which would have a pronounced dip or in some cases a cancellation resulting in zero response at an intermediate frequency, as for example, at approximately 300 cycles per second. However, by returning this network through the capacitor 16 rather than directly to line 9, the dip in the response curve is substantially eliminated. The capacitance of capacitor 16 is chosen to secure the maximum cancellation of this dip. The general level of the upper portion of the frequency spectrum may be set by a suitable choice

of the value of resistor 17. Increasing the value of this resistor decreases the relative degree of bass accentuation and also decreases the insertion loss of the network as a whole. Potentiometer 19 may be used to adjust the relative degree of bass accentuation, maximum accentuation being secured when the movable arm 25 is at the top of potentiometer 19. When slider 25 is at the bottom of potentiometer 19, there is a marked loss in the bass portion of the frequency spectrum, due to the fact that capacitors 15, 22 and 16 are effectively in series with resistor 17, acting as the load resistor.

In one particular embodiment of the circuit arrangement of Fig. 1, the following values of circuit components were found to operate satisfactorily:

Resistor 8	megohms	4.7
Resistor 11	ohms	390,000
Resistors 14 and 18	do	220,000
Resistor 17	do	7,000
Potentiometer 19	do	500,000
Capacitors 7, 15 and 22	microfarads	0.01
Capacitor 16	do	0.2
Vacuum tube 3		Type 6AV6

When the above values were employed in the embodiment of Fig. 1, the measured response curve was substantially that represented by curve 28 of Fig. 3. It will be observed that substantial accentuation of the bass frequencies is achieved and that there is no appreciable effect upon the middle and upper portions of the frequency spectrum.

Referring now to Fig. 2 of the drawing, it will be noted that the portion of the circuit to the left of capacitor 13 is identical with that of Fig. 1, which was described in detail above. A series network comprising a resistor 29 and a potentiometer 30 is connected between capacitor 13 and line 9. A capacitor 31 is connected between the movable arm or slider 32 of potentiometer 30, and line 9.

Capacitors 33 and 34 are connected between the junction 35 of capacitor 13 and resistor 29, and line 9. A shunt network comprising a resistor 36 and a capacitor 37 is connected between arm 32 of potentiometer 30 and the junction 39 of capacitors 33 and 34. Junction 39 is also connected to output terminal 26, output terminal 27 being connected to line 9.

In operation, resistors 29 and 36 and capacitors 31 and 34 constitute a network which attenuates the middle and upper portions of the frequency spectrum. Capacitor 33 provides a by-pass around this network for certain of the middle and high frequencies. The degree of accentuation of the bass portion of the frequency spectrum may be varied by potentiometer 30, which controls the effective reactance of capacitor 31 and increases the resistance in series with capacitor 31. Maximum bass response is obtained if potentiometer 30 has a high resistance value. The capacitance of capacitor 31 serves to remove the dip or cancellation which otherwise would be present in the response curve.

Curve 40 of Fig. 3 represents the approximate response curve which was achieved with the embodiment of Fig. 2, employing the following values of components:

Resistor 8	megohms	4.7
Resistor 11	ohms	360,000
Resistors 29 and 36	do	270,000
Potentiometer 30	megohms	5.0

Capacitors 7 and 13	microfarads	0.01
Capacitors 31 and 34	do	0.003
Capacitor 37	do	0.001
Capacitor 33	do	0.0005
Vacuum tube 3		Type 6AV6

It will be noted that curve 40, like curve 28, is substantially free from any appreciable dip in the middle-frequency region thereof, and that the embodiment of Fig. 2 provides marked bass accentuation and a relatively sudden transition to the level of the middle and upper portions of the frequency spectrum.

While there has been described what is at present considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a system for transmitting a relatively wide band of audio frequencies, means for substantially attenuating the middle and upper portions of said frequency band without appreciably affecting the lower portion of said frequency band, comprising: a three terminal network having an input terminal, an output terminal and a common terminal; a series path including two impedance elements between said input and output terminals; a pair of series-connected capacitively reactive impedance elements connected in shunt with one of said two impedance elements; and another capacitively reactive impedance element and another impedance element connected in series between the common connection between said capacitively reactive impedance elements and said common terminal.

2. In a system for transmitting a relatively wide band of frequencies, means for substantially attenuating the middle and upper portions of said frequency band without appreciably affecting the lower portion of said frequency band, comprising: a three terminal network having an input terminal, an output terminal and a common terminal; a series path including two impedance elements between said input and output terminals; a pair of series-connected capacitively reactive impedance elements connected in shunt with one of said two impedance elements; another capacitively reactive impedance element and another impedance element connected in series between the common connection between said capacitively reactive impedance elements and said common terminal, and a path of adjustable impedance between said output terminal and the connection between said another capacitively reactive impedance element and said another impedance element.

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