United States Patent

[11] 3,626,350

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[33] Japan
[31] 45/12442; Feb. 20, 1969, Japan, No. 45/14387; Feb. 20, 1969, Japan, No. 45/12438; Feb. 20, 1969, Japan, No. 45/14388

[54] **VARIABLE RESISTOR DEVICE FOR ELECTRONIC MUSICAL INSTRUMENTS CAPABLE OF PLAYING MONOPHONIC, CHORD AND PORTAMENTO PERFORMANCES WITH RESILIENT CONTACT STRIPS**

7 Claims, 13 Drawing Figs.

[52] U.S. Cl. 338/69, 338/96, 338/199
[51] Int. Cl. H01c 9/02
[50] Field of Search 338/47, 92, 96, 199, 69

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Assistant Examiner—Gerald P. Tolin
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ABSTRACT: A variable resistor utilized as a keyboard of an electronic musical instrument is comprised of an elongated rectangular base member, a plurality of strip-shaped resistor bodies formed on one surface of the base member, a resilient pressure contact member covering resistor bodies and a plurality of mutually spaced apart strips of metal mounted on the inner surface of the pressure contact member to confront the resistor bodies with a small gap therebetween. By continuously varying the point of contact between the resistor body and the metal strip it is possible to produce monophonic chord and portamento signals and to vary the coloring and volume of the musical tone signals, or each or combinations of them.

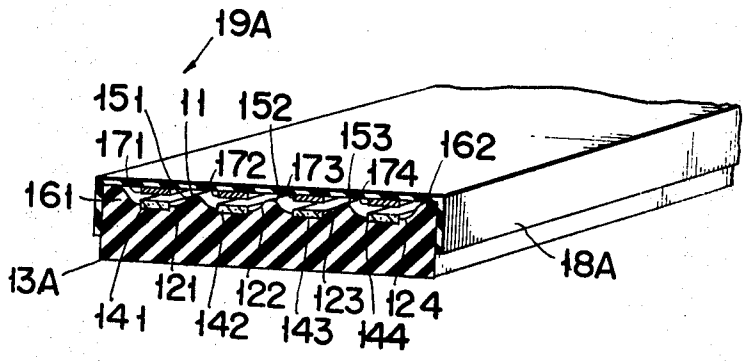

FIG. 1

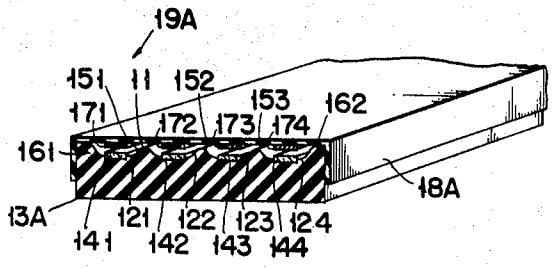

FIG. 2

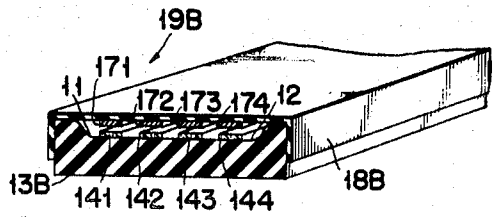

FIG. 3

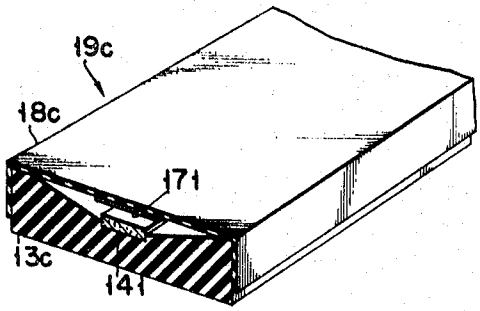

FIG. 5

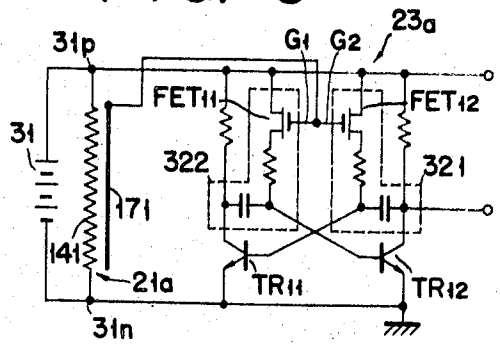

FIG. 4

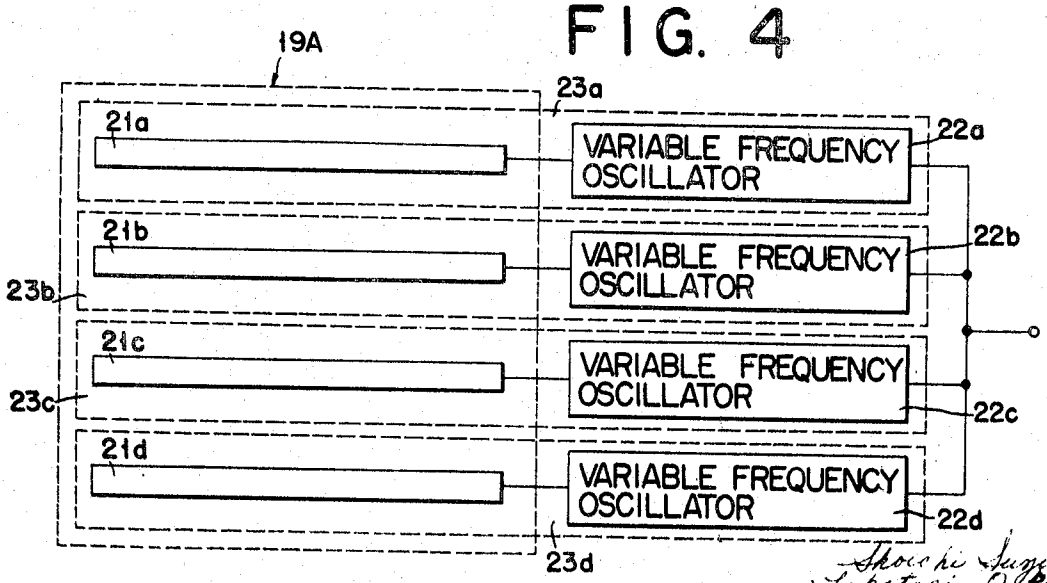

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FIG. 6

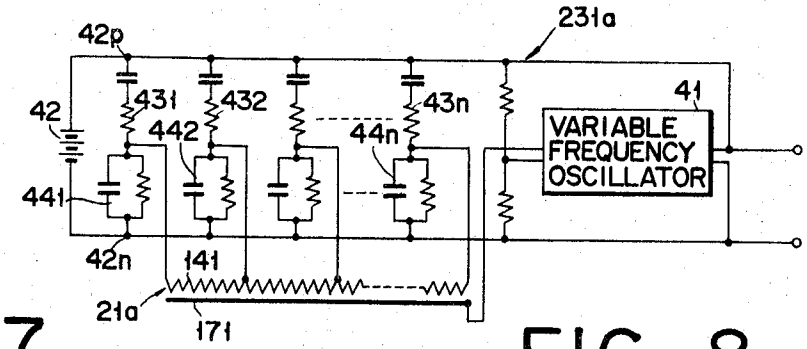


FIG. 7

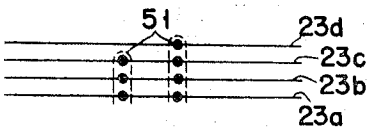


FIG. 8

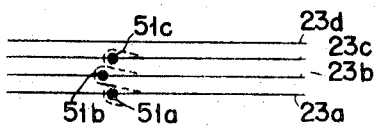


FIG. 9

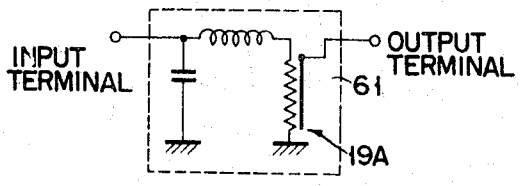


FIG. 10

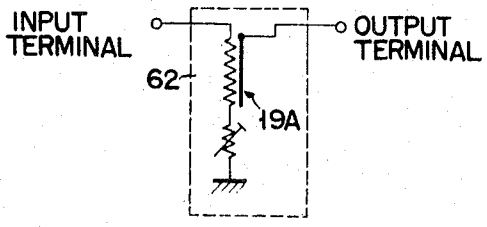


FIG. 12

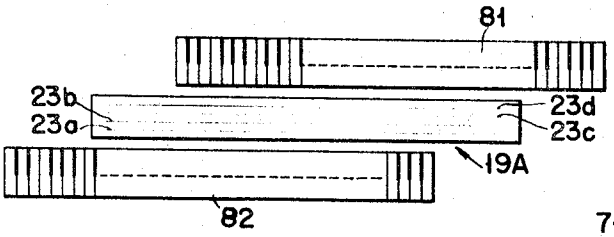


FIG. 11

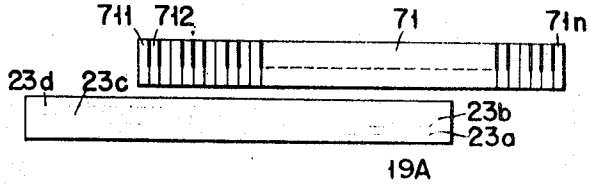
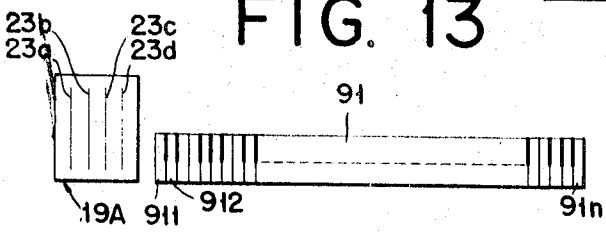


FIG. 13



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VARIABLE RESISTOR DEVICE FOR ELECTRONIC MUSICAL INSTRUMENTS CAPABLE OF PLAYING MONOPHONIC, CHORD AND PORTAMENTO PERFORMANCES WITH RESILIENT CONTACT STRIPS

BACKGROUND OF THE INVENTION

This invention relates to a variable resistor for operating an electronic musical instrument which enables a player to operate the musical instrument in substantially the same manner as an ordinary electronic musical instrument provided with a keyboard and more particularly to a variable resistor which permits the player to produce a monophonic signal as well as chord signal of any tone pitch, or a portamento signal wherein the tone pitches of the monophonic and chord signals are continuously varied and to readily vary the pitch and the tone color of the musical tone signals or to perform such operations singly or in combination.

As a recent trend it is highly desirable for electronic musical instruments to be provided with an operating portion which can produce a variety of musics with as far as possible simple operation. However, HOwever, in the conventional keyboard-operation musical instrument although it is possible to produce a monophonic, chord or glissando signal of any tone pitch it is not possible to produce a portamento signal wherein the tone pitch is varied continuously. According to one operating portion of a prior art musical instrument capable of playing the portamento, for example, in the Ondes Martenot, a ribbon with rings for receiving fingers is passed in an endless form around a plurality of spaced-apart pulleys and the ribbon is moved toward right or left to continuously vary the capacitance values of variable capacitors so as to continuously vary the oscillation frequencies of a variable-frequency oscillator, thus continuously varying the tone pitch.

However, with the operating portion of the above-described construction playing of only portamento wherein the tone pitch is varied continuously is possible and it is not possible to play melodies wherein sounds of any tone pitch are varied discontinuously or stepwisely. Thus, said arrangement is constructed to play monophonic signals alone and is not suitable to play chord signals.

Another example of the operating portions for prior art musical instrument capable of playing portamento involves utilization of a normal close-type sliding resistor as an element for determining the oscillation frequency of a variable-frequency oscillator acting as a tone signal generator.

However, with such an operating portion utilizing a normal close type variable resistor, similar to above-described Ondes Martenot, although it is possible to play a portamento signal, it is difficult to play a melody signal. Moreover, it is difficult to start to play from any desired point unless the contact of the resistor has previously been set to a desired position. Thus, it is not possible to provide rapid and smooth play. Moreover, there is a problem that during play slide noises are introduced owing to the sliding contact of the variable resistor.

SUMMARY OF THE INVENTION

Accordingly, it is the principal object of this invention to provide a novel variable resistor for operating an electronic musical instrument having a simple normal open contact type construction and can be operated in substantially the same manner as a keyboard of a conventional keyboard-operated electronic musical instrument, said variable resistor being used as an element for determining the oscillation frequency of a variable-frequency oscillator acting as a tone signal generator, a variable tone coloring controller of a tone-coloring filter, or a variable volume controller for variably controlling the volume of the musical tone signal whereby to enable to play not only monophonic, chord and portamento signals but also to readily and smoothly vary the volume and/or coloring of the musical tone signals.

In accordance with this invention, there is provided a variable resistor for operating an electronic musical instrument comprising an elongated rectangular base member, a plurality of strip-shaped resistor bodies formed on one surface of the base member, a resilient pressure contact member covering the surface of the base member on which the resistor bodies are carried and a plurality of mutually spaced apart strips of conductive metal respectively confronting the resistor bodies with a small gap therebetween. Alternatively, each pair of a resistor body and a strip of metal may be enclosed by independent base member and pressure contact member. Thus, the resistor is of a normally open type wherein, only when a selected portion of the pressure contact member is depressed a selected portion of the metal strip is caused to contact the corresponding portion of the resistor body, thereby freely controlling each or combinations of the frequency of signals from said variable-frequency oscillator acting as a tone signal generator, the color of tone signals from a tone-coloring filter and the volume of the musical tone signals. As a result, an electrical musical instrument with a fingerboard comprised of the novel variable resistor can be operated with a single or plurality of fingers of one or both hands capable of starting from any desired point just in the same manner as the conventional keyboard electronic musical instrument. Moreover, portamento can be readily played by mere continuous movement of the finger along the fingerboard comprised of the novel resistor, it is not only possible to play monophonic music, chord, portamento signals but also to continuously and smoothly vary the coloring and volume of the musical tone signals.

The fingerboard comprised of the novel resistor may be combined with a conventional keyboard to increase the variety of the music.

BRIEF EXPLANATION OF THE DRAWINGS

FIGS. **1** to **3** shown perspective views of different embodiments of the novel variable resistor;

FIG. **4** is a block diagram of operating units of an electronic musical instrument utilizing novel variable resistors as the frequency-determining elements of variable-frequency oscillators;

FIG. **5** shows a detailed circuit construction of one of the operating units shown in FIG. **4**;

FIG. **6** shows a modified circuit construction of one operating unit;

FIGS. **7** and **8** are diagrams to explain methods of playing an electronic musical instrument with operating units shown in FIG. **4**;

FIG. **9** shows a diagram to show the application of the novel variable resistor as a tone-coloring filter;

FIG. **10** is a similar diagram to show the application of the novel variable resistor as a volume controller;

FIGS. **11** and **12** are plan views of two-stage and three-stage manuals, respectively incorporating the operating units shown in FIG. **4** as one of the stages; and

FIG. **13** is a plan view of a modified keyboard arrangement.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. **1** of the accompanying drawings which shows a perspective view of one embodiment of this invention, there is shown a variable resistor **19A** comprising an elongated rectangular base member **13A** of an insulator such as wood, plastics or the like. On one wider surface **11** of the base member are provided a plurality of (for example four) equally spaced longitudinal grooves **121**, **122**, **123** and **124** having a depth of approximately 2 to 3 mm. to respectively receive elongated strip-shaped resistor bodies **141**, **142**, **143** and **144**, each about 1 to 2 mm. thick. It is desirable that barriers **151**, **152** and **153** provided between adjacent grooves **121** and **124** have a height lower than that of opposite sidewalls **161** and **162** by about 0.01 to 1 mm. in order to facilitate the depression operation to be described later. The upper surface of the base member **13A** is covered by a channel-shaped cover or a pressure contact member **18A** made of an insulator having sufficient resiliency and flexibility such as nylon and the like plastics. On the inner surface of the cover

18A there are provided 4 elongated strip-shaped conductive metal films **171**, **172**, **173** and **174** having substantially the same configuration as the resistor bodies **141** and **144**. These metal films are vapor deposited or suitably bonded to the inner surface to oppose respective resistor bodies with a small spacing of about 1 to 2 mm. therebetween. Side flanges of the cover snugly fit against longitudinal side surfaces of the base member.

With this construction, respective metal films **171** to **174** are normally spaced apart a small distance from respective resistor bodies **141** to **144** on the base member **13A**. When a point or points on the cover **18A** corresponding to one or more resistor bodies **141** to **144** are depressed by a finger or fingers of right or left hand corresponding portion or portions of the metal film are caused to come into contact opposing resistor bodies whereby the resistor can be used as a normal open contact type variable resistor whose resistance value is varied only when the cover is depressed. By continuously moving the contact point to the right or left along the longitudinal length of the resistor bodies the resistance value of the resistor can be varied continuously and smoothly. Where suitably spaced apart taps (not shown) are provided along the length of respective resistor bodies the resistance value is varied discontinuously or stepwisely.

FIG. **2** is a perspective view of a modified embodiment of the novel variable resistor **19B**. While in the previous embodiment resistor bodies **141** to **144** are disposed in independent grooves **121** to **124** of base member **13A**, in this modified embodiment, all resistor bodies **141** to **144** are disposed in a common wide groove or recess **12** formed in one surface **11** of base member **13B**. It will be clear that this modified variable resistor **19B** can act substantially in the same manner as the variable resistor **19A** of the previous embodiment. However, with this modification wherein all resistor bodies **141** to **144** are disposed in a common wide groove, upon depression of a selected portion of the cover **18B** facing to a selected one of the resistor bodies, not only the selected portion of a selected resistor body but also other resistor bodies adjacent thereto are simultaneously contacted opposing conductive metal films **171** to **174**. This problem can be alleviated by increasing the spacing between adjacent metal films.

FIG. **3** shows another modification of the novel variable resistor **19C** comprising a base member **13C**, a single resistor body **121** and a conductive metal film **171** attached on the inner surface of a cover **18C**. Any desired number of such variable-resistor unit may be combined (parallel arranged) to form a variable resistor comparable with those shown in FIGS. **1** and **2**. In this modification, the base member and cover may not necessarily be made of insulator but may be fabricated with a suitable resistance material and metal.

FIG. **4** is a block diagram of an operating portion of an electronic musical instrument utilizing variable resistors shown and described with reference to FIG. **1**, **2** or **3** as the frequency-determining elements of variable-frequency oscillators serving as tone signal generators. Thus, four pressure contact units **21***a*, **21***b*, **21***c* and **21***d* of the variable resistor **19A** each including an elongated resistor body and a metal film which is normally spaced apart therefrom a small distance are arranged in a juxtaposed relationship similar to a keyboard of a conventional electronic musical instrument and connected to function as the frequency or tone pitch determining elements of variable-frequency oscillators or tone signal generators **22***a*, **22***b*, **22***c* and **22***d* thus forming the first to fourth performing units **23***a*, **23***b*, **23***c* and **23***d* of the electronic musical instrument.

FIG. **5** shows a detailed circuit construction of one (for example **23***a*) of performing units **23***a* to **23***d* shown in FIG. **4**. The opposite ends of an elongated resistor body **141** of a pressure contact unit **21***a* are connected across positive and negative terminals **31***p* and **31***n* of a DC source **31**. One end of an elongated metal film **171** is connected to input terminals of a pair of active circuit elements, for example, gate terminals G_1 and G_2 of a pair of field effect transistors FET_{11} and FET_{12} which are connected as shown to constitute portions of a pair of CR time constant circuits **321** and **322** acting as the frequency-determining elements of a tone signal generator shown as an astable multivibrator including a pair of NPN-type transistors TR_{11} and TR_{12}.

When utilized in the performing units of the electronic musical instrument thus far described, the novel variable resistor acts as a kind of variable DC voltage generator. Thus, whenever any selected portion of the metal film **171** is depressed into contact the corresponding portion of the resistor body **141** a desired DC voltage can be produced by varying the conductivity or equivalent internal resistance of field effect transistors FET_{11} and FET_{12} thus producing tone signals of any desired tone pitch.

FIG. **6** shows a modified circuit construction of a performing unit **231***a* utilizing the novel variable resistor. In this embodiment, the pressure contact unit **21***a* is connected, in the following manner, to a CR oscillation frequency-determining network of a wien bridge type variable-frequency oscillator **41**, said network comprising a plurality of series circuits connected in parallel across positive and negative terminals **42***p* and **42***n* of a DC source, said series circuits including a plurality of series combinations of capacitors and resistors **431**, **432** ... **43***n* and parallel combinations of capacitors and resistors **441**, **442** ... **44***n*. More particularly, suitably spaced apart points along the length of the elongated resistor body **141** are connected to respective junctures of the series combinations **431** and **43***n* and parallel combinations **441** to **44***n* of capacitors and resistors. Similar to the embodiment shown in FIG. **5** by depressing a selected portion of the metal film **171** into contact the corresponding portion of resistor body **141** a tone signal of any desired pitch can be produced.

An electronic musical instrument utilizing a plurality of juxtaposed performing units as shown in FIG. **5** or FIG. **6** can produce not only monophonic music, chords and portamentos but also a variety of musics. For example, the first to fourth performing units **23***a* to **23***d* are preset to produce tone signals of the pitch (frequency) ratio of 4:5:6:7. Then, as shown in FIG. **7**, simultaneous playing of three performing units **23***a*, **23***b* and **23***c* by depressed means of a single finger **51** results in the production of tone signals of C, E and G for a major chord of C whereas simultaneous operation of all performing units **23***a* to **23***d* results in the production of tone signals of G, B, D and F for a 7th chord of G_7. Under these conditions, when the finger is moved upwardly or downwardly dispersed chord (Alberti bass) signals of C, E, G and B^b may be obtained. Furthermore, as shown in FIG. **8**, by the simultaneous operation of the first to the third performing units **23***a*, **23** *b* and **23***c* with three fingers **51***a*, **51***b* and **51***c* (only **51***b* is offset by a semitone leftward) tone signal of C, Eb, and G for a minor chord of Cm may be produced.

While in the foregoing embodiments all performing units **23***a* to **23***d* are associated with tone signal generators, when one or a plurality of units are used as a portion of a tone-coloring filter **61**, as shown in FIG. **9** or as a portion of a volume controller **62** as shown in FIG. **10**, in addition to the monophony, chord and portamento described above, it is possible to vary the color and/or volume of the musical tone signals.

Further, it will be clear to those skilled in the art that the depth and speed of vibrato modulation and tremolo modulation or buildup and attenuation characteristics of attack effect, percussion effect, sustain effect can be readily controlled.

While each one of the above-described performing units **23***a* to **23***d* can be effectively used as the performing portion of an electronic musical instrument, by incorporating them into a conventional keyboard operated electrical musical instrument in the following manner it is possible to obtain a novel electronic musical instrument capable of producing a variety of musics.

FIG. **11** shows a plan view of two stage manuals. The upper keyboard **71** has a construction similar to that of a conven-

tional musical instrument and includes a plurality of keys **711**, **712** ... **71***n* whereas the lower fingerboard comprises four performing units **23***a* to **23***d* which are disposed in parallel with the upper keyboard **71** so that they can be operated in the same manner as the upper keyboard. Each of the performing units comprises spaced-apart resistor body and a metal film as described above.

FIG. **12** shows a plan view of three-stage manuals wherein a fingerboard of performing units **23***a* to **23***d* is interposed between upper and lower keyboards **81** and **82** in the same manner as in FIG. **11**.

Where it is difficult to dispose performing units **23***a* to **23***d* in parallel with another keyboard as shown in FIGS. **11** and **13**, such performing units may be disposed at right angles to the keyboard **91** including a plurality of keys **911**, **912** ... **91***n*, and on one end of the keyboard, as shown in FIG. **13**.

With a musical instrument having a manual arrangement shown in FIG. **11**, **12** or **13** the conventional keyboard may be operated by one hand to produce a melody signal and/or accompanying signal while the performing units **23***a* to **23***d* by the other hand to produce a variety of musics as above described.

What we claim is:

1. A variable resistor for controlling the operation of an electronic musical instrument in response to manual operation comprising an electrical insulating base member, a plurality of mutually insulated elongated, strip-shaped first electrical conductors carried by one surface of the base member, said first conductors having mutually parallel axes, a resilient pressure contact member spaced from and covering the first electrical conductors, a plurality of mutually insulated, elongated strip-shaped second electrical conductors fixedly secured to and carried by a surface of the resilient contact member facing the first electrical conductors, said second conductors having mutually parallel axes, the axis of each first conductor being aligned with the axis of a different one of each second conductor, said first and second plurality of conductors normally being spaced from each other whereby conductors of the first and second conductors are arranged in cooperating pairs adapted to engage each other in response to manual depression of a selected portion of the contact member, each of the conductors of one of said first or second plurality of conductors being a resistive body the resistance of which increases from one end of the strip to the other end of the strip, each of the conductors of the other one of the plurality of conductors being a metal conductive strip having a resistance much less than the resistance of the resistive body, and means for preventing more than one cooperating pair of first and second conductors from contacting each other in response to a single manual depression of a portion of the resilient pressure contact member aligned with the cooperating pair, said contact member and each of the plurality of second conductors having sufficient resiliency to establish point contact between aligned regions of each cooperation pair substantially aligned with a manual depression point of the resilient pressure contact member.

2. The resistor of claim **1** wherein the means for preventing comprises ridges between adjacent ones of the first conductors, said ridges extending toward the resilient pressure contact member.

3. The variable resistor of claim **2** wherein the pressure contact member is formed as a channel having sidewalls fitted to corresponding sidewalls of the base member.

4. The resistor of claim **1** wherein the means for preventing comprises ridges between adjacent ones of the first conductors, said ridges extending toward and into contact with the resilient pressure contact member.

5. The resistor of claim **1** wherein the means for preventing comprises ridges between adjacent ones of the first conductors, said ridges extending toward and terminating in spaced relationship with the resilient pressure contact member.

6. The resistor of claim **1** wherein the resistance of the resistive body varies continuously from one end of the strip to the other end of the strip.

7. The variable resistor of claim **1** wherein the pressure contact member is formed as a channel having sidewalls fitted to corresponding sidewalls of the base member.

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