United States Patent

Lace

[15] 3,663,755

[45] May 16, 1972

[54] VARIABLE RESISTANCE CONTROL DEVICE

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[22] Filed: **Apr. 23, 1970**

[21] Appl. No.: **31,212**

[52] **U.S. Cl.**.....**179/1 D**, 179/1 G, 179/1 VL

[51] **Int. Cl.**.....**H04r 5/00**, H03g 5/12, H03g 1/02

[58] **Field of Search**.....179/1 G, 1 VH, 1 VL, 1 D; 338/72, 73, 74, 90, 96

[56] **References Cited**

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[57] **ABSTRACT**

A variable impedance device for controlling a plurality of independent functions from a single control shaft means. The control shaft means has a two dimensional movement by manually sliding the shaft means within a confined space so as to change the resistive component between a contactor associated with the control shaft means and a plurality of fixed points of terminal connection formed on a flat resistance element over which the contactor moves during the adjustment. The control shaft means extends through a nonconductive plate and has associated therewith two knobs and other resistance elements which are used independent of one another and also independent of the flat resistance element.

5 Claims, 6 Drawing Figures

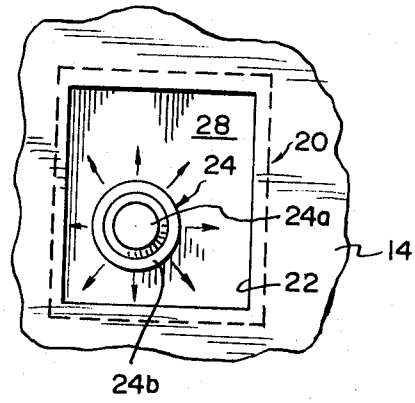


FIG. 1

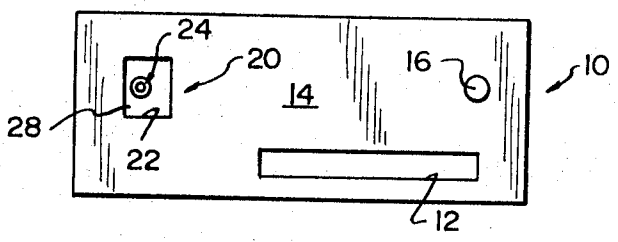


FIG. 3

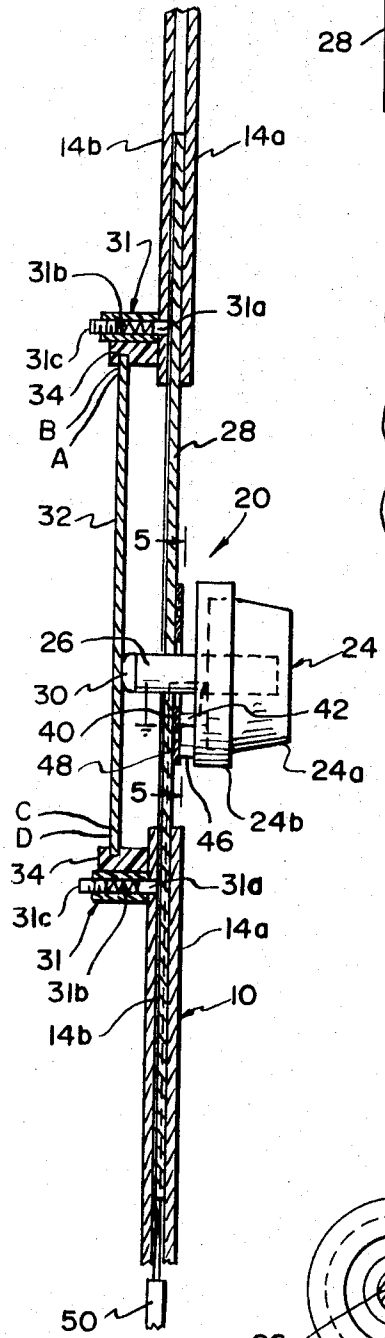


FIG. 2

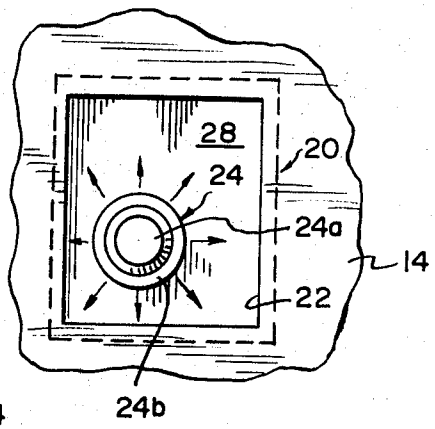


FIG. 4

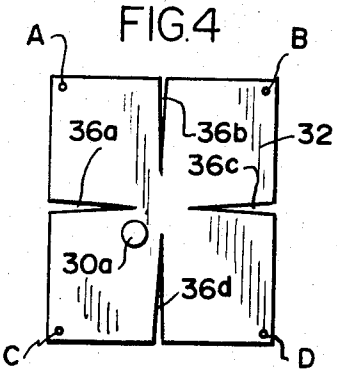


FIG. 6

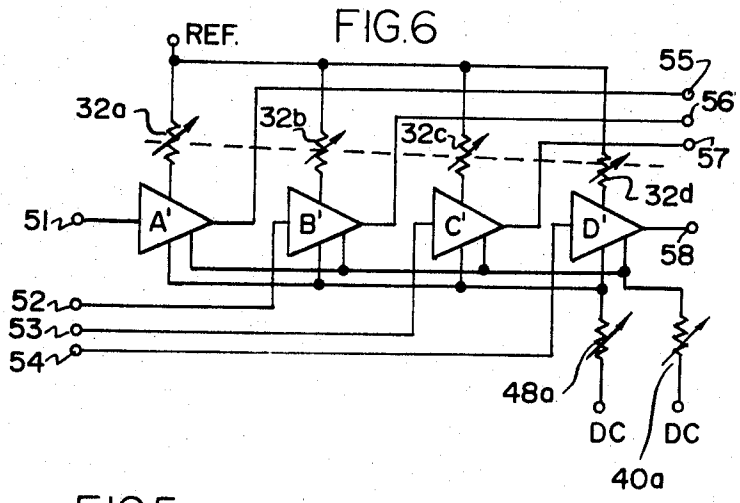
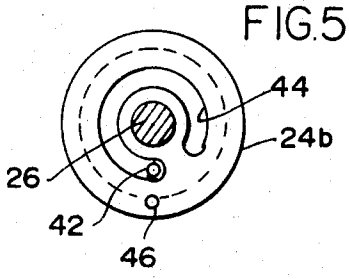


FIG. 5



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VARIABLE RESISTANCE CONTROL DEVICE

BACKGROUND OF THE INVENTION

This invention relates generally to variable resistance devices used for volume and tone control or the like, and more particularly, to a plurality of variable resistance devices controlled by a common shaft means.

Heretofore, variable resistance devices of the type commonly used to control volume and tone characteristics of audio signal reproducing means were generally of the type formed in separate housings and ganged together for control by a common control shaft. These potentiometers or rheostats, whichever the case may be, become relatively large and cumbersome when two or more of such variable resistance devices are ganged together. Furthermore, it is a difficult task to match a given pair of variable resistance devices, as for example, two volume controls on a common shaft for use in stereo operation.

The concept of four or more channels of audio to be controlled by volume and tone control knobs further aggravates the situation in that the size of four variable resistance elements on a common control shaft is for most applications too large, and the tracking problem of four variable resistance devices is very difficult to say the least. However, when utilizing a single control knob for each channel the problem of tracking is eliminated but this will create much confusion to the operator, particularly a driver of an automobile. That is, when four channel tape players are used in automobiles, the requirement of two, three or four control knobs for both volume and tone control is a cumbersome and hazardous thing. In a four channel audio system, double stereo so to speak, the operator of a motor vehicle desires a minimum number of controls to manipulate to achieve the desired volume, tone and balance control of all four channels of audio being reproduced at the speakers. If the operator of a motor vehicle has too many control knobs to manipulate, it most probably will distract his attention from driving, thus creating a hazardous condition which may result in a serious accident. Also, the driver has a difficult time trying to center the sound emanating from the four speakers so that he or a group of persons appear to be at the center of sound.

SUMMARY OF THE INVENTION

An object of this invention is to provide a plurality of variable impedance devices operable from a common control shaft means which is smaller than heretofore could be obtained.

Another object of this invention is to provide adjustment means for balancing the relative volume level of a four channel sound system so that the adjustment means itself represents the position of the user, i.e., or driver of an automobile, or the like, within a two dimensional reference plane, and movement of such adjustment means, within the reference plane represents the position of the user-listener, relative to the center of sound.

Yet another object of this invention is to provide adjustment means for balancing the relative volume level of a four channel sound system, by visual as well as listening aid.

A feature of this invention is the formation of a resistance plate, or the like, over which a contact moves, and where three or more fixed points for terminal connections are formed on the resistance plate, and the resistance component between each of these fixed points and the movable contact varies with movement of the movable contact over the surface of the resistance plate.

Many other objects, features and advantages of this invention will become more fully realized and understood from the following detailed description when taken in conjunction with the accompanying drawings wherein like reference numerals throughout the various views of the drawings are intended to designate similar elements or components.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front diagrammatic view of a four channel tape player using the variable impedance device of this invention;

FIG. 2 is an enlarged fragmentary view of a portion of the tape player of FIG. 1 showing the variable impedance device of this invention;

FIG. 3 is a side sectional view of FIG. 2 showing details of construction thereof;

FIG. 4 is a plan view of the plate-like resistance element used in this invention;

FIG. 5 illustrates one control knob rotatable about the common shaft of FIG. 3 and showing access means for a second control knob mounted adjacent thereto; and

FIG. 6 illustrates a four channel audio amplifier system wherein the variable impedance device of this invention is used.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, there is seen a front view of a four channel audio sound reproducing apparatus, which is here illustrated as a four channel, eight track, tape player of a type for receiving tape cartridges, and is designated generally by reference numeral **10**. The tape player **10** includes an entryway **12** formed in the front wall **14** thereof and cartridges containing prerecorded tape are insertable into the entryway **12** in a conventional and well-known manner. In many cases, insertion of a cartridge will cause automatic turn on of the tape player to reproduce music, or the like, from the tape. A control knob **16** may be formed on the front wall **12** and may have any desired function, as for example, changing position of the magnetic tape pickup head within the tape player. Where four channels of sound are reproduced from a single sound system, it is desirable to use a variable impedance device **20**, constructed in accordance with this invention, simultaneously but independently to control the various functions of the separate channels. Most advantageously, a control space **22** is defined by an aperture formed within the front wall **14** of the tape player **10**, and a single control knob means **24** which is located within the control space **22** can be moved in any direction in the plane of the space **22**. Preferably, the control knob means **24** includes inner and outer control knobs **24***a* and **24***b*, respectively, rotatable about the common shaft means **26**. For example, the operator may rotate the inner control knob **24***a* to vary the volume of a four channel audio system or he may rotate the outer control knob **24***b* to vary the tone quality of the system, these actions occurring simultaneously in all four channels.

In accordance with this invention, the shaft means **26** extends from a nonconductive plate **28**, as best seen in FIGS. **2** and **3**, and has a movable contactor **30** formed at the other end of the shaft which is movable, anywhere and by any path within the two dimensions over the surface of a flat resistance element **32**. The shaft **26** is connected to ground potential or any other suitable reference potential as desired through a printed circuit conductor formed within the plate **28**. The flat plate resistance element **32** is mounted behind the front wall **14** which acts as a support means, and the resistance element **32** is substantially in registry with the aperature **22** formed therein and provides a variable resistance area over which the contact **30** moves in all directions by sliding the control knob means **24** and the nonconductive plate **28** in any direction. That is, the nonconductive plate **28** moves in a plain so that the contact **30** is at all times engaged with the surface of the variable resistance element **32** to vary the resistance value between each of the four contact points A, B, C, and D and the contact **30**.

In the illustrated embodiment, two dimensional movement of the knob means **24** is accomplished by providing a pair of spaced apart wall members **14***a* and **14***b* between which the nonconductive plate **28** has portions thereof extending sufficiently so as to always be confined therebetween. The two dimensional control space defined by the aperature **22** can be semi-spherical, or the like, or may take configurations other than rectangular and which allows the control knob means **24** to be moved left, right, up, down or any combination thereof.

To firmly hold the movable nonconductive plate **28** in its preselected position so that it won't inadvertently shift its position due to vibration of a motor vehicle, suitable friction means are provided. Here, for example, a plurality of pressure devices **31** are provided at several locations at the rear of the wall **14***b* to urge the nonconductive plate **28** against the front wall **14***a* frictionally to hold the same. The pressure devices **31** include pressure contact means **31***a* such as Teflon or the like urged forward by a spring **31***b* the compression of which is adjustable by a screw **31***c*. To ensure that the control knob means **24** moves freely under the influence of moderate hand pressure by the user thereof, the rear surface of the front wall portion **14***a* may be coated with Teflon or some other smooth material.

The aperature **22** preferably represents the configuration of the interior of an automobile in the plan view and the location of the control knob means **24** represents the place at which the sound emanating from four speakers at the four separate corners of the motor vehicle will converge so as to surround the listener therein with sound. By moving the control knob within the plain of the plate **28**, this effectively represents moving the listener within the sound area. For example, when the operator of a motor vehicle is driving alone, it may be desirable to locate the center of the sound substantially where the driver is sitting. However, with passengers in the motor vehicle, the center of sound can be easily adjusted by merely moving the control knob **24** in any of the directions indicated by the arrowhead lines in FIG. **2**. The feature allows the operator to accurately position the center of sound with the visual aid of the location of the knob **24** within the space **22**.

The resistance plate **32** may be mounted in registry with the aperature **22** by suitable support means **34** surrounding the same or located at a plurality of discrete locations about the periphery thereof. The four circuit connection means indicated by the reference letters A, B, C and D are electrically connected to fixed points for terminal connections at the four quadrants of the resistance element **32**, this being best illustrated in FIG. **4**. The circular area **30***a* represents the contact area of the contact member **30**, FIG. **3**, and it is here illustrated that the resistance between the contact area **30***a* and any one of the fixed points A, B, C or D, changes with the change of location of the area **30***a*. Preferably, means are formed on the resistance element **32** to vary the electrical characteristic thereof such as, for example, exponentially from one location to another location of the contactor **30**. This means is here illustrated as the slots **36***a*, **36***b*, **36***c* and **36***d* extending from the four sides of the resistance element and terminating short of the center thereof, as illustrated in FIG. **4**. It will be understood that the resistance element **32** may include any suitable means formed therein to cause impedance variation characteristics at least at the surface thereof. These slots may take any configuration to achieve the desired electrical characteristic and they are sufficiently narrow to allow the contact **30** to always move easily across them.

The connections A, B, C and D are connected in circuit with respective different ones of the four channels of the audio reproducing system to adjust their relative gain with respect to one another so as to balance the channels one with the other similarly to a balance control of a conventional stereophonic system, but this now being accomplished in a four channel system.

The volume control provided by the impedance device of this invention is formed by a resistance element **40** arcuately shaped about the shaft **26** and secured to the nonconductive movable plate **28**. A movable wiper contactor **42** of the volume control knob **24***a* is in contact with the arcuate resistance element **40** and varies the resistance by rotating the knob **24***a* in the conventional manner. An arcuate slot **44** is formed in the tone control knob **24***b* to allow access of the wiper contactor **42** through the control knob **24***a*. The tone control **24***b* has a wiper contactor **46** which is in contact with an arcuately shaped resistance element **48** outwardly of the resistance element **40**. By suitable printed circuit leads extending from the ends of the arcuately shaped resistance elements **40** and **48** connection of these variable resistance devices is made to suitable lead means designated generally by reference numeral **50** located at one extreme end of the movable nonconductive plate **28**. The wiper contactors **42** and **46** are also connected to the lead means **50** through suitable flexible leads extending therefrom and along or through the shaft **26**. This is readily accomplished as it is not necessary for the shaft **26** to rotate but merely to provide an axis for the control knobs **24***a* and **24***b* to rotate about, with the control knobs being held in place thereon by suitable retainer means not shown.

FIG. **6** illustrates diagrammatically a four channel audio reproducing system wherein the variable impedance device of this invention is shown connected schematically in the circuit. Here, four independent amplifiers for the four channels are designated by reference letters A′, B′, C′ and D′ and have their inputs connected to terminals **51**, **52**, **53** and **54** for receiving discrete audio signals from a magnetic pickup within the tape player **10**. Accordingly, discrete outputs **55**, **56**, **57** and **58** are provided for connection to suitable speaker means, not shown. Here the variable resistance elements **32***a*, **32***b*, **32***c* and **32***d* represent the resistance between the contact area **30***a* and any of the fixed points A, B, C and D respectively. Movement of the contact **30** across the surface of the resistance element **32** simultaneously changes the resistance value of each of the resistances **32***a*, **32***b*, **32***c* and **32***d* to balance the audio system. The volume control is here designated by reference numeral **40***a* and is a single potentiometer connected to circuit means of each of the amplifiers A′, B′, C′ and D′ with the other end of the potentiometer **40***a* connected to a source of DC voltage. Similarly, the tone control **48***a* is connected to circuit means of each of the amplifier states A′, B′, C′ and D′ and is also connected to a source of DC voltage.

What has been described is a simple, compact and effective means for controlling a plurality of variable functions from a single control shaft means which moves in two dimensions to obtain common control of the balance of each of the channels of an audio reproducing system to locate the center of sound, while inner and outer control knobs rotatable about the common shaft means provide volume and tone controls for the audio system. Accordingly, it will be understood that variations and modifications of this invention may be effected without departing from the spirit and scope of the novel concepts disclosed and claimed herein.

I claim:

1. A variable impedance device comprising support means including a pair of parallel spaced apart wall members defining a channel-like space therebetween, said wall members including openings defining a control space;

an impedance element of rectangular configuration mounted adjacent to and parallel with one of said wall members in registry with said control space, said impedance element having fixed points for terminal connection at the four corners thereof;

a nonconductive plate means movable within the channel-like space defined between said first and second wall members, contact means including a shaft having its axis extending perpendicular to said nonconductive plate, such that movement of said plate within said channel allows movement of said contact means over the surface of said impedance element in any direction and at any point within said control space, to change the impedance between said contact means and said fixed points for terminal connections to provide an electrical balancing signal, a first knob on said shaft rotatable about its axis, a first arcuate resistance element formed on said nonconductive plate adjacent to said first knob, a first wiper contactor formed on said first knob and movable therewith to be engaged with said first arcuate resistance element to vary the resistance thereof;

a second knob formed on said shaft and rotatable about its axis, a second arcuate resistance element formed on said

nonconductive plate adjacent to said first arcuate resistance element, a second wiper contactor on said second knob and engaging said second arcuate resistance element to vary the resistance thereof;

and means for electrically connecting each of the fixed points to separate circuit means,

whereby, the variable impedance device changes the impedance between the four corners of said rectangular resistance element by moving said control knobs anywhere within the plane of said control space, to develop signals having a balance ratio in accordance with the visual position of said knobs within said control space, and variation of the resistance of said first arcuate resistance element is accomplished by rotating said first control knob and variation of said second arcuate resistance element is accomplished by rotating said second control knob, and the variation of each of the resistance elements is accomplished independent of the other resistance elements.

2. A variable impedance device for controlling the variable functions of volume, tone and balance controls of a four channel sound system, comprising in combination:

an impedance element having four fixed points for terminal connections, each fixed point connected in circuit with a separate one of the four channels;

electric contact means in contact with and movable over the surface of said impedance element in more than one direction to change the effective impedance between each of the four fixed points and said electric contact means electrically to balance the four channels of the four channel sound system;

shaft means connected to said electric contact means to allow manual movement of said electric contact means over the surface of said impedance element;

a second impedance element associated with said shaft means, and a control knob having wiper contact means engaging said second impedance element and electrically connected in circuit with all four channels of the four channel sound system simultaneously to control the volume thereof; and,

a third impedance element associated with said shaft means and a second control knob having wiper contact means engaging said third impedance element for controlling the tone characteristic of all four channels of the four channel sound system.

3. A variable impedance device comprising a support means defining a control space, a nonconductive plate movable in two dimensions adjacent said control space, an impedance element having at least three fixed points of terminal connection and mounted adjacent said support means to be adjacent said control space, electric contact means including a shaft having the axis thereof extending perpendicular to said nonconductive plate and contacting said impedance element, said shaft movable within two dimensions over said impedance element, said shaft of said contact means being connected to a reference potential and its movement across said impedance element changes the impedance between said contact means and said at least three fixed points to provide an electrical balancing signal, and means for electrically connecting each of the fixed points to separate circuit means to develop signals having a balance ratio in accordance with the visual position of said knob of said contact means within said control space, a first knob on said shaft rotatable about the axis thereof, a first arcuate resistance element formed on said nonconductive plate adjacent said knob, and a first wiper contact means movable with said knob and engaging said first arcuate resistance element to vary the resistance between either end of said first arcuate resistance element and said contact means, and means for connecting said first contact wiper means and said first arcuate resistance element to circuit means.

4. The variable impedance device of claim 3 including a second knob on said shaft rotatable about the axis thereof, a second arcuate resistance element formed on said nonconductive plate adjacent said first arcuate resistance element and a second wiper contact means movable with said second knob and in contact with said second arcuate resistance element for varying the resistance thereof; and means for connecting said second arcuate resistance element and said second wiper contact means to circuit means.

5. A variable impedance device for controlling the balance of sound of a four channel sound system which has four speakers positioned at a given location within a listening area, including in combination, a rectangular control space representing the listening area, a point in each quadrant of said rectangular control space representing the given position of the four respective speakers in the listening area, an impedance element positioned in a spaced relation to said control space, said impedance element having four fixed points of terminal connection, one fixed point in each quadrant, circuit means connecting each of said points of terminal connection to respective speakers for controlling the balance of sound therein, electric contact means including a knob movable within two dimensions within said control space and arranged to be in contact with said impedance element during such movement, such movement of said knob changes the impedance between said electric contact means and said four fixed points of terminal connection thereby providing a balancing signal in said circuit means, and said knob provides a graphic representation to the operator of the location of the point of the center of sound of the four speakers in the listening area.

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