March 12, 1940. R. C. BALLARD 2,192,959

TONE CONTROL SYSTEM

Filed April 30, 1937

Fig. 1.

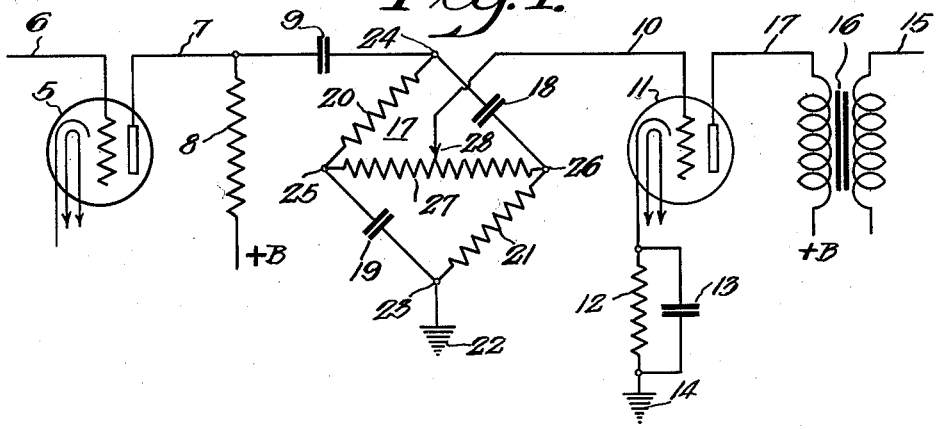


Fig. 2.

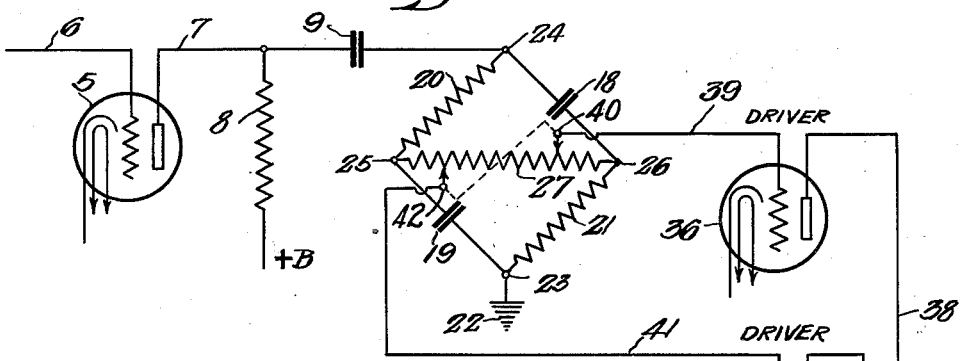
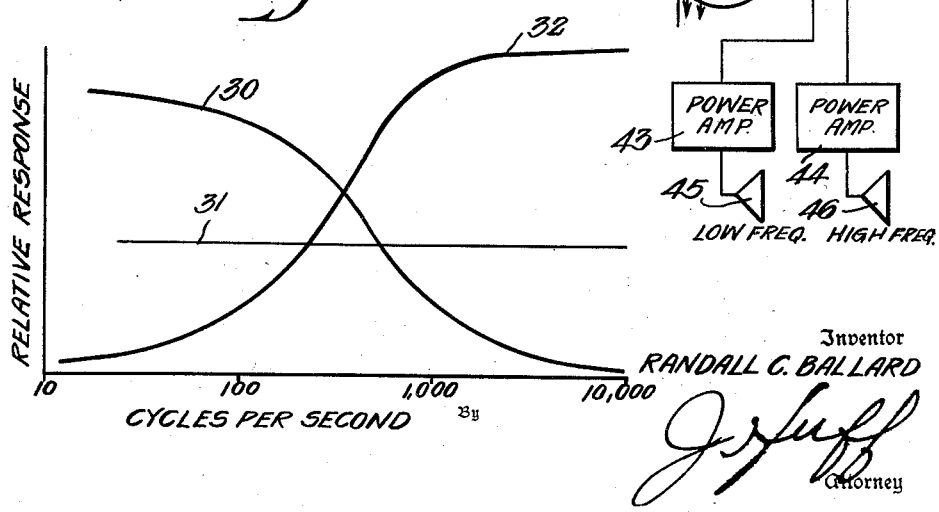


Fig. 3.



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Patented Mar. 12, 1940 2,192,959

UNITED STATES PATENT OFFICE

2,192,959

TONE CONTROL SYSTEM

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Application April 30, 1937, Serial No. 139,849

2 Claims. (Cl. 179—171)

The present invention relates to a tone control system for audio frequency amplifiers and the like and has for its object to provide continuously variable control of the audio frequency response or tone characteristic of an amplifier or audio frequency signal transmission circuit, between a condition of adjustment for maximum attenuation of audio frequency signals in the upper or high frequency portion of the audio frequency range, and a condition of adjustment for maximum attenuation of audio frequency signals in the lower frequency portion of the audio frequency range, whereby any desired frequency response may be obtained between said limits of adjustment by a single control element.

It is also an object of the present invention to provide a tone control system for an audio frequency signal transmission circuit which provides a continuously adjustable proportion between the high and low frequency components of signals transmitted therethrough.

It is also a further object of the invention to provide a high and low frequency tone control system for an audio frequency signal circuit comprising resistor and capacity elements having a single control element comprising a potentiometer resistor provided with a single movable contact, whereby the system is simplified in operation and may be provided at relatively low cost.

It is also an additional object of the present invention to provide a tone control system for proportioning the high and low frequency response thereof which may permit deriving the high and low frequency components of an audio frequency signal from the circuit through a simple resistor-capacitor network providing for output in separate channels.

Other objects and advantages of the invention will appear 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 portion of an audio frequency amplifier or signal transmission circuit, provided with a tone control system embodying the invention,

Figure 2 is a similar schematic circuit diagram showing a modification of the circuit of Fig. 1, and a further embodiment of the invention, and

Figure 3 is a graph showing curves illustrating differing conditions of operation of the circuit shown in Fig. 1.

Referring to Fig. 1, 5 is an audio frequency amplifier tube having an input circuit indicated at 6, and an output circuit indicated at 7 and provided with a coupling resistor 8 and output coupling capacitor 9 for connection with the input circuit 10 of a second stage audio frequency amplifier tube 11. The tube 11 is provided with a self-bias resistor 12 having a suitable audio frequency by-pass capacitor 13, and is connected to chassis or ground 14 which may be considered as the negative anode or B potential supply connection.

The second stage amplifier tube 11 may be coupled to an audio frequency output circuit 15, through a transformer 16 or other suitable coupling device connected in the output circuit.

The audio frequency transmission channel provided between the tubes 5 and 11 is of the impedance coupled type. The grid circuit portion of the impedance coupling is constituted by a resistor-capacitor network 17 resembling a bridge network in form. However, the legs of the bridge are unbalanced, being provided with equal reactance elements or capacitors 19 and 19 in two opposite legs and equal impedance elements 20 and 21 in the two remaining opposed legs. The network is connected to ground 22 at a low potential terminal 23 between the adjacent capacitor 19 and resistor 21, while the diametrically opposite high potential terminal, indicated at 24 and connected also between adjacent capacitor and resistance elements, 18 and 20, respectively, is connected with the output circuit 7 of the preceding stage, through the coupling capacitor 9.

This arrangement provides substantially two parallel circuits between the high potential side of the audio frequency transmission circuit and the low potential side of said circuit, each of the parallel circuits comprising a resistor and a capacitor in series, the resistors and capacitors in each branch or parallel circuit being equal, and in reverse order from the other circuit.

The junctions between the resistors and capacitors in each branch circuit, indicated at 25 and 26, provide output terminals to which the output or grid circuit 10 is variably connected through a high resistance potentiometer device 27, having its terminals connected with the output terminals 25 and 26, and having a movable tap 28 connected with the lead 10.

The impedance of the parallel branch circuits in shunt with the audio frequency transmission circuit at the output terminal 25 is such that the impedance to ground or the low potential terminal 23 is relatively low to signals in the high frequency end of the audio frequency range and at the terminal 26 is likewise relatively low with

respect to the high potential side of the circuit or the terminal 24.

With resistors 20 and 21 of substantially 270,000 ohms, capacitors 18 and 19 of substantially .0025 microfarad, and an output potentiometer 27 of substantially one mebohm resistance, operation of the tone control system in accordance with the curves of Fig. 3 have been obtained, the curve 30 being the audio frequency response of the system with the output contact 28 at the terminal 25, the curve 31 being the response characteristic of the network with the contact 28 in the mid position, substantially as shown, and the curve 32 being the audio frequency response characteristic of the network with the output contact 28 at the terminal 26.

By moving the output contact 28 toward the terminal 25, the high frequency portion of the audio frequency range of signals transmitted through the circuit are increasingly suppressed, and by moving the contact 28 toward the terminal 26, the low frequency portion of the audio frequency range of signals transmitted through the circuit are increasingly suppressed, thereby providing control of both "highs" and "lows" by a single, continuously variable means. In the mid-position, the transmission characteristic is substantially flat, as indicated.

The circuit arrangement shown readily permits continuous adjustment of the proportion of the high frequency to the low frequency response through the transmission circuit by means of a potentiometer resistor connected between the two branching circuits at the junction of the series elements as a single control element, the output contact being movable along the resistor between the junction points. These points are, in effect, high and low frequency output terminals, the terminal 25 being the low frequency output terminal and the terminal 26 being the high fresuency output terminal.

This circuit, therefore, further permits of a separation of the low and high frequency components of the signals transmitted through the network, as shown in Fig. 2, in which like circuit elements and circuits as in Fig. 1 have the same reference numerals.

In this circuit, the branch circuits 20—19 and 18—21 are connected between the terminals 24 and 23 and are provided with audio frequency signals from the amplifier 5 through the coupling capacitor 9, as in the circuit of Fig. 1. However, in this circuit two output amplifier branches including amplifier tubes 35 and 36 provide a low frequency output circuit 37 and a high frequency output circuit 38 by reason of the connections for the two tubes with the impedance network.

For this purpose, the high frequency amplifier 36 is connected through an input lead 39 and an adjustable tap 40 with the resistor 27, whereby the high frequency signals available at the terminal 26 may be derived therefrom at any desired amplitude by moving the contact 40 along the resistor 27 toward the terminal 26.

The low frequency amplifier 35 is connected through an input lead 41 with an adjustable tap 42 on the potentiometer resistor 27, whereby the tap 42 may be moved along the potentiometer resistor toward the terminal 25 to derive low frequency signals therefrom at any desired amplitude.

This arrangement is desirable where signals are to be further amplified in the channels 37 and 38 by means of ampliers indicated at 43 and 44 and applied to differing loud-speaker or other output means 45 and 46, respectively, for wide range audio frequency sound reproduction.

From the foregoing description, it will be seen that means are provided for effecting a division of tone control in the bass and treble ranges, with one control device and comprising a minimum number of simple circuit elements of relatively low cost.

Since the shunt paths are provided with duplicate reactance elements and resistances, the frequency attenuation in one channel begins at substantially the same point that the frequency response begins to increase in the other channel, where two output channels are provided, thereby providing a desirable "cross-over" arrrangement for high fidelity amplifier systems adapted to cover both a low and a high audio frequency response range. Stated in other words, the frequency response in one channel falls gradually from a predetermined normal amplitude to a minimum value with increasing frequency, while the frequency response or signal amplitude in the other channel rises gradually from a minimum to a predetermined normal value, the falling off and the rise in amplitude occurring within substantially the same portion of the response range of the amplifier. The system further has the advantage that the response in either range may be adjusted in amplitude. For example, in Fig. 2 the control contacts 40 and 42 may be operated jointly to reduce the bass as the treble is increased, and vice versa, or to change the "cross over" point to compensate for apparent change in volume.

While the invention may be applied to any suitable audio frequency signal tranmission circuit, it is particularly adapted for use as an interstage coupling network wherein the output connection may be made into a grid circuit or other circuit having a relatively high impedance, whereby the network may not be loaded appreciably on the output side thereof. A wide change of tone characteristic may be obtained in this manner without apparent change in volume.

I claim as my invention:

1. In an audio frequency amplifier, the combination with an interstage coupling circuit, of a control network comprising means providing two parallel and equal reactance paths in shunt to said first-named circuit, each path including a capacitor and an additional impedance element arranged in series in one order in one path and in a reverse order in the other path, said capacitors having substantially equal capacity and said impedance elements being substantially equal in impedance, means providing a pair of signal output channels having differing audio frequency response ranges, a potentiometer device providing a connection between the junction of the series-connected elements of one path and the junction of the series-connected elements of the other path, said means providing a variable connection for each channel through said device with one of said paths at a point between the series connected elements thereof, whereby through said connection the frequency response in one channel falls gradually from a predetermined normal to a minimum value and the frequency response in the other channel rises gradually from a minimum to a predetermined normal value within substantially the same portion of the response range of the amplifier, and means for varying said connection for each channel to vary the response characteristic of said amplifier in each of said channels.

2. In an audio frequency amplifier, the combination with an interstage coupling circuit, of a control network comprising means providing two parallel and equal reactance paths in shunt to said first-named circuit, each path including a capacitor and an additional impedance element arranged in series in one order in one path and in a reverse order in the other path, said capacitors having substantially equal capacity value and said impedance elements being resistors having substantially equal resistance value, means providing a pair of signal output channels having differing audio frequency response ranges, a potentiometer device providing a connection between the junction of the capacitor and impedance element in one path and the junction of the capacitor and the impedance element in the other path, a high impedance input circuit for each of said channels variably connected each with one of said paths through said potentiometer device at a point between the series connected elements thereof, thereby through said connection to cause the frequency response in one channel to fall gradually from a predetermined normal to a minimum value and the frequency response for the other channel to rise gradually from a minimum to a predetermined normal value within substantially the same portion of the response range of the amplifier, and means for conjointly varying said connections on said potentiometer device to vary the signal response of said amplifier in said channels in predetermined relation to each other.

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