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W. P. MAGINNIS

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AUDIO FREQUENCY VOLUME CONTROL MEANS

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FIG. 1.

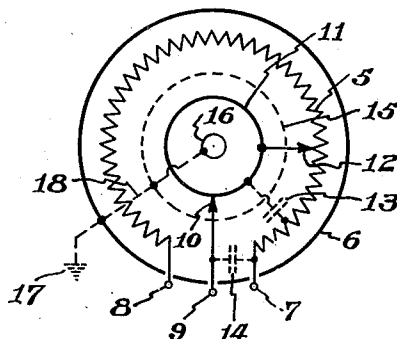


FIG. 2.

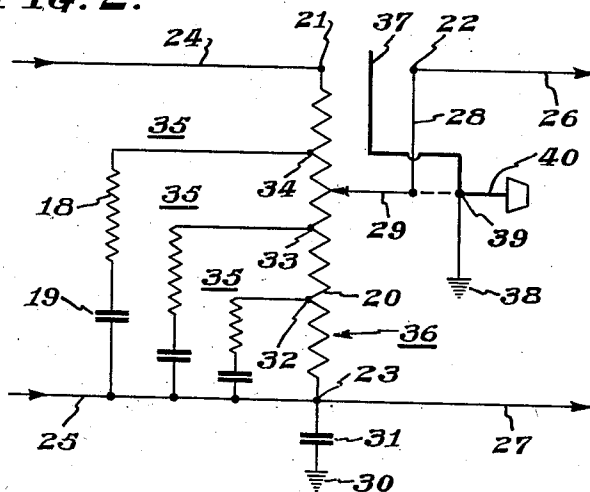
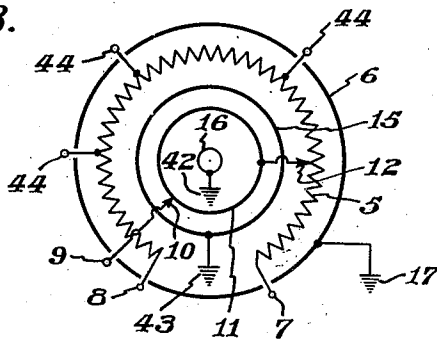


FIG. 3.



INVENTOR
William P. Maginnis

BY *J. Huff*

ATTORNEY

UNITED STATES PATENT OFFICE

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AUDIO FREQUENCY VOLUME CONTROL MEANS

William P. Maginnis, Upper Darby, Pa., assignor
to Radio Corporation of America, a corporation
of Delaware

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The present invention relates to audio frequency volume control means, and has for its object to provide an improved means of that character which may be effective to control audio frequency circuits which convey audio frequency signals at relatively high audio frequency.

It is a further object of the present invention, to provide an improved audio frequency volume control means which is adapted to provide improved operation at high audio frequency in connection with tone compensating circuits, whereby the compensation is not disturbed by stray capacity coupling between input and output circuit elements.

It is also an object of the present invention, to provide an improved volume control device wherein the component parts are arranged to provide a high degree of separation electrostatically and physically between the input and the output terminals thereof.

It is also an object of the invention to provide a volume control device having an internal electrostatic shield between the input and the output terminals and a terminal arrangement for preventing coupling between the input and output terminals.

The invention will 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 an audio frequency volume control device embodying the invention.

Fig. 2 is a circuit diagram of a portion of an audio frequency volume control network provided with volume control means embodying the invention, and

Fig. 3 is a schematic circuit diagram of a volume control device embodying the invention, and being similar to that shown in Fig. 1 including certain modifications thereof.

Referring to Fig. 1, 5 is the circular and arcuate resistance element of a volume control device located in a shielding casing 6 and having terminal ends connected with external or exteriorly extending, insulated terminals 7 and 8. A third external insulated terminal 9 is connected with output connection means comprising a contact element 10 for connector element 11 carrying or connected with a contact arm or movable tap 12 for the resistance element 5.

Operation of the contact 12 along the element 5 provides a resistance adjustment which may be utilized as a potentiometer for controlling elec-

trical circuits and in particular audio frequency volume control circuits. For example, in a well known volume control arrangement, the terminal 7 is the input terminal and the terminal 9 is the output terminal. The terminal 8 is a common input and output terminal, whereby as the contact arm 12 is moved along the resistor element 5 in a counter-clockwise direction, as viewed in the drawing, the portion of the resistor included between the output terminals 8 and 9 becomes less, thereby serving to reduce the output potential or volume.

Whatever may be the adjustment of the arm 12, the conducting parts such as the ring or output connector means 11 for the arm is electrostatically coupled to the input terminal 7 and to the high potential end of the resistor 5 adjacent to that terminal, by stray electrostatic coupling which is represented by the dotted capacity 13. Likewise a similar electrostatic coupling may exist between the input terminal 7 and elements connected therewith, and the terminal 9 and the conducting elements connected therewith, as indicated by the represented capacity at 14. Both electrostatic coupling areas occur in effect between the input or high potential terminal 7 and the output high potential terminal 9, whereby in the control of audio frequency signals having a wide frequency range, the high frequency portions thereof are less attenuated than the lower frequency portions thereof, by reason of the high frequency coupling afforded by the stray capacity represented by the elements 13 and 14.

Since the usual volume control device is circular in form and contains rotary elements, the movable contact, as the rotatable element, may be shielded in all positions from the input terminal by a circular shield element represented at 15 interposed between the output connection means 11 and the resistor element 5. The element 11 may be a flat plate connecting with the arm 12 and operating thru insulated connection with a central rotary shaft 16, and the shield 15 may be provided by a shallow cup shaped metal plate and may be connected to the shaft, to the outer shield casing 6, and to ground as indicated at 17. Such connection is represented diagrammatically by the dotted connection lead 18, although in actual practice such connection is made by joining the various parts thru operating contacts provided for example, by the contact between the shaft and its bearing, which bearing may be grounded to the casing.

It will be seen that the introduction of an electrostatic shield between the high potential ter-

terminal and the end of the volume control resistor and the movable arm or contact element, will eliminate stray and undesirable capacity coupling effects represented by the capacitor 13 whereby adjustment of the contact 12 will serve to adjust the output potential for low audio frequency signals and high audio frequency signals to the same degree, thereby permitting proper operation of the device as volume control means.

The effect of capacity coupling between the movable contact element and the high potential input portion of the volume control resistor in a potentiometer type of audio frequency volume control device is not serious when the overall impedance or resistance is relatively low. Accordingly the use of a shield is of greater benefit in high impedance audio frequency circuits and volume control devices.

Capacity coupling between the high potential side of the resistor element and the conductor element for the movable arm or contact is highly undesirable and has been found seriously to affect the operation of multiple tapped volume control resistors for so-called compensated volume control systems. In such tone compensated systems, a plurality of taps may be provided along the volume control resistor element and connected with impedance elements for changing the degree of attenuation of audio frequency signals in certain portions of the audio frequency range.

A system of this character is shown in Fig. 2, to which attention is now directed, and in which a volume control resistor element is indicated at 20 with an input terminal at 21, an output terminal at 22 and a common input and output terminal at 23. An audio frequency input circuit is connected with the element 20 the high side or lead 24 of the input circuit being connected with the terminal 21, and the low side or lead 25 of the input circuit being connected to the terminal 23. An audio frequency output circuit is connected at its high potential side or lead 26 with the terminal 22, and on its low potential side thru a lead 27 with the terminal 23. The output terminal 22 is connected as indicated, thru a connecting element 28, with the movable contact 29 which operates in connection with the resistor element 20 as the volume control element between the input and the output circuits.

The low potential terminal 23 may be connected to ground or to any grounded circuit through a low audio frequency path which in the present example is represented by the ground connection 30 to which the terminal 23 is connected thru a by-pass capacitor 31 having low impedance to all frequencies within the range of audio frequencies to be transmitted thru the volume control device.

A plurality of spaced taps 32, 33, and 34 are provided along the volume control resistor element 20 and each is connected to the low potential side of the system and the terminal 23 thru a separate tone compensating circuit represented at 35. Each of the circuits may include suitable attenuating elements such as series connected resistors and capacitors 18 and 19, respectively.

As the volume control contact 29 is moved from the terminal 21 towards the terminal 23 to reduce the volume, the tone compensating circuits are progressively rendered effective to attenuate signals in the output circuit as is well known and understood.

When the volume control contact is at a point

for low volume response, such as at point 36, adjacent the low potential end 23 of the resistor 20, the voltage attenuation may be relatively high and of the order of 1000/1 because of the loading of the resistor element by the compensating element 33. However, the impedance from the point 36 to ground or to the terminal 23 must then be considerably less than 1/1000 of the impedance of the capacity existing between the high potential input terminal and the contact arm at the higher end of the audio frequency range if the higher audio frequency range is to be attenuated as effectively as the lower audio frequency range when the control arm is in the low volume control position such as at 36.

It will therefore be seen that when the volume control adjustment is such that the output voltage or volume is materially reduced, the high frequency portion of the audio frequency signals may still be unaffected thereby and permitted to pass thru the control, giving rise to a highly undesirable rise in the higher audio frequency response.

However, by placing an electrostatic shield element, represented in the present example by the element 37, between the high potential end of resistor element 20 and output terminal connection including the terminal 22 and the conductor 28, and grounding the same as indicated at 38, the high input side of the system is effectively shielded from the high side of the output circuit. This eliminates a major portion of stray capacity in the control device and eliminates the resultant rise in high audio frequency response.

It is preferable, as indicated in the present circuit and in connection with the device of the preceding figure, to ground the control shaft to the shield as indicated by the connection 39 with the shaft for the control knob represented at 40.

Referring now to Fig. 3, an improved volume control means embodying the invention and particularly adapted for its preferred use in compensated volume control circuits, such as the circuit of Fig. 2, is diagrammatically represented. The device is additionally provided with an improved terminal arrangement for eliminating the stray capacity 14 shown in Fig. 1 whereby the input and output terminals of the device are completely and effectively isolated electrostatically, thereby permitting proper and effective functioning of the compensating circuit in a predetermined manner.

For the purpose of reference to Fig. 1 and for a better understanding of the invention, like parts throughout bear the same reference numerals as in Fig. 1.

In this modification it will be noted that the arcuate resistor element 5 is provided with terminal ends 7 and 8 which are widely spaced apart, and the contact 10 for the movable arm 12 is connected with the output terminal 9 in a position with respect to the terminals 7 and 8 such that the low potential terminal 8 is interposed between the high potential output terminal 9 and the high potential input terminal 7. Since the terminal 8 may be and often is grounded or connected with ground as shown in the circuit of Fig. 2, the terminal 9 is placed more adjacent thereto whereby it may be in effect shielded from stray capacity coupling by the presence of the low potential terminal. In any case, the output terminal is transposed from its usual central location to a position widely spaced from the input terminal.

It will thus be seen that the stray capacity

represented as 14 in Fig. 1 is effectively eliminated in the modification shown in Fig. 3 and that the stray capacity 13 represented in Fig. 1 is also effectively eliminated by the electrostatic shield 15 which is interposed between the conductor element 11 for the contact arm 12 and the resistor element 5, whereby the arm connection and resistor element are electrostatically shielded throughout. In the present example the shaft 16 and the electrostatic shield 11 are grounded as indicated at 42 and 43 respectively. It will also be noted that the resistor element 5 is provided with spaced tap terminals 44 to which may be connected compensated circuits after the manner of the circuit arrangement in Fig. 2. The terminal 44 and also the terminals 7, 8, and 9 are preferably extended thru the outer shield casing 6 which is grounded as indicated at 7, and each of the terminals is suitably insulated from the casing 6 so that the electrical circuits within the volume control means are entirely free of ground connection, while the shaft, electrostatic shield and outer casing are all effectively connected together and to ground.

I claim as my invention:

1. In an audio frequency volume control network comprising an input circuit and an output circuit, the combination of a high impedance volume control resistor element connected across said input circuit and having a terminal connection at one end jointly with said input and output circuits, means providing a movable tap for said resistor element, means providing a connection between said movable tap and said output circuit, and means providing an electrostatic shield between the last named means and the high signal potential end of said resistor element, whereby high frequency signals from said input circuit are prevented from being applied to said output circuit through stray capacity coupling therebetween.

2. In the audio frequency volume control network, means providing a tone compensated volume control including a volume control potentiometer resistor element having a high impedance between its terminals, a movable contact therefor and a tone compensating circuit connected across a high impedance portion of said resistor element, and means for rendering stray capacity coupling ineffective to change the degree of compensation provided thereby comprising a circuit connecting element for said tap and an electrostatic shield interposed between said connecting element and said resistor element.

3. A high impedance volume control potentiometer device, comprising a combination, and an arcuate impedance element, a shielding outer casing therefor, means including a tap providing spaced terminals for said impedance element extending exteriorly of said casing, said impedance element providing a high impedance between end terminals and between one end terminal and said tap, means providing a contact movable along said impedance element, means providing a conducting output connection for said contact lying within the confines of said arcuate impedance element, a conducting shield member surrounding said last named connection means between said means and said impedance element electrically insulated therefrom and from the output connection, and means providing an output terminal for said tap and output connection

therefor extending exteriorly of the casing in a position more adjacent to one of said first named terminals and in relatively widely spaced relation to the other.

4. A rotary high impedance volume control potentiometer device comprising a metallic casing, an arcuate high resistance resistor element in the casing having insulated end and tap terminals extending therefrom, a movable contact element for said resistor element located within the confines of the latter, means for electrostatically shielding said last named element from said resistor element, and means providing an insulated output terminal for said contact means extending exteriorly of the casing and located at a point other than between said first named terminals.

5. A volume control device for a volume control audio frequency network providing tone compensation, comprising in combination, a variable high impedance resistor element having terminals at its ends and having tone compensating taps spaced along and connected with said resistor element between said terminals, input terminals connected with said end terminals, tone compensated means connected with said taps providing predetermined degrees of tone compensation with volume control, a movable contact element for said resistance element, means providing a conductive output connection therefor having a terminal in isolated spaced relation to said last-named terminals, and electro-static shield means interposed between said resistance element and said connection means for the movable contact, whereby stray capacity coupling is prevented from changing the various degrees of compensation provided at said taps.

6. In a high impedance audio frequency volume control network comprising a shunt volume control resistor having a resistance of the order of several hundred thousand ohms, a high potential terminal at one end thereof and tone compensating circuits connected in shunt with a portion of said resistor having a lower impedance to the opposite terminal than said first-named terminal, the combination with said resistor, of a volume control contact therefor movable between said terminals, and electrostatic shield means for preventing coupling between said contact and the high potential terminal at high audio frequencies when said contact is operating in a range including said lower impedance portion of said resistor element, whereby the predetermined compensation effected by said compensating circuits are substantially undisturbed by the physical relation between said contact and said high potential terminal.

7. In a volume control network comprising an input circuit and an output circuit, the combination of a high impedance volume control resistor element connected across said input circuit and having a terminal connection at one end jointly with said input and output circuits, means providing a movable tap for said resistor element, means providing a connection between said movable tap and said output circuit, and means providing an electrostatic shield between the last named means and the high signal potential end of said resistor element, whereby high frequency signals from said input circuit are prevented from being applied to said output circuit through stray capacity coupling therebetween.

WILLIAM P. MAGINNIS.