United States Patent

Suzuki et al.

[15] **3,694,559**

[45] **Sept. 26, 1972**

[54] **ELECTRONIC MUSICAL INSTRUMENT EMPLOYING VARIABLE RESISTOR FINGERBOARDS**

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[22] Filed: **Nov. 4, 1970**

[21] Appl. No.: **86,955**

Related U.S. Application Data

[62] Division of Ser. No. 11,983, Feb. 17, 1970, Pat. No. 3,626,350.

[52] **U.S. Cl.** **84/1.01,** 84/1.17, 84/1.24

[51] **Int. Cl.**.....**G10h 1/02**

[58] **Field of Search**.....84/1.01, 1.17, 1.24, 1.25, 84/1.27, 424, DIG. 7; 338/69, 99, 101, 112

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Assistant Examiner—Stanley J. Witkowski
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[57] **ABSTRACT**

An electronic musical instrument wherein there are several performing units. These performing units are made up of variable resistor fingerboards and variable frequency oscillators acting as tone generators. These oscillators are connected to the respective contact units which determine the frequencies of these oscillators. Tone signals are generated when one or more fingers simultaneously depress the performing units at points on the fingerboards. The relationship between the pressure contact unit and the variable frequency oscillators is so determined as to make the frequencies of the generated tone signals correspond to those of notes which are harmonized into a single chord. By continuously varying the point of finger contact it is possible to produce monophonic chord and portamento signals and to vary the coloring and volume of the musical tone signals on each of them or combinations of them.

5 Claims, 13 Drawing Figures

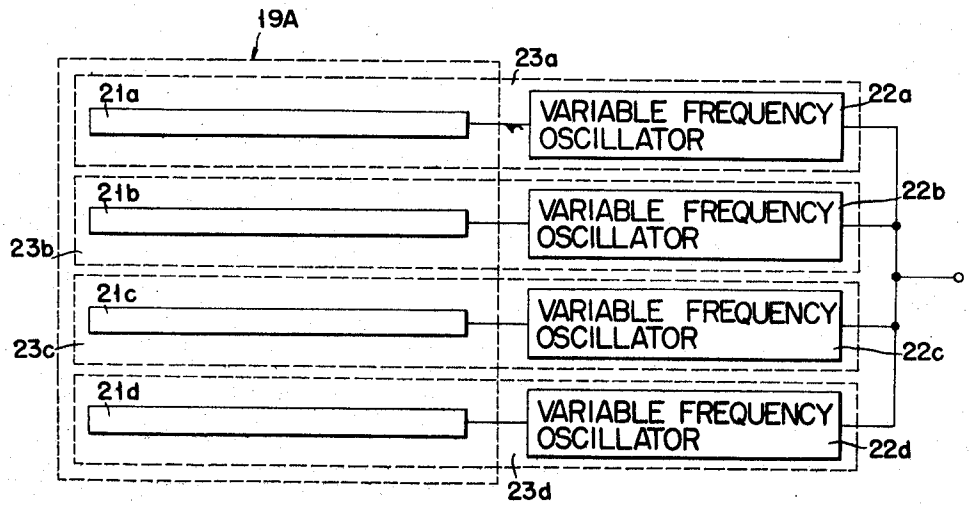


FIG. 1

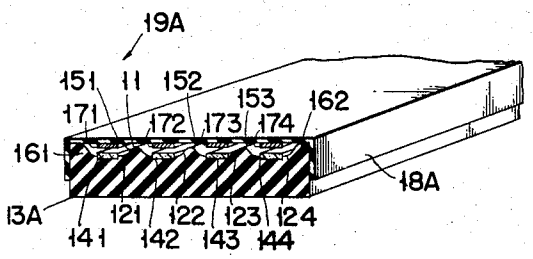


FIG. 2

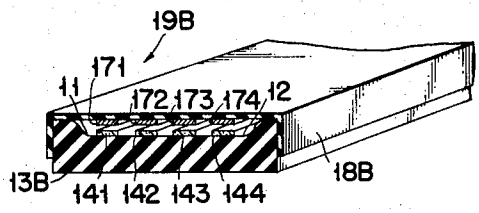


FIG. 3

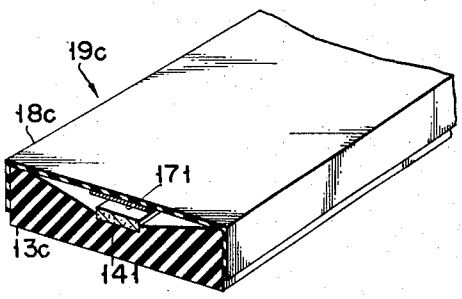


FIG. 5

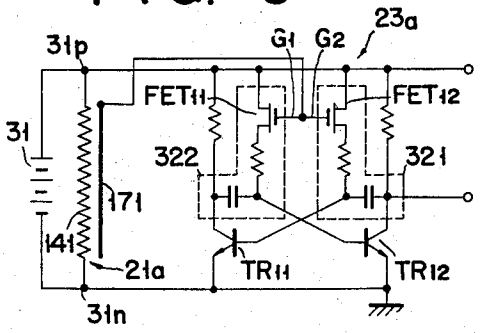


FIG. 4

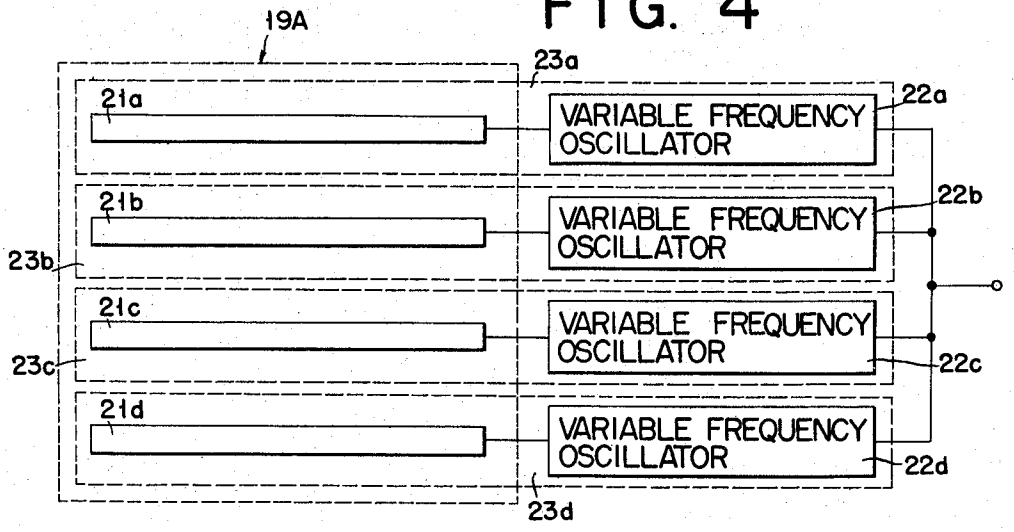


FIG. 6

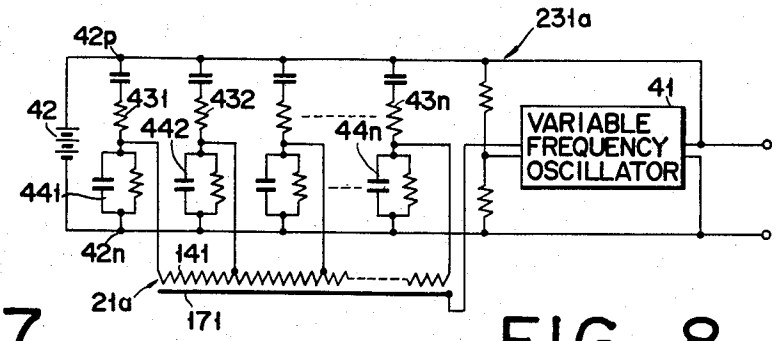


FIG. 7

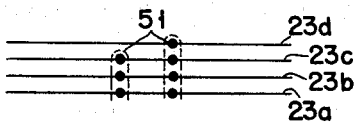


FIG. 8

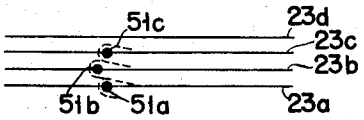


FIG. 9

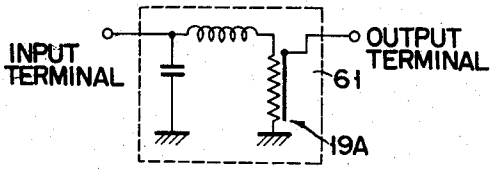


FIG. 10

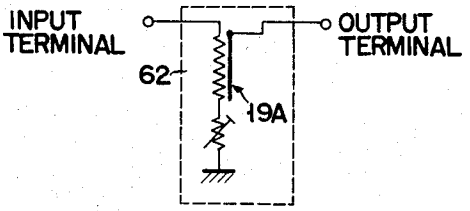


FIG. 12

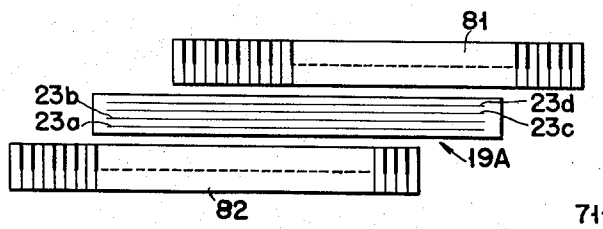


FIG. 11

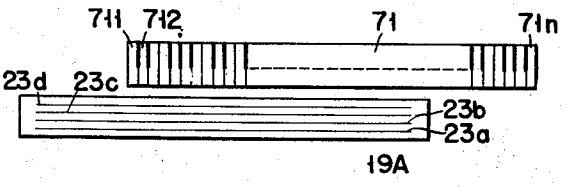
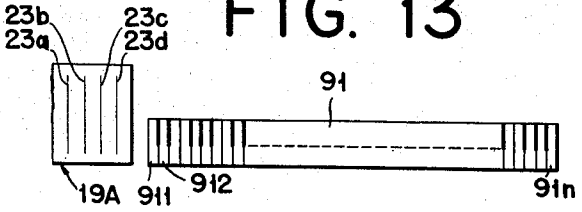


FIG. 13



ELECTRONIC MUSICAL INSTRUMENT EMPLOYING VARIABLE RESISTOR FINGERBOARDS

This is a divisional application of Ser. No. 11,983, filed on Feb. 17, 1970 (now U. S. Pat. No. 3,626,350).

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 a 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 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 music with as simple an operation as possible.

However, in the conventional keyboard operated 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 varying the oscillation frequencies of a variable frequency oscillator, thus continuously varying the tone pitch.

However, with the above described construction, it is possible to play only the portamento wherein the tone pitch is varied continuously but 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 playing. Moreover, there is a problem that during playing 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 which 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 so as to enable to the playing of 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 an 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 electronic 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** show 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 the 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** to **124** have a height lower than that of opposite side walls **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 elongated strip shaped four conductive metal films **171**, **172**, **173** and **174** having substantially the same configuration as the resistor bodies **141** to **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 **141** 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 (parallely 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 to 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 $B^{\flat}$ 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 build-up 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 music.

FIG. 11 shows a plan view of two stage manuals. The upper keyboard 71 has a construction similar to that of a conventional musical instrument and includes a plurality of keys 711, 712 ... 71*n* whereas the lower finger-board 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. In an electronic musical instrument having a plurality of variable resistors coupled to variable frequency oscillators as the frequency or tone pitch determining element for said oscillator in response to manual operation, said resistors each including an elongated rectangular base member and a metal strip-shaped conductor juxtapositioned over said base member and spaced a small distance therefrom functioning as a keyboard, the improvement therein wherein there are a plurality of strip-shaped resistors acting as 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, 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 second conductors having sufficient resiliency to establish point contact between aligned regions of each cooperating pair substantially aligned with a manual depression point of the resilient pressure contact member.

2. An electronic musical instrument as claimed in claim 1, including a parallel circuit, a strip-shaped resistor being connected as one parallel component in said circuit, a two gate gating active circuit and an astable multivibrator in parallel with said elongated resistor base member as another parallel component circuit.

3. An electronic musical instrument as claimed in claim 1 wherein a capacitor and a resistor are connected in series as a first part of a circuit and a second capacitor and second resistor are connected in parallel as a second part of the same circuit, said circuits all being in parallel to form one network and coupled to a variable oscillator, said resistor base member being in parallel with said network.

4. An electronic musical instrument as claimed in claim 1 wherein at least one of said first or second plurality of conductors is a keyboard.

5. An electronic musical instrument as claimed in claim 1 wherein each of the conductors of one of said first or second plurality of conductors is a resistive body the resistance of which increases from one end of the strip to the other end of the strip, and 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.

* * * * *