Dec. 22, 1970 W. A. BARDEN ET AL 3,550,059

VARIABLE RESISTANCE CONTROL

Filed Nov. 2, 1967 3 Sheets-Sheet 1

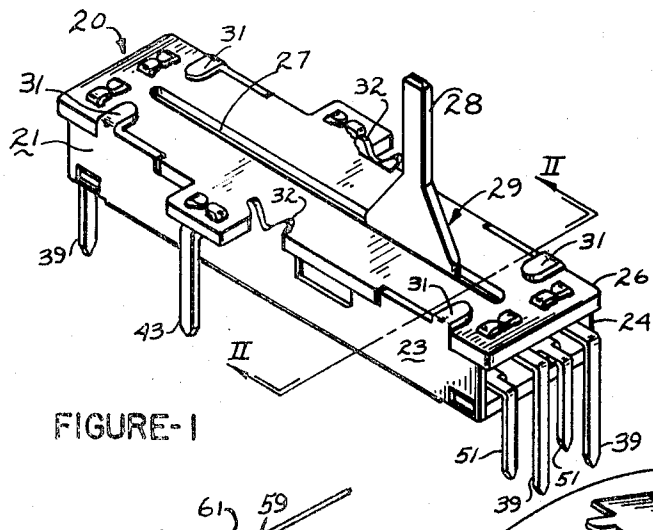


FIGURE-1

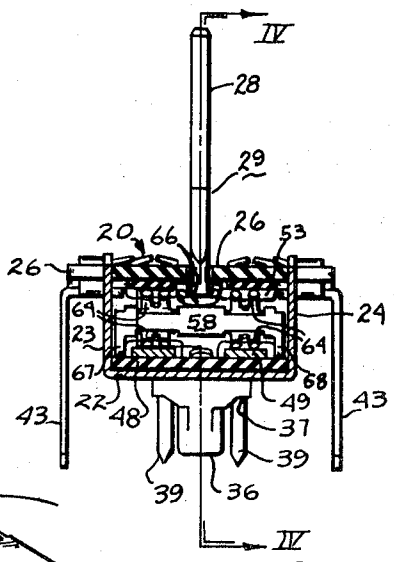


FIGURE-2

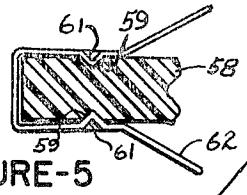


FIGURE-5

FIGURE-3



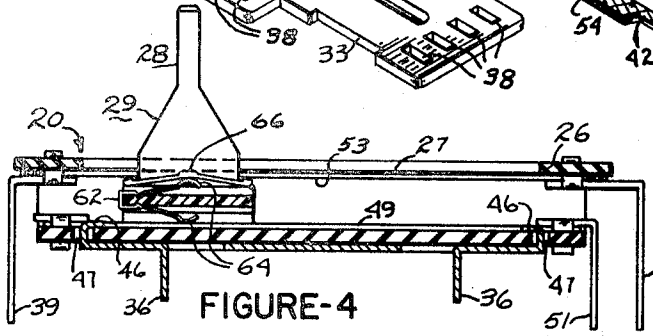


FIGURE-4



FIGURE-6


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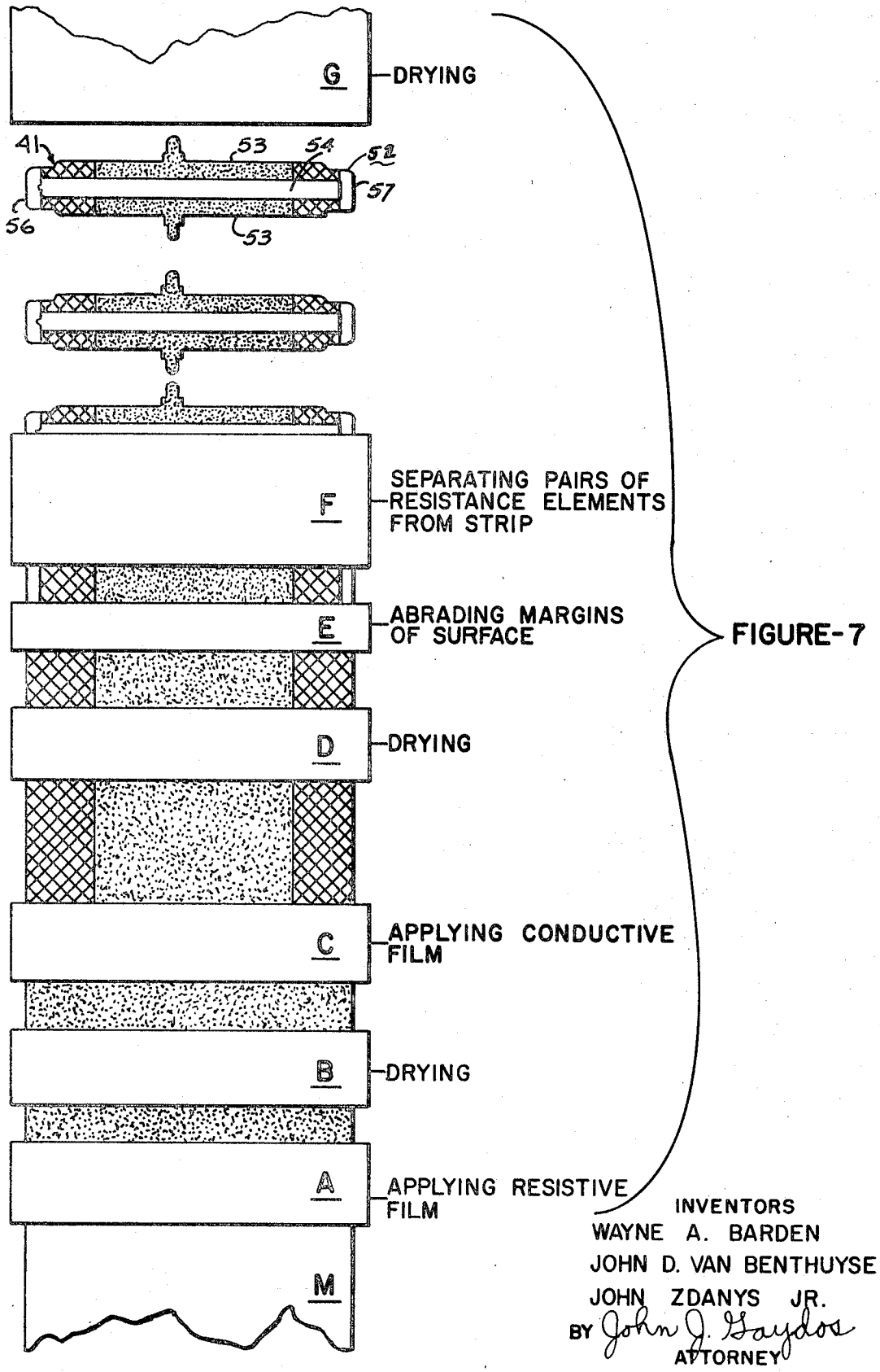



FIGURE-7

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VARIABLE RESISTANCE CONTROL

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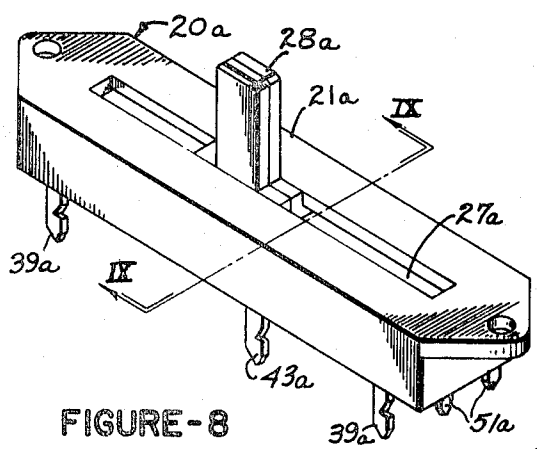



FIGURE-8

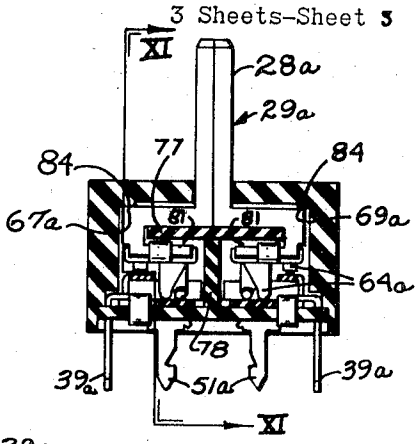



FIGURE-9

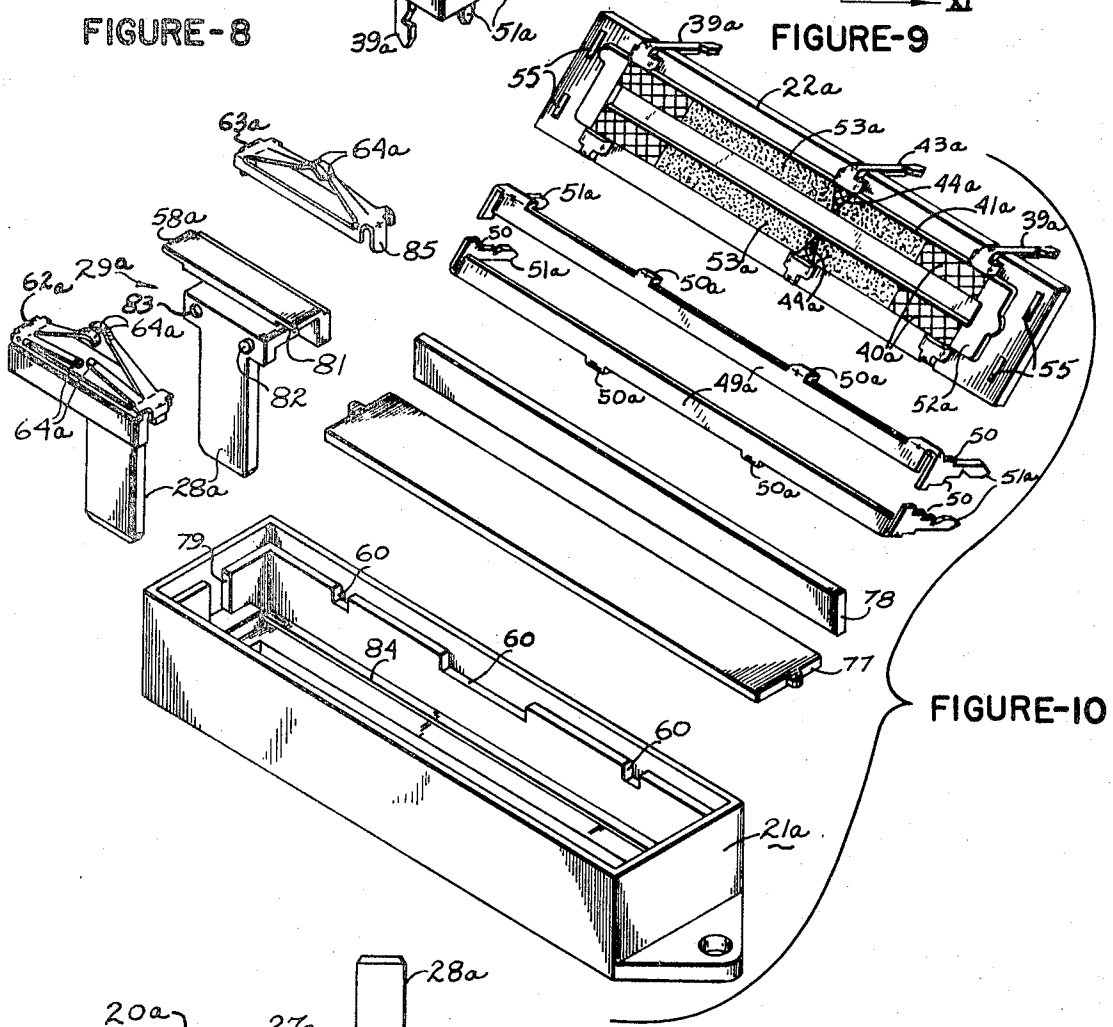



FIGURE-10

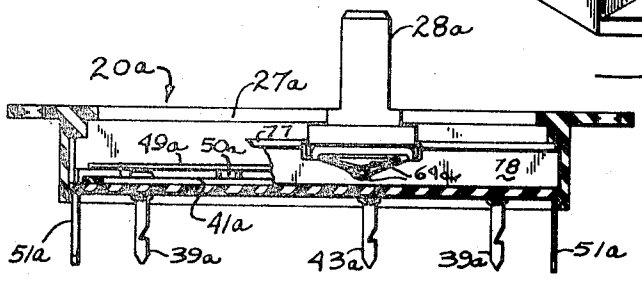



FIGURE-11


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3,550,059

# VARIABLE RESISTANCE CONTROL

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Int. Cl. H01c 5/02
U.S. Cl. 338—176 25 Claims

## ABSTRACT OF THE DISCLOSURE

Intrinsically equalized resistance elements each comprising a separate portion of a film of resistive material supported by a discrete segment of a one-piece dielectric substrate are wipingly engaged by discrete contactors within a plural section variable resistance control housing. One or more webs of dielectric material hold the intrinsically equalized resistance elements in mechanical alignment relative to each other and stabilizing means promote smooth movement of an operating means for the control. One form of the stabilizing means comprises a spring urging the bearing surfaces of a contactor carrier against one or more reaction surfaces in the housing. Contactors provided with contactor carrier gripping means are constrained to move with a contactor carrier and include aligned wiping fingers movable sequentially into and out of engagement with an improved tap arrangement comprising a surface of conductive film deposited on the resistance elements having edges angularly disposed relative to a line normal to the longitudinal axis or center line of the resistance elements. One method of the invention includes the steps of depositing a film of resistive material on a strip of dielectric substrate material during a substantially continuous process to form a continuous and substantially homogeneous film covering spaced portions of the surface of the substrate material, and removing a plurality of discrete and intrinsically equalized resistance elements from the film-covered substrate strip by separating the strip into discrete segments held together by one or more webs of substrate material extending therebetween. An improved method of making a variable resistance control includes the steps of assembling terminals with intrinsically equalized resistance elements and fixedly positioning resistance elements, collector means, and movable contactors in a control housing.

The present invention relates to a variable resistance control and, more particularly, to a plural section variable resistance control particularly adapted for use in stereophonic sound reproducing systems and to methods of making such controls and intrinsically equalized resistance means that may be used therein.

Stereophonic sound reproducing systems have two or more separate amplifier-speaker systems or channels. As indicated in Vaksvik Pat. 3,012,213 issued on Dec. 5, 1961, after the outputs of two or more channels have been initially balanced and matched properly by a control having two similar but electrically independent sections, it is desirable that the control be operable to make substantially simultaneous and identical adjustments in each section thereof so that the outputs of the two channels remain balanced for all settings of the control.

In one prior art construction of a plural section variable resistance control, each section of the control comprised a film type resistance element spaced from a collector within the control housing with a contactor wipingly engaging the resistance element and collector. In the prior art construction, the contactors for each section are carried by a pair of drivers constrained to move with one



of a pair of friction coupled but independently adjustable concentric shafts. These concentric shafts may be adjusted relative to each other to attain an initial desired degree of balance between each channel of the system in which the control is to be used.

In theory, after initial adjustment of the concentric shafts relative to each other, subsequent movement of both shafts while coupled together should achieve continued balanced operation between the channels. In practice however it has been difficult, if not impossible, to continuously maintain balanced operation for all settings of the control without continuously changing the relative adjustment between the concentric shafts. This difficulty in achieving a continuously balanced condition has been observed when using controls having either linear or nonlinear tapers, and has been particularly noticeable and objectionable when using controls having log, audio, or other nonlinear tapers.

It will be understood that the achievement of continuously balanced operation requires, among other things, that the resistance elements in each section of the control have substantially identical electrical characteristics throughout the extent thereof or in other words be "equalized." Some of the factors that make it difficult to produce equalized resistance elements are related to slight differences or variations in viscosity or composition of the resistive material as it is being applied to a supporting substrate, and manufacturing variables occurring during application of the resistive material to the supporting substrate thereby resulting in differences in the electrical characteristics of the resistance elements.

To attain continuously balanced operation, it is also necessary that the resistance element in one section of the control be in precise alignment with the resistance element in one or more other sections of the control so that the db tracking characteristics of the different sections of the control will be substantially the same. The importance of maintaining exact mechanical alignment of the resistance elements in a two section control will be appreciated when it is considered that in a variable resistance control having overall resistance element lengths of about two and one-half inches and the resistive film conforming to an audio taper, relative mechanical misalignment between a pair of resistance elements in an amount of 0.006 of an inch can cause a difference of 9 decibels in sound output between two channels of a sound reproducing system.

Suggested techniques for attaining approximately equalized resistance elements have included the steps of testing each individual resistance element for overall resistance value and conformation to a preselected taper, sorting the individual resistance elements into batches having similar electrical characteristics, and selecting matched resistance elements for use in a single plural section control. The only practical satisfactory solution to the mechanical alignment problem heretofore has included the steps of mounting a resistance element in each section of a control and then tediously aligning each section relative to the other and checking the db tracking characteristics of each control. Accordingly, it would be desirable to provide a plural section variable resistance control wherein discrete resistance elements intrinsically equalized or electrically balanced relative to each other are assembled into a housing of a control without requiring electrical matching of the elements prior to assembly and mechanical alignment of the elements relative to each other during and after assembly.

In variable resistance controls it is also desirable to provide stabilizing means for the contactor carrier to prevent objectionable twisting of the contactor carrier or rocking or jerking movement of a contactor constrained to move with the contactor carrier as the control is adjusted. The use of stabilizing means is desirable to pre-

vent a twisting or slight rotation of the contactor carrier relative to the resistance means since such twisting can cause an unbalance condition to occur in the control. The use of stabilizing means is also especially desirable in controls having taps formed with layers of conductive material, since an increased jerking or rocking tendency has been observed when contactors move across taps embossed on resistance elements. Rocking and jerking movement is generally objectionable not only because of a rough feel when operating the control but for the further reason that skipping of the contactors onto or off of an embossed tap may cause momentary open circuit conditions in the controlled circuit and generate noise therein.

Since misaligned contactors may cause unbalanced operation of a plural section control even when the resistance elements are meticulously matched and aligned, it is also desirable to provide means for precisely aligning and maintaining alignment of a plurality of contactors relative to each other.

With increasing demand in recent years for variable resistance controls of the rectilinear type as disclosed for example in Rubenstein Pat. No. 2,242,327 issued May 20, 1941, it has also become desirable to provide a plural section variable resistance control of the rectilinear type wherein intrinsically balanced resistance elements are utilized to facilitate assembly of the control without requiring sorting of acceptable individual resistance elements into different batches having similar db tracking characteristics prior to assembly, or relative adjustment between the sections of the control during final assembly.

Accordingly, it is an object of the present invention to provide a plural section variable resistance control comprising intrinsically equalized resistance elements such that the control exhibits continuously balanced characteristics between each section thereof during operation. A more specific object of the present invention is to provide an improved plural section variable resistance control wherein intrinsically equalized resistance elements are permanently held together in mechanical alignment so that adjustment of the control operating means will result in equal adjustment of each section of the control. Another object of the present invention is to provide an improved plural section variable resistance control wherein interlock means locate and maintain a plurality of discrete contactors in alignment relative to each other. Yet another object of the present invention is to provide a tap arrangement for resistance means in a variable resistance control whereby the contactor is subjected to reduced mechanical disturbances while being moved across the tap and the tendency to momentarily open the electrical circuit between the resistance means and contactor is diminished. An additional object of the present invention is to provide an improved variable resistance slide control capable of being finely adjusted without noticeable jumping or jerking of the slider and a more specific object of the present invention is to provide a slide control with stabilizing means preventing rotational or twisting movement of the slider relative to the resistance elements and permitting adjustment of the slider without jumping or rocking as contactors constrained to move therewith are moved along the resistance means. A further object of the present invention is to provide an improved method of manufacturing intrinsically equalized discrete resistance means for use in a plural section variable resistance control. A still further object of the present invention is to provide an improved method for manufacturing a plural variable resistance control.

Briefly, the present invention is concerned with a variable resistance control wherein discrete contactors wipingly engage resistance means comprising a plurality of electrically discrete and intrinsically equalized resistance elements. The discrete resistance elements comprise separate portions of a film of resistive material supported on different segments of a one-piece dielectric substrate and held in mechanical alignment relative to each other



by the one-piece substrate. The intrinsically equalized and aligned resistance elements are mounted in a variable resistance control housing in any suitable manner and are adjustably connected to collectors by the contactors.

In another aspect of the invention, stabilizing means are provided to promote smooth movement of the control operating means, to prevent rotation of the contactor carrier relative to the resistance means, and to prevent jumping or rocking of the operating means while being moved relative to the resistance means. In one form, the stabilizing means comprise shoulders on a contactor carrier presenting bearing surfaces spaced laterally from the axis of movement of the control operating means. In one specific form of the invention, the stabilizing means additionally comprise a leaf spring formed of any suitable resilient material urging the bearing surfaces against reaction surfaces in the housing.

To further reduce rocking in controls having a resistance element provided with one or more taps, the film of conductive material used in making each tap is arranged to cover an area of the resistive film with two edges of the conductive material angularly disposed relative to a line normal to the longitudinal axis or center line of the resistance element. With this arrangement, aligned wiping fingers on a contactor will sequentially move into or out of engagement with the tap to diminish contactor jumping due to the presence of the tap.

In yet another aspect of the invention a contactor for a variable resistance control is provided with detent means engageable with a groove in the contactor carrier to locate positively the contactor on the carrier. This arrangement is also used to maintain positive alignment of discrete but similar contactors relative to each other in an assembled plural section slider type control.

In still other aspects of the invention, we have provided improved methods of making variable resistance controls and intrinsically equalized discrete resistance elements. In carrying out one method of the invention, resistive material is deposited on a strip of dielectric substrate material during a substantially continuous process to form a continuous and substantially homogeneous film covering the surface of the substrate. As is well understood in the art, a single application or formulation of resistive material may be used for linear taper resistance elements or multiple applications of formulations of resistive or conductive material may be used to provide conductive termination areas and non-linear taper resistance elements. Depending on the final desired configuration of the resistance elements, the margins of the strip may be shielded to prevent the application of resistive material thereto during the resistive material application step. Alternatively, the entire surface of the strip may be covered with a film after which the film may be removed from areas adjacent the margins thereof. Discrete and intrinsically equalized resistance elements comprising separate portions of the resistive material supported by segments of a one-piece substrate are then removed from the film covered strip by separating the strip into multiple one-piece sections and removing one or more portions from the one-piece substrate so that at least one web of substrate material holds the intrinsically equalized resistance elements in mechanical alignment. The improved method of making a variable resistance control further comprises the steps of assembling terminals to intrinsically equalized resistance elements and then assembling the control by fixedly positioning the intrinsically balanced resistance elements, collector means, and movable contactors in a control housing.

The subject matter which we regard as our invention is set forth in the appended claims. The invention itself, however, together with further objects and advantages thereof, may be better understood by referring to the following description taken in connection with the accompanying drawings.

## DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view of a plural section variable resistance slide control embodying the present invention; FIG. 2 is a sectional view taken along line II—II of FIG. 1; FIG. 3 is an exploded view of the control shown in FIG. 1; FIG. 4 is a sectional view taken along line IV—IV of FIG. 2, assuming that FIG. 2 assuming that FIG. 2 is shown in full; FIG. 5 is an enlarged fragmentary view of the slider and contactors of the control shown in FIG. 4; FIG. 6 is an isometric view illustrating a modified control operating means that may be used in the embodiment of FIG. 1; FIG. 7 is a schematic illustration of steps that may be performed in the practice of one method of the invention; FIG. 8 is an isometric view of another embodiment of the invention; FIG. 9 is a sectional view taken along line IX—IX of FIG. 8; FIG. 10 is an exploded view of the control in FIG. 8; and FIG. 11 is a sectional view, with parts broken away, taken along line XI—XI of FIG. 9, assuming that FIG. 9 is shown in full.

Referring now more particularly to the drawings, a variable resistance control embodying one form of the invention is generally identified by the reference numeral **20**. As shown in FIGS. 1–4 the variable resistance control **20** comprises an elongate housing **21** having a bottom wall **22** and side walls **23, 24**. Closing the open top of the housing **20** is a dielectric base **26**. As shown in FIG. 1 the base **26** has a centrally located longitudinally extending slot **27** formed therein through which projects a manually operable portion **28** of a control operating means **29**. To facilitate proper alignment during assembly of the housing **20**, ears **31** and **32** are provided integral with the side walls **23, 24** and notches **33, 34** interfitting therewith are provided along the edges of the base **26**. Since it is desirable for the manually operable portion **28** of the operating means **29** to be freely movable in the slot **27**, the ears **32** are split to permit longitudinal spreading thereof. By this means, the application of transverse compressive forces to the base is avoided when the ears **32** are deformed during assembly and the desired dimensions of slot **27** are easily maintained.

As best shown in FIG. 4, a pair of ears **36** are folded downwardly from the bottom wall **22** of the housing **21** and are insertable into slots provided in a not-shown mounting panel. Shoulders **37** (see FIG. 2) provided on the ears are useful to space the housing **21** from the panel and the ends of the ears **36** are twisted to secure the housing to the panel. It will be appreciated that ears could also extend upwardly from the side walls of the housing **21** when forward mounting of the variable resistance control **20** is desired.

Now having reference to FIG. 3, the base is provided with a plurality of slots **38** for receiving the mounting tabs of terminals **39**. When a resistance means **41** is positioned on the base **26**, the terminals **39** are positioned over conductive portions **42** of the resistance means with the tab portions of the terminals **39** extending through the slots **38** in the base **26** and crimped thereover. The terminals **43** are positioned over taps **44** in a similar manner. Keys **46** project from the bottom wall of the housing and extend through keyways **47** in the dielectric member **48**. During assembly the keys **46** are deformed over dielectric member **48** to which may be secured in any suitable fashion collector means such as collector bars **49** and terminals **51**. When the terminals **51** are used to secure the collector bars **49** to the member **48**, the bottom wall of the housing **20** is foreshortened to provide clearance for the terminals.

The resistance means **41** comprise a one-piece dielectric substrate **52** supporting a plurality of intrinsically balanced and permanently aligned adjacent but discrete portions of a film of resistive material. As schematically shown in FIG. 7, the resistance means are preferably produced by applying a continuous film of resistive material onto a strip of dielectric material moving past the work stations A through G. The resistive material may



be applied by well known spraying or rolling techniques or any other suitable deposition technique and as will be understood, the film of resistive material may be applied to produce any desired resistive pattern or taper as shown for example in Pat. No. 2,060,114, issued Nov. 10, 1936.

The strip of dielectric material M is selected from available materials having suitable electrical and mechanical characteristics to be determined by the particular type of control in which the resistance means are to be used. For example, for use in a rectilinear type control and some rotary controls, the strip may be relatively rigid and nonflexible. On the other hand, if deformation of the resistance means is contemplated, it would be desirable to use a very flexible strip capable of being deformed into any desired shape.

After the resistive film has been applied to the strip of dielectric material M, and all film material has been removed from an area adjacent the margins of the strip by a surface abrading operation at station F, individual resistance means **41** comprising pairs of discrete intrinsically balanced resistance elements **53** are produced by separating portions of the film covered dielectric material from the strip and removing a central section thereof to form a slot as shown at **54**.

Webs of dielectric material comprising end portions **56, 57** of the substrate **52** hold the resistance elements **53** in mechanical alignment. Since the webs are not covered with resistive or conductive material the resistance elements **53** are electrically isolated, one from the other. Although it is practical to cover completely the strip M with a conductive and resistive film along the margins thereof when applying such films and then remove all traces of film from the margins of the strip by means of a suitable solvent or a surface abrading operation as schematically illustrated, it may be preferred that the edges or margins of the strip be shielded or otherwise masked while the films are being applied. It will also be appreciated that only one web could be used to align the discrete resistance elements **53** with each other on the dielectric substrate **52**.

Since at least one web holds a plurality of substantially identical resistance elements together, expensive sorting and matching steps are dispensed with. In addition, complicated assembly techniques for aligning and maintaining alignment of the discrete resistance elements are eliminated when the design of the control is such that the web can be utilized to maintain permanent alignment between the resistance elements.

By depositing portions of resistive material adjacent to each other on a dielectric strip during an essentially continuous process, variations in viscosity or composition of the resistive material, variations in operation of the material depositing means, and variations in the relative velocity between the strip and the depositing means will have substantially the same effect on each resistance element in any given pair of resistance elements. Similarly, since each pair of resistance elements are held together by one or more webs, any desired subsequent processing steps such as but not limited to special drying or curing cycles well known in the art will have substantially the same effect on the mechanical and electrical properties of each resistance element in any given pair of resistance elements. Accordingly, in any given pair of resistance elements, the elements will be intrinsically equalized, i.e., the discrete resistance elements in each pair will have substantially identical mechanical and electrical properties at corresponding points through the extent thereof.

As will be understood, since the resistance elements comprise a film of resistive material, the specific resistivity of each resistance element is expressed in terms of ohms per unit area of film. Accordingly, in order to accurately establish the overall area of resistive film and overall resistive value of each resistance element we prefer to utilize a blanking or stamping operation at station F. For some

applications, however, sufficient uniformity between resistance elements may be achieved by shielding preselected portions of the substrate between the resistance elements. This shielding in turn may be accomplished by using a shield or tape that is removable after the resistive material is applied to the dielectric substrate.

When a shield or masking tape is used, the resistance elements may be formed transversely across the dielectric strip as illustrated in FIG. 7 or longitudinally along the strip. Utilization of the latter arrangement and a dielectric strip of a width equal to the desired final overall transverse dimension of the resistance elements can reduce the complexity of tools that must be used in the practice of our method since the strip need only be separated into segments with each segment comprising a plurality of discrete intrinsically balanced resistance elements.

Again having reference to FIG. 3, the operating means **29** include a contactor carrier comprising a rectilinear slider **58** provided with detent receiving notches **59** sooperating with detents **61** formed in contactors **62, 63** to maintain the contactors **62, 63** in alignment relative to each other.

When the control **20** is assembled as shown in FIG. 4, resilient fingers **64** compressively and wipingly engage the surface of resistance elements **53** and the collectors **49**. By reason of this compressive engagement, the contactors **62, 63** resiliently grip the rectilinear slider **58** and the detents **61** are urged into the detent-receiving notches **59** as shown in FIG. 5.

Since longitudinal forces are applied to the portion **28** of the operating means **29** in order to change the setting of the control **20** during operation and since the rectilinear slider **58** essentially floats between the collectors **49** and resistance elements **53**, it is desirable to provide stabilizing means to inhibit rocking of the manually operable portion **28** relative to the control housing **21**. In the exemplification, the stabilizing means include a spring **66** and shoulders **67, 68** extending from the rectilinear slider **58**. As shown in FIG. 2, the shoulders **67, 68** are biased against the dielectric member **48** by the action of the spring **66** compressed between the base **26** and an upper surface of the slider **58**. In an actual reduction to practice of the exemplification, the spring **66** was made of polychlorotrifluoroethylene, a thermosetting plastic, but it will be understood that any other material, metal or nonmetal, having suitable wear and elastic memory characteristics could be used.

In some applications, it is desirable to provide taps **44** on the resistance means **41**, as shown for example, in FIG. 3. Accordingly, the taps **44** are illustrated as comprising embossed layers of a film of conductive material deposited over preselected areas of the resistance means. In order to reduced the amount of drag as the contactors **62, 63** move against and across the taps **44**, the taps are positioned to cover an area having edges **72, 73, 74, 76** thereof angularly disposed relative to a line normal to the longitudinal axis or center line of the resistance elements **53**. With the illustrated arrangement, the resilient fingers **64** on the contactors **62, 63** are sequentially movable into and out of engagement with the edges **72, 73, 74** and **76** of the tap areas with the result that mechanical disturbances due to engagement and disengagement of the taps is diminished. In addition to reducing mechanical disturbances, the provision of tapered taps also improves the electrical operating characteristics of the control **20** by reducing the tendency for momentary open circuit conditions between the contactors and resistance means. Thus, if a leading resilient finger **64** should bounce away from the surface of the resistance means when engaging or disengaging a tap, a trailing resilient finger **64** would still maintain a desirable closed circuit condition with the resistance means.

In order to maximize the stability of the operating means **29** and reduce objectionable rotation of the slider **58** in the housing **20** when the manually operable means **28** are twisted, the slider **58** must fit between the side walls **23, 24** with very close tolerances. The difficulties encountered in maintaining exact tolerances may be largely avoided by using a modified operating means **29'** shown in FIG. 6 in lieu of the operating means **29** illustrated in FIG. 3. Stabilizing means in the form of shoes **30** project obliquely away from the slider **58'** and, after assembly the shoes are resiliently deformed against the side walls **23, 24** and dielectric member **48** within the housing. Since the operating means **29** are intentionally constructed for an interference fit within the housing **20**, the criticality of maintaining manufacturing tolerances for the housing **21** and rectilinear slider is measurably reduced. Since the shoes **30** project obliquely downwardly and are deformed against the member **48**, the slider **58'** is resiliently urged upwardly against the base **26** and, when the shoes are made sufficiently long, the spring **66** may also be dispensed with.

Now having reference to FIGS. 8 through 11, a description will be had of another control embodying features of our invention. Like reference numerals with appropriate subscript notation are used in FIGS. 8–11 to denote elements corresponding to, but somewhat different from elements in the embodiment of FIGS. 1–6.

In FIG. 8 a front mounting housing **21*a*** of a control **20*a*** is shown having a slot **27*a*** formed therein to accommodate a manually operable portion **28*a*** of an operating means **29*a***. A resistance means **41*a*** comprises a pair of intrinsically equalized resistance element **53*a*** comprising separate portions of a film of resistive material supported on separate segments of a one-piece dielectric substrate **52*a***, the resistance means being held in assembled relation with a base **22*a*** by terminals **39*a*** and **43*a***. Collector means **49*a*** provided with integral standoffs **50*a*** and end terminals **51*a*** are also supported by the base **22*a***, with shoulders **50** spacing the collectors **49*a*** from the base **22*a*** and the resistance means **53*a***. In order to properly position the collector means, terminal receiving apertures **55** are formed in the base **22*a***. The internal surfaces of the housing **21*a*** are contoured and formed with notches **60** to provide a clearance for the terminals **39*a*** and **43*a*** as best shown in FIG. 10.

Stabilizing means are provided in the form of a stabilizing plate **77**, spacer plate **78**, spacer plate receiving channels **79** formed in the housing **21*a***, and stabilizing plate receiving channels **81** formed in the operating means **29*a***. In order to facilitate the manufacture of operating means **29*a*** from a moldable plastic material, the means **29*a*** is made in two parts with interfitting bosses **82** and cavities **83** to assure proper alignment after assembly. When assembled, the operating means **29*a*** slideably embraces the stabilizing plate **77** and is held in spaced relation from the base **22*a*** by means of the spacer plate **78**. During operation of the control **20*a***, shoulders **67*a*** and **69*a*** on the operating means **29*a*** slide along bearing surfaces **84** formed in the housing **21*a***. Channels **81** permit the operating means to slide along the stabilizing plate **77**. Tabs **85** formed integrally with contactors **62*a***, **63*a*** maintain alignment of the contactors on the contactor carrier **58*a*** and resilient wiping fingers **64*a*** wipingly engage the resistance elements **53*a*** and collectors **49*a*** to form an electrically conductive path therebetween. Taps **44*a*** have been illustrated as covering a tapered area of the resistance means **41*a*** in a manner similar to the arrangement illustrated in FIG. 3.

In the foregoing description and following claims it will be understood that a plural section control is a control having two or more sections, whether the sections are disposed in tandem or otherwise. From the foregoing description of plural section variable resistance controls and methods for making the controls and resistance means used therein, it will be seen that we have provided improved controls and methods that are characterized by simplicity, increased efficiencies in manufacture, and improved and uniform electrical characteristics. While the

application of our teachings will yield improved controls with any desired resistance taper it will be appreciated that the present invention is particularly successful in solving long recognized problems associated with the manufacture of variable resistance controls characterized by log or audio resistance taper curves generally similar to curve "*a*" shown in FIG. 1 of the aforementioned U.S. Pat. No. 2,060,114.

It also will be appreciated that the specific embodiments of the invention which we have described herein for purposes of illustration may be changed and modified without departing from the principles of the invention. Improved arrangements disclosed herein can be advantageously employed in many different variable resistance controls useful in applications other than stereophonic sound reproducing systems. It is to be understood, therefore, that we intend by the appended claims to cover all such changes and modifications that fall within the true spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

**1.** A plural section variable resistance control comprising a housing, a one-piece dielectric substrate supported by the housing, resistive means and collector means supported within the housing, terminals connected to the resistive means and the collector means for connecting the control to an external electrical circuit, operating means supported for movement relative to the resistive means for effecting changes in the setting of the control, and a plurality of electrically discrete contactors constrained to move with the operating means and wipingly engaging the resistive means and the collector means, the resistive means comprising a plurality of discrete intrinsically equalized separate but adjacent portions of a resistive material film, the separate but adjacent portions of resistive material being supported on the dielectric substrate and held in mechanical alignment relative to each other by the dielectric substrate.

**2.** A plural section variable resistance control comprising a plurality of dielectric substrate portions, resistive means secured to the dielectric substrate portions, a plurality of collectors supported in the control and spaced from the resistive means, at least one termination for the resistive means, at least one termination for each of the collectors, operating means supported for movement relative to the resistive means, a plurality of contactors constrained to move with the operating means and wipingly engaging the resistive means and the collectors, and means holding said plurality of substrate portions in alignment relative to each other, the resistive means comprising a plurality of discrete intrinsically equalized adjacent portions of a film of resitive material, each portion of the resistive material being supported on one of the plurality of dielectric substrate portions, one of the contractors electrically interconnecting one of the discrete portions of the resistive material and one of the collectors, and another one of the contactors electrically interconnecting another discrete portion of the resistive material and another one of the collectors.

**3.** The control of claim **2**, wherein the operating means comprises a slider movable rectilinearly along the resistive means and the control includes stabilizing means for limiting rocking movement of the slider during adjustment of the control.

**4.** The control of claim **2**, wherein the operating means comprises a slider movable rectilinearly along the resistive means, the slider and the contactors being provided with interlocking detents and detent receiving means for holding the contactors in aligned relation on the slider.

**5.** The control of claim **2**, wherein the operating means comprises a contractor carrier disposed adjacent the resistive means and the collectors and stabilizing means for inhibiting rotation of the contractor carrier relative to the resistive means, and the contactors each include means for maintaining alignment of the contactors relative to to each other.

**6.** A plural section variable resistance control comprising a plurality of portions of a dielectric substrate, resistive means supported on a surface of each of the portions of the dielectric substrate, a pair of collectors, means supporting the collectors in spaced relation to the resistive material, operating means, and a pair of discrete contactors constrained to move with the operating means making bridging contact with the collectors and resistive material, the discrete films of resistive material comprising separate portions of a substantially continuous film of resistive material and being held in exact alignment by the portions of the dielectric substrate.

**7.** The variable resistance control of claim **6**, wherein the resistive means further comprise a plurality of taps formed of conductive material applied over preselected areas of the films of resistive material, said preselected areas each at least partly defined by a pair of opposite nonparallel sides thereby to diminish mechanical disturbance of the contactors as the contactors are moved into and out of contact with the taps.

**8.** In a plural section variable resistance control the combination comprising a rectilinear slider, a pair of resistance elements comprising discrete portions of a single dielectric substrate and a pair of discrete equalized resistive means, a pair of collectors, means supporting the collectors in spaced relationship to the resistive means, and a pair of contactors carried by the rectilinear slider electrically connecting the collectors and the resistive means, each of said discrete equalized resistive means comprising a separate portion of a film of resistive material supported on a surface of the dielectric substrate and held in mechanical alignment relative to each other by the substrate.

**9.** In a variable resistance control the combination comprising resistive means, collector means, means supporting the collector means in spaced relation with the resistive means, operating means, and at least one contactor constrained to move with the operating means, the contactor comprising resilient fingers wipingly engaging the resistive means and the collector means to provide an electrically conductive path therebetween, the resistive means comprising a film of resistive material and a tap comprising a film of conductive material covering a tapered area of the film of resistive material whereby the resilient fingers are sequentially movable into and out of engagement with the conductive material thereby to reduce rocking movement of the operating means as the contactor moves across the tap.

**10.** Control operating means for supporting at least one contactor within the housing of a variable resistance control, the control operating means comprising a slider, and resilient means electrically insulated from the contactor for stabilizing movement of the slider within the control housing, the slider comprising means formed integrally therewith for positively positioning said at least one contactor relative thereto.

**11.** The control operating means of claim **10** wherein the resilient means for stabilizing movement of the slider within the control housing comprises a spring seated on the slider for compressively biasing the slider in a predetermined direction within the housing.

**12.** The control operating means of claim **10** wherein the resilient means for stabilizing movement of the slider within the control housing comprises a plurality of shoes extending from the slider for cooperating with a plurality of bearing surfaces in the housing thereby to resiliently bias the slider in a predetermined direction within the housing.

**13.** The control of claim **11**, wherein the spring is provided with an opening and the operating means comprises an operable portion extending upwardly of the slider passing through the opening in the spring.

**14.** The control of claim **12**, wherein said shoes project obliquely downwardly from said control operating means.

15. The control of claim 12, wherein said control operating means comprises a rectangular slider and said shoes extend outwardly from corners of the slider.

16. A variable resistance slide control comprising a dielectric substrate, resistive means secured to the dielectric substrate and lying in a first plane, at least one collector supported by said dielectric substrate, at least one collector termination, operating means supported for movement relative to the resistive means, at least one contactor constrained to move with the operating means for wipingly engaging the resistive means and collector, a terminal connected to the resistive means, and a portion of the collector spaced relative to the resistive means and lying in a plane different from the first plane, thereby providing dielectric spacing between said portion of the collector and said terminal.

17. The control of claim 16 wherein a terminal is connected to the resistive means, and at least a portion of the collector is spaced from the dielectric substrate thereby to provide a clearance between said portion of the collector and the substrate for said terminal.

18. The control of claim 16 wherein a terminal is connected to the resistive means, and at least a portion of the collector is spaced relative to the resistive means to provide dielectric spacing between said portion of the collector and said terminal.

19. The control of claim 16, wherein said collector termination supports said portion on said dielectric substrate and maintains said portion in spaced relation to the resistive means.

20. A variable resistance slide control comprising a housing having a bottom wall and a top wall, one of said walls having a slot therethrough, a resistance member supported in the housing, a collector member supported in the housing in spaced relation to the resistance member, a contactor supported in said housing for wipingly engaging said resistance member and said collector member, control operating means supported for movement in said housing, an operable portion on said control operating means extending outwardly through said slot, bearing surfaces formed on the housing and spaced laterally of said solt, shoulders on said control operating means coacting with said bearing surfaces, and stabilizing means disposed in said housing, one of said means being provided with channel engaging means for slideably engaging said channel.

21. The control of claim 20, wherein the stabilizing means comprises an elongated member supported by the housing, said control operating means having a channel formed therein.



22. The control of claim 20, wherein said stabilizing means comprises a plate supported by said housing and spaced from said resistance member, said control operating means having channels formed therein for slideably engaging the plate.

23. A variable resistance slide control comprising a housing having a plurality of walls, one of said walls having an opening extending therethrough, a resistance member and a collector member supported in said housing, control operating means supported for movement in said housing comprising an operable portion extending outwardly through said opening and a contactor detachably secured to said control operating means and constrained to move with said control operating means for wipingly engaging said resistance member and said collector member, bearing surfaces formed on the housing and spaced on opposite sides of said opening, said control operating means having spaced surfaces coacting with said bearing surfaces, and stabilizing means supported by said housing, one of said means being provided with a channel and the other of said means being provided with channel engaging means for slideably engaging said channel.

24. The control of claim 23, wherein the stabilizing means comprises an elongated member supported by the housing, said control operating means having a channel formed therein.

25. The control of claim 23, wherein said stabilizing means comprises a plate supported by said housing and spaced from said resistance member, said control operating means having channels formed therein for slideably engaging the plate.


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338—183, 202

# UNITED STATES PATENT OFFICE
# CERTIFICATE OF CORRECTION

Patent No. 3,550,059 Dated December 22, 1970

Inventor(s) Wayne A. Barden, John D. Van Benthuysen and John Zdanys, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Specification:

| | |
|---|---|
| Column 7, line 19; | Change "so" to ---co---. |
| Column 7, line 53; | Change "reduced" to ---reduce---. |
| Column 11, line 52; | Change "resitive" to ---resistive---. |
| Column 11, line 54; | Change "contractors" to ---contactors |
| Column 11, line 73; | Change "contractors" to ---contactors |

In the Claims:

| | |
|---|---|
| Column 12 (shown on patent as 11), line 42; | Change "solt" to ---slot---. |
| Column 12, line 45; | Insert after "with" --- a channel the other of said means being pro with---. |

Signed and sealed this 12th day of October, 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Paten