A device for coordinately controlling a plurality of variable resistors so as to achieve a desired combination of a plurality of variable resistors, said device comprising a first horizontal crosspiece having a lengthwise slot and a lateral plate perpendicular to the length of the crosspiece per se at each end thereof and second crosspiece having the similar slot and lateral plates the underside of which is partly on the same level as the underside of the first crosspiece when it is mounted on the second crosspiece, the two crosspieces being arranged crosswise and being moved relatively on a plane so that their movement moves a plurality of wipers so as to wipe the corresponding resistor elements.

13 Claims, 11 Drawing Figures
COORDINATED CONTROL DEVICE FOR VARIABLE RESISTORS

BACKGROUND OF THE INVENTION

This invention relates to a device for coordinately controlling a plurality of variable resistors to create any desired combination of resistances. More particularly, this invention provides a small-sized device with simple compact structure having a single handle for coordinated control of a plurality of variable resistors.

There has been growing demand for an inexpensive simple device for controlling a plurality of variable resistors, which are useful in the field of consumer electronics, especially for instance, in the case where volumes of a plurality of loud speakers are to be coordinately controlled so as to create a desired sound balance as in a stereo or quadraphonic speaker system.

Various devices to achieve this purpose are known. A typical device of the prior art comprises a control stick or lever supported by a ball-and-socket joint which allows the nutation (joystick movement) of the lever, and two U-shaped bridge-like supporters or bridge members having a lengthwise slot which are pivotally supported horizontally at right angles in a gyroscope-like fashion, whereby the lower end of the lever penetrates the slot of the two bridge members so that the two bridge members swing as the lever nutates. The ends of each bridge member are provided with a wiper which respectively wipes the surface of a resistor element which is placed perpendicular to the rotation or swing axis of each bridge member when the bridge member swings. In some cases, those bridge members directly contact the variable resistors. Thus the desired resistance is determined by the distance between the contact point of the wiper on the resistor element and the lead terminal of either end of the resistor element for four resistors in this case. However, the construction of the control device of this kind is complicated and therefore is inevitably bulky and costly.

Another typical device of the prior art comprises a horizontally movable crosspiece having a lengthwise slot and another horizontally movable crosspiece having a lengthwise slot which is movable in a direction perpendicular to the direction of the movement of the first crosspiece, said two horizontal crosspieces being moved by means of a joystick the lower end of which is inserted in the slots of both crosspieces at the crossing thereof, and contact means provided at the end of each crosspiece which slide along a resistor element as represented by U.S. Pat. No. 3,629,775.

In the device of U.S. Pat. No. 3,629,775, the resistor element which keeps contact with one cross piece is not on the same level as that of the resistor element which keeps contact with another crosspiece, and therefore the size of the device is inevitably large.

Prior to the present invention, I invented a device comprising a plate member horizontally movable in any direction and a plurality of wipers which move in accordance with the movement of the horizontally movable plate member in engagement therewith respectively maintaining contact with a resistor. (U.S. Patent Application Ser. No. 249,241 filed May 1, 1972) This device can achieve wide varieties of combination of a plurality of resistances very easily and very smoothly.

I have now invented a further improved device, which is the subject of this patent application. This device can provide more varied combinations of a plurality of resistances with less play than the devices of the prior art.

SUMMARY OF THE INVENTION

According to this invention, a simple compact device for coordinately controlling a plurality of variable resistors is provided, which comprises: a first horizontal crosspiece which has a lengthwise slot and a lateral plate perpendicular to the length of the crosspiece so that at each end thereof and is movable in the direction of the width thereof; a second horizontal crosspiece which has a lengthwise slot and a lateral plate perpendicular to the length of the crosspiece per se at each end thereof, is shaped such that, when it is mounted on the first crosspiece, the underside thereof is partly on the same level as the underside of the lower one, and is movable in the direction of the width thereof; said two crosspieces being arranged crosswise with the second crosspiece upon the first; a shaft which penetrates the slots of the two movable horizontal crosspieces at the crossing thereof and drives the crosspieces simultaneously in pair or all at a time; and a plurality of wipers which move in accordance with the movement of the two horizontal crosspieces maintaining contact with resistor elements provided on a common plane.

The stem or shaft may be a lever or joystick which is supported by a ball-and-socket joint at the middle thereof, the lower end penetrates the slots of the two crosspieces at the crossing thereof and the other end functions as a handle. Or it may be a short shaft provided with a knob on its upper end, which can be moved horizontally.

Preferably a short cylindrical or annular member is placed in the slots of the crosspieces at the crossing or intersection thereof, the lower end of the joystick that forms a small ball is inserted in this short cylindrical member, so that the crosspieces can be moved smoothly by the joystick even when it deeply nutates.

Usually four wipers are used, each of which is supported on an insulated base plate at the one end thereof by an axis provided near the center of the base plate so that the other end thereof can rotate keeping contact with a resistor element provided at the peripheral portion of the base plate.

The crosspieces and the wipers have engaging means so that the wipers are moved as the crosspieces are moved. Usually protrusions are provided at suitable positions on the underside of each crosspiece and a slot or groove is provided on the upper surface of each wiper, and a protrusion is placed in the slot or groove of the corresponding wiper. When the crosspieces are moved each protrusion rotates the corresponding wiper as it slides in the slot or groove.

The resistor elements are arranged in the peripheral portion of the base plate in a circular, quadrantal or square configuration.

The device of this invention can be easily manufactured by those skilled in the art guided by the drawings attached hereinafter.

BRIEF EXPLANATION OF THE ATTACHED DRAWINGS

FIG. 1 is a partially cut-away perspective view of a preferred embodiment of the device of this invention.
FIG. 2 is a cross-sectional view of the device of FIG. 1.

FIG. 3 is a plan view of the crosspieces and the base plane of the device of FIG. 1, partially showing the wipers.

FIG. 4 and FIG. 5 are plan views showing the positions of the wipers.

FIG. 6 is a perspective view showing construction of the wiper.

FIG. 7 and FIG. 8 are plan views of base plates showing other arrangements of resistor elements.

FIGS. 9 through 11 represent another embodiment of this invention.

DETAILED DESCRIPTION OF THE INVENTION

In FIG. 1, the above-mentioned crosspieces are shown at 4 and 5. The shaft or joystick is shown at 1. Member 15 is the base plate and member 3 is a housing. The crosspieces are designed so that they can move in the direction of the wipethereby guided by a pair of facing lateral walls of the housing. The joystick 1 is supported at the middle thereof by a ball-and-socket joint 25 provided at the center of housing. The ball-shaped lower end of the joystick 45 is inserted into a short cylindrical or annular member, which is placed in the slots 32 and 33 of the both crosspieces 4 and 5 at the crossing thereof.

The arrangement of the crosspieces and the joystick will be better understood by referring to FIG. 2 and FIG. 3. Each of the crosspieces has a lateral plate on each end thereof, which slides along a wall of the housing 3. A lateral plate of a size as large as possible is desirable as long as the plate does not restrict the movement of the crosspieces. The lateral plates ensure stabilized smooth movement of the crosspieces.

On the base plate 15, a resistor element is provided in a circular form not true circle in this case as shown at 31 in FIG. 1. The arrangement of the resistor elements will be better understood by referring to FIG. 3 and FIG. 4. Members 16, 17, 18 and 19 are lead terminals.

As seen in FIG. 4, four wipers 7(11), 8(12), 9(13) and 10(14) are rotatably secured to the base plate 15 by axes 21, 22, 23 and 24, which are located near the center of the base plate 15. Consequently, the shape of the resistor element 31 is not a true circle but comprises four arcs the centers of which respectively correspond to the axes of the wipers.

Each of the wiper consists of a finger and a finger carrier as shown in FIG. 6, in which (A) shows the finger carrier and (B) shows the finger. A finger has an axis hole and a slot (or a groove) 38, and a finger is fixed to the finger carrier by a suitable means.

On the other hand, the crosspieces have a pair of protrusions respectively 34, 35 and 36, 37 on the underside thereof. The pair of protrusions are usually provided at positions symmetric with respect to the center of each crosspiece. But for a specific purpose, the protrusions may be positioned asymmetrical to the center of the crosspiece.

Thus, the housing 3 bearing the joystick 1, the crosspieces 4 and 5, a short cylindrical or annular member 6 and the base plate bearing wipers are assembled so that the each protrusion (34, 35, 36 or 37) of the crosspieces placed in the slot or groove 38 of each finger carrier (7, 8, 9 or 10), and the lower end of the joystick is inserted in the annular member 6 placed in the slots 32 and 33 of the crosspieces at the crossing thereof.

With the thus assembled device, when the joystick takes the neutral position, the wipers take positions as shown in FIG. 4. When the joystick is nutated toward the corner C1, for instance, the four wipers take the positions as shown in FIG. 5. Thus by nutating or precessional moving the joystick to various positions, various combinations of resistances are obtained.

The construction and function of the device is explained in further detail.

The base plate 15 is made of an insulating material, and a resistor circuit 31 is provided thereon by printing for instance as shown in FIG. 3, or 4 or 5. The finger carrier 7, 8, 9 or 10 of the wiper has protrusions 39 and 40 for instance and the finger has corresponding holes 41 and 42 as shown in FIG. 6. The protrusions are to be caulked or swaged after the finger is placed on the protrusions. Each of thus formed wipers 7(11), 8(12), 9(13) or 10(14) is supported by a conductive rivet 21, 22, 23 or 24 as the rotation axis. The finger is pressed on both resistor element and rivet by virtue of the air pressure of the bent body thereof, and slides on the resistor element. The rivets 21, 22, 23 and 24 are secured to the base plate together with a common grounding terminal 20.

The crosspieces are designed so that one of them can be mounted on another so as to be arranged crosswise but the underside of the upper crosspiece is partly on the same level as that of the lower one so as to be engaged with the wipers provided on a plane. As had been explained above, the crosspieces have a lateral plate on each end and it slides in the direction of the width of the crosspiece along the walls of the housing and the base plate 15. Of course the lateral plates are made of an insulating material. Usually the lateral plates are formed integrally with the crosspiece. The crosspieces are provided with small protrusions 34, 35, 36 and 37 on the underside thereof, which are respectively placed in the slot or groove 38 of the finger carriers 7, 8, 9, 10 of the wipers. The range of movement of the crosspieces is determined by the length between the lower end 45 of the joystick 1 and the fulcrum (ball) 2 thereof, the diameter of the opening 53 of the bearing member 26 and the diameter of the part 52 of the stick 1. An annular member 6 is loosely placed in the slots 32, 33 of the crosspieces at the crossing thereof, and the lower end 45 of the joystick is inserted in the annular member.

The fulcrum (ball) 2 of the joystick 1 is tightly but rotatably supported by means of bearing members 25 and 26 at the center of the top of the housing 3. When the joystick is operated, the crosspiece 4 moves in the direction of line Y – Y' in FIG. 3, and the crosspiece 5 in line X – X'.

With respect to FIG. 4 and FIG. 5 the operation of the device is explained. FIG. 4 shows the positions of the four wipers when the joystick takes its neutral position. If the joystick is nutated in the Y'-direction, the lower end 45 thereof moves in a vertical plane including the Y' - Y line drawing an arc. But this movement is converted into a horizontal movement in the Y-direction of the crosspiece 4 through the annular member 6. The Y'-ward movement of the crosspiece 4 moves the outer ends of the wipers 7(11) and 8(12) in the Y-direction, the wipers being rotated around the axes or rivets 22 and 21 since the protrusions 34 and
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35 of the crosspiece 4 inserted in the slots of the wipers 7 and 8 pull said wipers in the Y-direction. Thus the wipers 7 and 8 (protrusions 34 and 35) will turn to the positions 34' and 35' as shown in broken lines. Under this condition, if the joystick is not nutated toward the Y'-direction to the utmost, when the joystick is nutated toward the X-direction or X'-direction, the wipers 9 and 10 are moved in the directions of the arrows shown in the figure, while the wipers 7 and 8 (protrusions 34 and 35) remain at the positions 34' and 35'. This means that one pair of resistances are kept constant and another pair of resistances can be relatively changed. If the joystick is nutated toward the corner C4 as in FIG. 5, the four wipers will take positions as shown in FIG. 5. Suppose this device is used for a four-channel or quadraphonic stereo, and the terminals 17 and 16 are connected to front speakers FS1 and FS2, and the terminal 18 and 19 are connected to rear speakers RS1 and RS2 respectively. Then, under the condition as explained above with respect to FIG. 4, the volumes of the front speakers are diminished while the volumes of the rear speakers are relatively changed. Under the condition represented by FIG. 5, the volume of the C4 corner speaker is the largest and those of the other three speakers are diminished. This means balance of volumes of the four speakers can be regulated by nutating or moving the joystick preconventionally. When the joystick is moved to front and rear, volumes of the front and rear speakers are relatively changed and when the joystick is moved to right and left, the volumes of the right side speakers and left side speakers are relatively changed. Thus, any desired balance of volumes can be obtained by selecting a suitable position of the joystick.

As has been explained above, this invention has made it possible to coordinately control a plurality of resistors by operating a single lever or stick very smoothly without play of the working elements. The device of this invention can be easily manufactured with fewer steps of required circuit formation work. The device is also so simple and compact that it will contribute to designing of stereo audio implements.

The invention of this application can be embodied in different ways as follows, too. As to the shape of the resistors, a common tap or separate taps may be provided in each resistor element as shown in FIG. 7 or FIG. 8. For a specific purpose, a resistor element comprising four separate units each having a tap as shown in FIG. 8 can be employed. In some cases, four sets of a straight resistor element 55 and a straight current collector element 56 arranged in parallel with the former are provided along the four sides of the base plate as shown in FIG. 9. Each resistor element may or may not be provided with a tap. (FIG. 9 shows such taps.) In this case, on the underside of each of the crosspieces 4 and 5 is secured a short-circuiting member 57 instead of rotatable wipers as shown in FIGS. 10 and 11. By these arrangements, the purpose of this invention is achieved, too.

What I claim is:

1. A device for coordinately controlling a plurality of variable resistors comprising: a first horizontal crosspiece which has a lengthwise slot and a lateral plate perpendicular to the length of the crosspiece in such a way that each end thereof is movable in the direction of the width thereof; a second horizontal crosspiece which has a lengthwise slot and a lateral plate perpendicular to the length of the crosspiece per se at each end thereof, and is movable in the direction of the width thereof; and a housing along the inside surfaces of the side walls of said lateral plates of the crosspieces slide; a shaft which penetrates the slots of the two movable horizontal crosspieces and drives the crosspieces simultaneously in pair or all at a time; and a plurality of wipers which move in accordance with the movement of the two horizontal crosspieces maintaining contact with resistor elements provided on a common plane.

2. A device for coordinately controlling a plurality of variable resistors as set forth in claim 1, wherein four wipers are separately rotatably supported by an axis provided on a base plate made of an insulating material on which a resistor element or elements are provided, and said wipers are moved in accordance with the movement of said crosspieces by means of interlocking of protrusions provided on the underside of the crosspieces and grooves provided on the upper surface of the wipers.

3. A device for coordinately controlling a plurality of variable resistors as set forth in claim 2, the shaft is a joystick provided at the center of the top of a housing, the lower end of which penetrates the slots of the two crosspieces and the other end of which functions as a handle.

4. A device for coordinately controlling a plurality of variable resistors as set forth in claim 3, wherein a short cylindrical member in place in the slots of the crosspieces at the crossing or intersection thereof; and the lower end of the joystick that forms a small ball is inserted in this short cylindrical member.

5. A device for coordinately controlling a plurality of variable resistors as set forth in claim 2, the shaft is a short shaft with a knob at the upper end thereof which is moved horizontally.

6. A device for coordinately controlling plurality of variable resistors as set forth in claim 5, the short shaft has a broad brim as the guide for the movement thereof.

7. A device for coordinately controlling a plurality of variable resistors as set forth in claim 2, wherein a circular resistor element with four terminals is provided on the surface of the base plate and the end of each wiper sweeps a part of the resistor element when it is rotated around an axis provided near the center of the base plate.

8. A device for coordinately controlling a plurality of variable resistors as set forth in claim 7, wherein the resistor element comprises four separate arcuate units quadrantly arranged on the base plate.

9. A device for coordinately controlling a plurality of variable resistors as set forth in claim 7, wherein the resistor element has tapping circuits.

10. A device for coordinately controlling a plurality of variable resistors as set forth in claim 8, wherein each resistor element unit has a tapping circuit.

11. A device for coordinately controlling a plurality of variable resistors as set forth in claim 2, wherein the resistor comprises a finger and a finger carrier.

12. A device for coordinately controlling a plurality of variable resistors as set forth in claim 1, wherein the
resistor element comprises four straight units squarely arranged on the surface of the base plate in combination with parallel current collectors, and a short-circuiting means is provided at each end of the two crosspieces, which keeps contact with the corresponding resistor element and current collector.

13. A device for coordinately controlling a plurality of variable resistors as set forth in claim 12, wherein the resistor element units have tapping circuits.

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