

[54] VARIABLE RESISTOR 3,343,115 9/1967 Greenwood..... 338/174  
3,456,228 7/1969 Wright..... 338/176  
[75] Inventor: Shunzo Oka, Hirakata, Japan  
[73] Assignee: Matsushita Electric Industrial Co.,  
Ltd., Osaka, Japan  
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Primary Examiner—Thomas J. Kozma  
Assistant Examiner—David A. Tone

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[58] Field of Search ..... 338/125, 126, 127, 174,  
338/176; 179/1 G, 1 VL

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[57] ABSTRACT

A variable resistor is disclosed in which the terminals for external connections of a plurality of resistor structures which are electrically insulated from each other are also electrically insulated from each other in such a manner that the electrical connection between a pair of said plurality of resistor structures is established only through a wiper arm which is adapted to electrically bridge the resistor structures.

4 Claims, 7 Drawing Figures

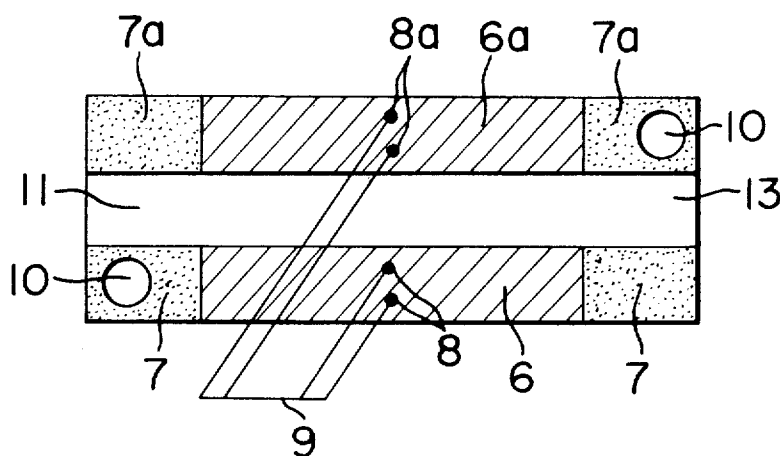


FIG. 1 PRIOR ART

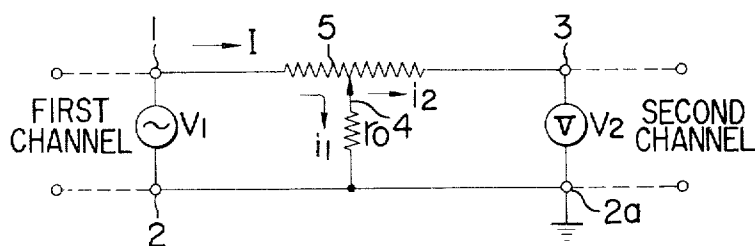


FIG. 2

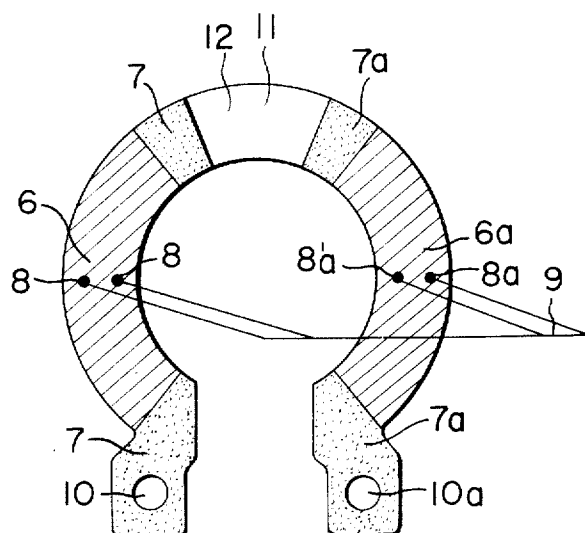


FIG. 3

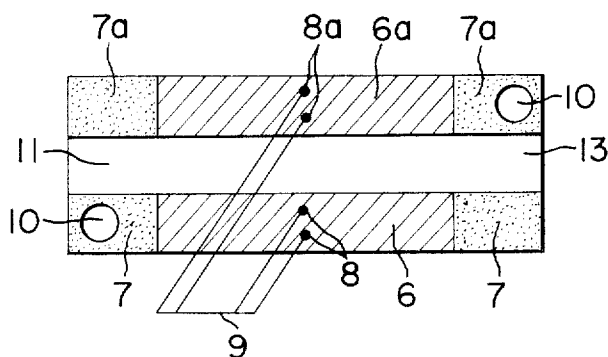


FIG. 4

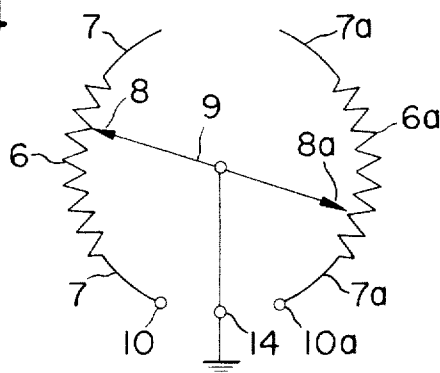


FIG. 5

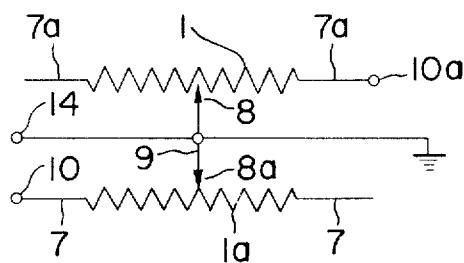


FIG. 6

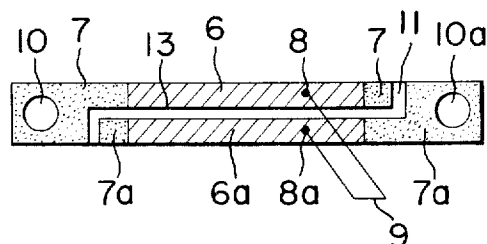
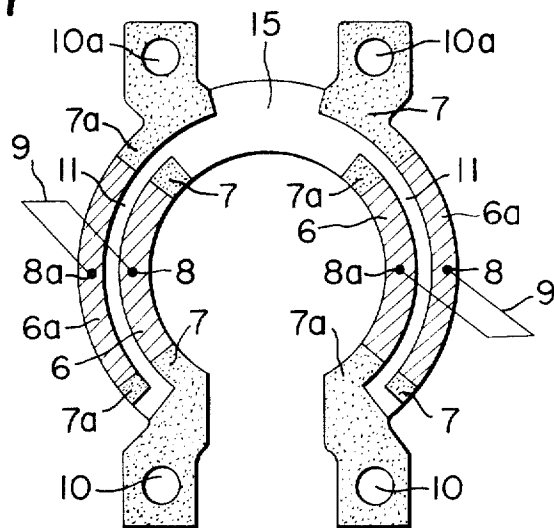


FIG. 7



## VARIABLE RESISTOR

## BACKGROUND OF THE INVENTION

The present invention relates to a variable resistor especially adapted for use in a stereophonic reproduction system.

In a stereophonic reproduction system, in order to attain the balance between the volumes of the different channels, a variable resistor is generally provided of the type in which, when an operating lever or the like is operated, the resistance between one terminal of the resistor and a wiper arm is increased while the resistance between the other terminal of the resistor and the wiper arm is reduced. The audio signal circuits of two different channels are connected between the wiper arm and the ends of the resistor so that as the wiper arm is moved, the resistance to one channel is increased whereas the resistance to the other channel is reduced, thereby attaining the balance of the volumes of the two channels. Since the terminal of one channel is electrically connected through the resistor to the terminal of the other channel, crosstalk between the channels is produced due to the contact resistance between the wiper arm and the resistor.

## SUMMARY OF THE INVENTION

One of the objects of the present invention is therefore to provide a variable resistor for a stereophonic reproduction system which may prevent crosstalk.

Briefly stated, a variable resistor in accordance with the present invention comprises a plurality of resistor structures electrically insulated from each other and at least one wiper arm bridging between at least two of a plurality of resistor structures. The terminals of the resistor structures are electrically insulated from each other, and the electrical connection between the terminals is established only through the wiper arm and the resistor structures. When the wiper arm is moved, the resistance between one terminal and the wiper arm is increased while the resistance between the other terminal and the wiper arm is decreased.

The above and other objects, features and advantages of the present invention will become more apparent from the following description of the preferred embodiments thereof taken in conjunction with the accompanying drawings.

## BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWING

FIG. 1 is a circuit diagram of a prior art variable resistor;

FIG. 2 is a top view of a first embodiment of the present invention;

FIG. 3 is a top view of a second embodiment of the present invention;

FIGS. 4 and 5 are circuit diagrams of the variable resistors shown in FIGS. 2 and 3, respectively;

FIG. 6 is a top view of a variation of the variable resistor shown in FIG. 3; and

FIG. 7 is a top view of a variation of the variable resistor shown in FIG. 2.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

## Prior Art

Referring to FIG. 1 illustrating a circuit diagram of a prior art variable resistor, a first channel is connected

to a terminal 1 and a ground terminal 2 whereas a second channel is connected to a terminal 3 and another ground terminal 2a. When the audio signal voltage  $V_1$  of the first channel is applied across the terminals 1 and 2, a voltage  $V_2$  is produced across the terminals 3 and 2a on the side of the second channel because there is a contact resistance between a wiper arm 4 and a resistor 5. As a result, the current  $I$  flowing from the first channel is divided into a current  $i_1$  flowing into the wiper arm 4 and a current  $i_2$  flowing into the second channel. In other words, the audio signals from the first channel adversely affect the second channel, and the same is true for the audio signals from the second channel. The above phenomenon is one of the major causes of crosstalk produced in a high-quality stereophonic system. In case of a variable resistor 24 mm in outer diameter the level of crosstalk is of the order of 30 dB to 40 dB.

## The Invention

## First Embodiment, FIGS. 2 and 4

Referring to FIG. 2 illustrating a first embodiment of the present invention, 6 and 6a denote film resistors of carbon formed upon a base 12 made of an insulating material; 7 and 7a denote, silver terminals at first ends of the film resistors 6 and 6a, respectively forming resistor structures therewith; 8 and 8a denote, contacts of a wiper arm 9 in contact with the film resistors 6 and 6a or the silver terminals 7 and 7a, respectively; 10 and 10a denote, terminals of the variable resistor for external connection; and 11 denote, an insulator interposed between the pair of silver terminals 7 and 7a, so that pair of resistor structures consisting of the thin-film resistors 6 and 6a and the silver terminals 7 and 7a are electrically insulated from each other. The insulator 11 between the pair of silver terminals 7 and 7a is a part of the horse-shoe shaped base 12 upon which are formed the thin-film resistors 6 and 6a, the silver terminals 7 and 7a.

## Second Embodiment, FIGS 3 and 5

A second embodiment shown in FIG. 3 is substantially similar in construction to the first embodiment shown in FIG. 2 except that a rectangular base 13 made of an insulating material is used and the wiper arm 9 is rectilinearly slidable.

Referring to FIGS. 4 and 5 illustrating the circuit diagrams of the first and second respectively the wiper arm 9 is electrically connected to a ground terminal 14.

## Variation of Second Embodiment, FIG. 6

A variation of the second embodiment is shown in FIG. 6. The embodiment shown in FIG. 7 is substantially similar to the first embodiment except that two pairs of the resistor structures are formed upon the horse-shoe shaped base 12. The variable resistor of the type shown in FIG. 7 is adapted for use in a four-channel stereophonic system. That is, the first and second channels are connected to the left terminals 10 and 10a and to the wiper arm 9 whereas the third and fourth channels are connected, to the right terminals 10 and 10a and the wiper arm 9.

In the variable resistors of the present invention with the construction described above, a pair of resistor structures are electrically insulated from each other by the insulator 11, and the electrical connection between the pair of terminals 10 and 10a is possible only

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through the wiper arm 9. Therefore, the voltage due to the resistance between the contact 8 or 8a of the wiper arm 9 and the film resistor 6 or 6a will not affect the adjustable resistance of the other resistor structure so that leakage current between the resistors may be prevented. As a result crosstalk may be effectively prevented and the performance of a stereophonic system incorporating the variable resistors of the present invention may be remarkably improved.

What is claimed is:

1. A variable resistor comprising

a. a substantially planar base made of an insulating material,

b. a pair of elongated film resistance elements formed on the substantially planar base, said elongated film resistance elements having equal resistances and having the same resistance-to-length characteristics and equal temperature coefficients of resistance,

c. a wiper arm electrically and mechanically bridging said pair of film resistance elements and movably arranged to slide from one end of the pair of elements to the other while maintaining electrical contact therewith,

d. a first terminal on said planar base and electrically connected to one end of said pair of film resistance elements,

e. a second terminal on said planar base electrically connected to the other of said pair of film resistance elements on an end of the pair of resistance elements opposite the end to which the first terminal is connected,

f. whereby movement of said wiper arm from one end of the pair of resistance elements to the other in-

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creases the electrical resistance between the wiper arm and one of the terminals and decreases the resistance between the wiper arm and the other terminal, said increase in electrical resistance being substantially equal to said decrease, and

g. said terminals being electrically connected solely through said film resistance elements and said wiper arm.

2. A variable resistor as defined in claim 1 wherein each of said resistance elements has an arcuate form, the resistance elements being symmetrically arranged on an imaginary circle coplanar with that base, and further comprising means for rotatively mounting said wiper arm about an axis that is coaxial with the center of said imaginary circle.

3. A variable resistor as defined in claim 1, wherein said resistance elements are linear and mutually parallel and wherein said wiper arm is confined to longitudinal motion in a direction parallel to the pair of resistance elements.

4. A variable resistor as defined in claim 1 wherein each of said resistance elements has an arcuate form, the resistance elements being arranged on adjacent arcs of two imaginary concentric circles coplanar with the base and having radii of different sizes, and further comprising means for rotatively mounting said wiper arm about an axis that is coaxial with the center of said imaginary circles, a second pair of arcuate resistor structures deposited on the base on two further adjacent arcs of said two imaginary circles, and further comprising a second wiper arm bridging said second pair of resistance elements and coaxially rotatable with said first wiper arm.

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