United States Patent

Yoshihara

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[54] **VARIABLE RESISTANCE DEVICE FOR A PORTAMENTO PERFORMANCE ON AN ELECTRONIC MUSICAL INSTRUMENT**

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Nov. 25, 1970	Japan	45/103460

[52] **U.S. Cl.** **338/69,** 84/1.01, 84/DIG. 7, 338/96

[51] **Int. Cl.** **H01c 9/00**

[58] **Field of Search** ..... 338/69, 47, 96, 92, 154; 84/1.24, DIG. 7, 1.01, 1.17

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Assistant Examiner—D. A. Tone
Attorney—Solon B. Kemon et al.

[57] **ABSTRACT**

A variable resistance device for a portamento performance on an electronic musical instrument wherein a conductive coiled spring is held by a supporting member and an elongate resistor is so held by the supporting member as to face the coiled spring at a small space. The elongate resistor is used to determine the output frequency of a tone signal generator. Depression of the coiled spring with player's finger causes it locally to contact the resistor, and the continuous shift of the player's finger successively varies resistance across the coiled spring and resistor, thereby providing a portamento performance.

10 Claims, 12 Drawing Figures

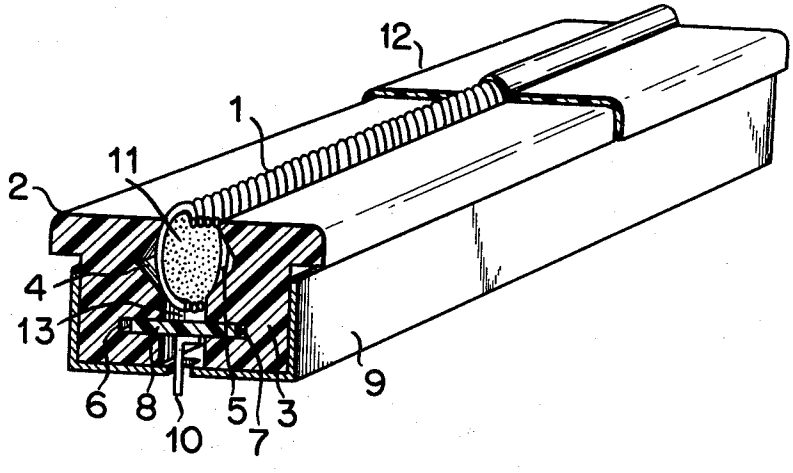


FIG. 1

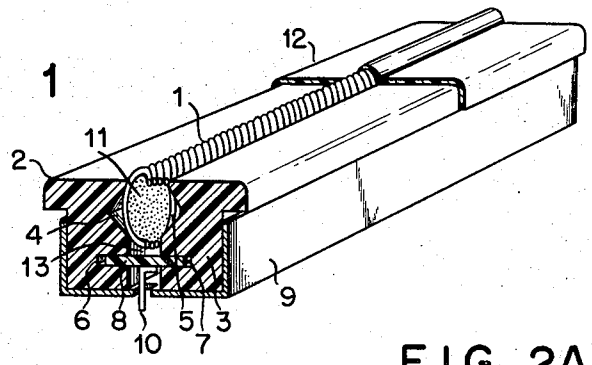


FIG. 3

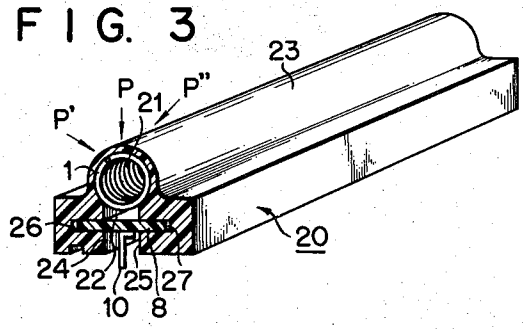


FIG. 2A

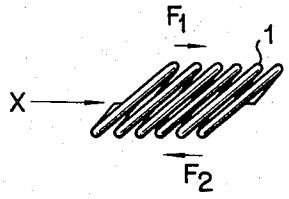


FIG. 2B

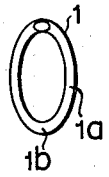


FIG. 4

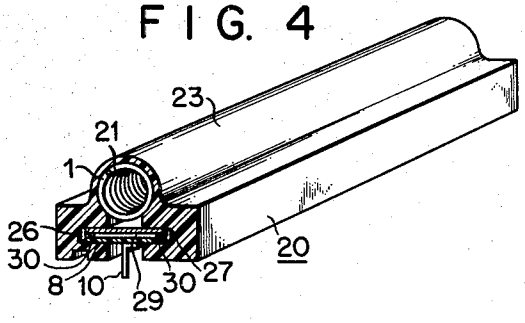


FIG. 2C



FIG. 5A

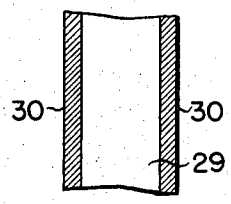


FIG. 5B

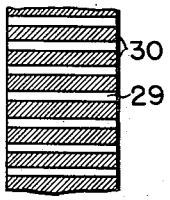


FIG. 5C

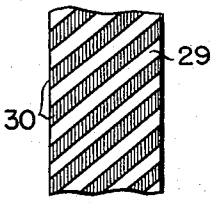


FIG. 6

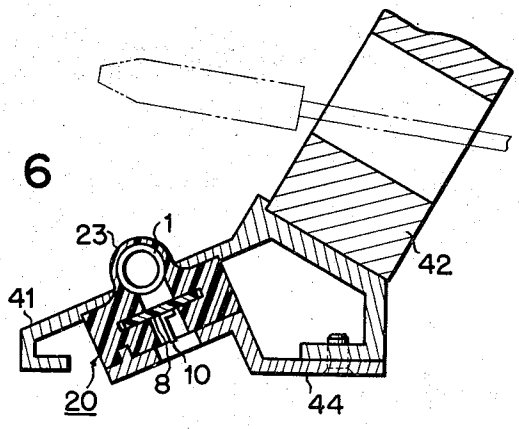


FIG. 7

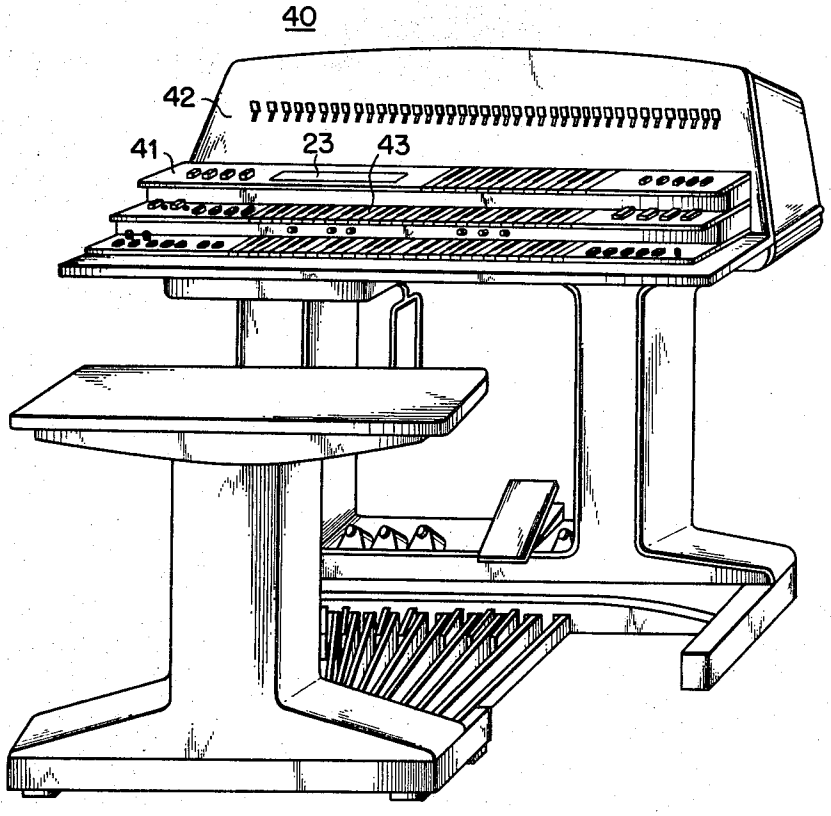
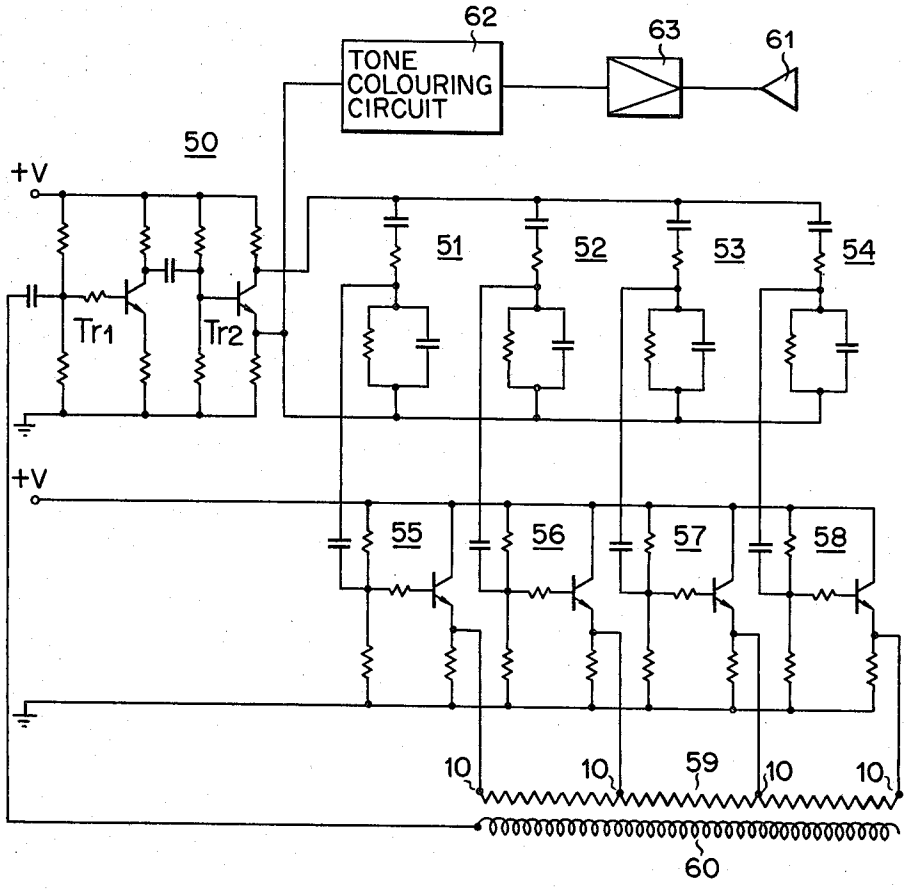


FIG. 8


62
TONE
COLOURING
CIRCUIT
63
61
50
+V
Tr1
Tr2
51
52
53
54
+V
55
56
57
58
10
10
59
10
10
60

VARIABLE RESISTANCE DEVICE FOR A PORTAMENTO PERFORMANCE ON AN ELECTRONIC MUSICAL INSTRUMENT

BACKGROUND OF THE INVENTION

This invention relates to an electronic musical instrument and more particularly to a variable resistor device adapted for a portamento performance thereon.

With the prior art electronic musical instrument, or electronic organ, there was imitatingly obtained a portamento effect by the glissando performance in which the finger was slidingly moved along the keyboard in the direction in which the keys were arranged.

The portamento effect results from successive variations in the frequency of sound waves. Therefore, the portamento effect in the truest sense of the word can be realized, in the case of an electronic musical instrument, by forming a tone signal generator from a variable frequency oscillator and using a variable resistance device as an element for determining the frequency of the oscillator and successively varying the resistance of the device so as to obtain a continuously changing oscillating frequency.

A variable resistance device for generating such a portamento effect is required to be of such type as allows the player to vary the magnitude of resistance easily by a single hand.

The prior art variable resistor device comprises a elongate resistor member, a supporting member for holding the elongate resistor member and a flexible sheet-like conductive contact member so secured by the supporting member as to face the narrow resistor member at a small space and provided with a large number of slits disposed at right angles to the lengthwise direction of the elongate resistor member.

When depressed by player's finger, the flexible sheet-like conductive contact member locally touches the elongate resistor member by the action of the slits. When the finger continuously slide on the contact member lengthwise of the resistor, there result successive variations in the resistance across the resistor and the contact member. If, in this case, the resistor and conductive member are so arranged as to effect contact therebetween as locally as possible, then there will be realized a portamento or melody performance smoothly and distinctly. With the aforesaid resistor device, the local contact between the resistor and conductive member is carried out by the action of the slits, requiring the conductive portions exposed between the adjacent slits to be as narrow as possible. However, such demand presents difficulties in manufacturing the conductive contact member and miniaturizing of the overall variable resistor device. Further, after local contact with the resistor, the conductive member has to be quickly brought back to its original state. However, the conventional resistor device does not easily permit the rapid return of the conductive member.

SUMMARY OF THE INVENTION

It is accordingly the object of this invention to provide a variable resistance device for a portamento performance on an electronic musical instrument which enables a conductive member locally to contact a resistor and thereafter quickly return to its original state and further simplifies the manufacture of its parts and realizes the assembly thereof in a compact compact form.

According to this invention, a coiled spring is used as a conductive member contacting the elongate resistor member or as an actuating member for bringing a conductive contact member in contact with the resistor member. In an embodiment of the invention, the coiled spring is forcefully deformed or twisted against its elasticity so as to present a vertically elliptic shape. The shorter diameter section of the coiled spring is held between the notched portions of first and second supporting members of insulating material so as to have its upper end project from the supporting members. The first and second supporting members further have a groove formed below the notched portions. Into these grooves are inserted both lengthwise edges of the elongate resistor member so as to face the coiled spring at a small space. When the upper part of the coiled spring slightly projecting upward from the first and second supporting members is depressed with player's finger, part of the turns of the coiled spring contacts the resistor member. Upon release of the finger, the part of the turns is quickly brought back to its original state due to the elastic restoring force of the forcefully deformed spring. Thus the elasticity of the spring enables the resistor to vary its value in succession smoothly and minutely. Use of a coiled spring as a conductive member simplifies the manufacture of the parts of a variable resistor device and realizes the assembly thereof in a fully compact form.

According to another embodiment of the invention, the supporting member for holding the coiled spring and resistor is formed by resilient insulating material. Further there are provided a cylindrical space for receiving the coiled spring and a groove below the space for supporting the elongate resistor member. The coiled spring is inserted into the cylindrical space and, when depressed with player's finger, is brought into contact with the elongate resistor member through the upper surface of the resilient supporting member.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view, partly in section, of a variable resistor device according to an embodiment of this invention;

FIG. 2A represents the top surface of a coiled spring subjected to a certain deformation and used as a conductive contact member in the resistor device of FIG. 1;

FIG. 2B is a side view of the coiled spring shown in FIG. 1 as taken in the direction of an arrow X in FIG. 2A;

FIG. 2C represents the top surface of the coiled spring, some turns of which are further deformed;

FIG. 3 is a perspective view, partly in section, of a variable resistor device according to another embodiment of the invention;

FIG. 4 is a modification of FIG. 3;

FIGS. 5A, 5B and 5C indicate the different forms in which there is coated an insulating film on the contact plate used in FIG. 4;

FIG. 6 schematically illustrates, partly in section, the manner in which there is fitted the resistor device of FIG. 3 to an electronic musical instrument;

FIG. 7 is a perspective view of an electronic musical instrument in which there is incorporated the variable resistance device of the invention; and

FIG. 8 shows a schematic circuit arrangement of an electronic musical instrument including a variable frequency tone signal generator provided with the variable resistance device of the invention as an element for determining the frequency of tone signals produced by the generator.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, reference numeral 1 denotes a coiled spring consisting of many turns of electrically conductive wire prepared by plating gold on, for example, nickel-silver, phosphor bronze, or piano wire. The coiled spring 1 is forcefully deformed or twisted against its elasticity with two forces F_1 and F_2 acting in opposite directions applied to both sides of the coiled spring 1 along the entire length thereof, thereby presenting an elliptic shape, as shown in FIG. 2B, when viewed in the direction of an arrow X in FIG. 2A. Thus, the coiled spring 1 is so formed as to have shorter diameter section 1*a* and a longer diameter section 1*b*, as indicated in FIG. 2B. The elliptically deformed coiled spring 1 is inserted in a long space formed between a first and a second elongated supporting members 2 and 3 made of electrically insulating rigid material such as hard rubber or synthetic resin, with its shorter diameter section supported between the mutually facing V-shaped notched portions 4 and 5 of the first and second supporting members 2 and 3. That is, the coiled spring 1 is inserted in the space formed by the V-shaped notched portions 4 and 5 with each turn of the coiled spring 1 directed obliquely to the lengthwise direction of the coiled spring 1, the obliquely directed turns being subjected to deformation against the elasticity of said coiled spring. In this case, the upper end of the larger diameter section of the coiled spring 1 is held by the first and second supporting members 2 and 3 so as slightly to project therefrom. In any case, the coiled spring thus deformed is held in the space formed by the V-shaped notched portions 4 and 5 and is kept from coming out of the space spontaneously as long as it is not subjected to a further deformation. The first and second supporting members 2 and 3 further have mutually facing grooves 6 and 7 formed below the respective notched portions 4 and 5. Into the grooves are inserted both lengthwise edges of a elongate resistor member 8. The space formed between the V-shaped notched portions 4 and 5 is communicated with the grooves 6 and 7 through an open space 13 somewhat narrower than the space between the notched portions 4 and 5.

The first and second supporting members 2 and 3 are held in position by a box-like frame 9. From below the resistor 8 are drawn out a number of conductive terminals (taps) 10 (only one is shown) through openings formed in the frame 9. The hollow space of the coiled spring 1 is filled with a flexible material 11 such as a soft polyurethane foam, but the material 11 may be eliminated.

When, in the variable resistance device of the aforementioned arrangement, there is depressed with player's finger the upper part of the coiled spring 1 projecting upward from the first and second supporting members 2 and 3, the depressed part of the turns of the coiled spring 1 is further deformed or twisted against its elasticity, as shown in FIG. 2C, with the depressed part of the turns increasing its obliquity and presenting a narrower elliptic shape than that shown in FIG. 2B, and comes down into the open space 13 until it is brought into contact with the resistor 8. Accordingly, there results across the coiled spring 1 and the conductive terminal 10 provided on the resistor 8 such a degree of resistance as corresponds to that part of the coiled spring 1 which contacted the resistor 8. There is produced by the tone signal generator a tone signal having a frequency corresponding to the degree of resistance. The circuit of the tone generator will be later described. When the depressed point on the coiled spring 1 is continuously shifted in its lengthwise direction, there are obtained tone signals from the tone generator whose frequencies successively vary.

Since the coiled spring 1 is deformed against its resiliency, release of a force with which the player's finger depress it causes it quickly to return to its original state due to the elastic restoring force of the coiled spring. The coiled spring 1 contacts the resistor 8 only at that part of its turns which is depressed, so that the resistance of the variable resistor device which determines the frequency of tone signals produced by the tone generator can be set very accurately.

The variable resistance device of this invention is prepared simply by disposing the coiled spring 1 and resistor 8 between the first and second supporting members 2 and 3 held by the frame 7, extremely facilitating the manufacture of these parts and their assembly. In this case, the coiled spring 1 is held between the first and second supporting members 2 and 3 with its turns forcefully deformed so as to present an elliptic shape due to forces acting lengthwise of the coiled spring 1 in opposite directions. Accordingly, it is securely set in place by its elastic restoring force.

The coiled spring 1 used in the aforementioned embodiment preferably consists of one prepared by winding a wire of about 0.3 to 0.6 mm thick to form a coil of many turns each having a diameter of 4 to 8 mm, thus rendering the resultant variable resistance device fully compact as a whole. The coiled spring 1 has only to be spaced 0.5 to 2 mm from the resistor 8. If the hollow space of the coiled spring 1 is filled with the very soft flexible material 11, it will help in prevention of dust from entering into the space 13 and being deposited on the resistor 8. It is further possible to cover the upper part of the variable resistance device with a protective cover 12 which is pliant and little subject to expansion and contraction such as piled cloth or that of Teflon.

There will now be described by reference to FIG. 3 a variable resistance device according to another embodiment of the invention. In FIG. 3, the supporting member 20 consists of elastic insulating material, for example, rubber or soft polyvinyl chloride and contains a cylindrical space 21 and a rectangular space 22 communicating therewith. That section 23 of the supporting member 20 which defines the cylindrical space 21 is formed with a thin wall and upwardly projects in a substantially semicircular shape. The other sections 24 and 25 of the supporting member 20 which face each other across the rectangular space 22 are provided with grooves 26 and 27 respectively.

The coiled spring 1 is inserted into the cylindrical space 21 of the supporting member 20, and the resistor

8 has both lengthwise edges fitted into the grooves 26 and 27. Below the resistor 8 is disposed the conductive terminal 10. According to the embodiment of FIG. 3, the coiled spring 1 is inserted into the cylindrical space 21 without being deformed or twisted at all, differing from the above-mentioned embodiment.

With a variable resistance device of the above-mentioned arrangement, vertical depression of the thin-walled semicircular projection 23 of the supporting member 20 in the direction of an arrow P in FIG. 3 causes the supporting member 20 to be deformed, bringing the coiled spring 1 into contact with the resistor 8. According to this embodiment, depression of the semicircular projection 23 slantwise from above as indicated by arrows P' and P'' also enables the coiled spring 1 fully to touch the resistor 8. As in the preceding case, the semicircular projection 23 may be surrounded with a protective cover.

In the two foregoing embodiments, the coiled spring 1 should preferably have its turns of wire plated with gold so as to be concurrently used as a conductive contact member. Since, however, the plating of precious metals is expensive, there is presented in FIG. 4 a modification of FIG. 3 to reduce the manufacturing cost.

Referring to FIG. 4, there are inserted into the grooves 26 and 27 of the supporting member 20 both lengthwise edges of a laminated layer consisting of the resistor 8 and an elastic conductive contact plate 29 of nickel-silver about 0.05 mm thick. One side of the contact plate 29 is coated by screen printing or spraying ribbon-shaped insulating films 30, as illustrated in FIG. 5A, along both lengthwise edges of the contact plate 29, or as shown in FIG. 5B, at a predetermined space at right angles to the lengthwise direction of the contact plate 29, or as indicated in FIG. 5C, in a spaced form slantwise extending at a predetermined angle to the transverse direction of the contact plate from one lengthwise edge to the other thereof.

Since the aforementioned insulating film 30 is about 0.01 to 0.05 mm, the contact plate 29 and resistor 8 face each other at a space of 0.01 to 0.05 mm. In FIGS. 5B and 5C, the ribbon-shaped insulating films 30 should be about 0.5 to 2 mm wide and should preferably be spaced about 0.5 to 1 mm from each other.

According to FIG. 4, the contact plate 29 replaces the coiled spring 1 of the preceding embodiments for use as a conductive element. When the contact plate 29 is depressed with player's finger through the coiled spring 1, those sections thereof which are exposed between the adjacent insulating films 30 are brought into contact with the resistor 8. Thus there takes place between the contact plate 29 and resistor 8 such a degree of resistance as corresponds to the contact point.

FIGS. 6 and 7 represent the manner in which the variable resistance device of this invention is incorporated in an electronic musical instrument. Reference numeral 41 denotes an inclined panel disposed between a control panel 42 and a keyboard 43 of an electronic musical instrument 40. The variable resistance device is held by a supporting member 44 so as to have its operating section 23 project from the aforesaid inclined panel 41. The variable resistance device of this invention is so compact that it can be disposed in any place where the player can easily operate it.

There will now be briefly described by reference to FIG. 8 the circuit of a variable frequency oscillator for a portamento performance using the aforementioned variable resistance device. The indicated oscillator is a Wien bridge oscillator which comprises an amplifier 50 including transistors Tr_1 and Tr_2, the circuits 51, 52, 53 and 54 of a frequency determining element connected parallel between the collector and emitter of the transistor Tr_2, each of which consists of a series circuit consisting of a resistor and capacitor connected in series with a parallel circuit including another resistor and capacitor and differs in phase shifting characteristics, emitter follower type impedance converters 55, 56, 57 and 58, each of which is supplied with signals from the junction of the aforesaid series and parallel circuits consisting of resistors and capacitors, a resistance element 59 provided with taps 10 connected to the emitter of the respective transistors included in the impedance converts 55, 56, 57 and 58 and a conductor 60 constituted by the coiled spring of the variable resistance device which is to be brought into contact with the resistance element 59. The conductor is connected to the transistor TR_1 of the amplifier circuit through a separate capacitor, thereby forming a feed back circuit.

The aforesaid circuits 51, 52, 53 and 54 of a frequency determining element have frequencies which successively differ from each other, for example, by one octave. Accordingly, frequency variation by three octaves is available in the embodiment shown in FIG. 8. Since there is not formed a feed back circuit unless the resistance element 59 and conductor 60 contact each other, it will be apparent that the aforementioned oscillator is not normally brought to an operable state. Where the conductor 60 contacts the element 59 between the taps of the element 59 connected to the emitter of each of the impedance transducer circuits 55 and 56, the oscillator oscillates at a frequency having a magnitude intermediate between those of the specific frequencies of the two circuits 51 and 52 of the frequency determining element which are located nearest to the contact point between the conductor 60 and element 59. Shifting of the contact point results in the sequential change of the oscillator frequency. Outputs from the oscillator are drawn out of the emitter of the transistor Tr_2 included in the amplifier 50 and supplied to a loud-speaker 61 through a tone coloring circuit 62 and another amplifier 63. If the conductor plate 60 is intermittently depressed by the finger for contact with the resistance element 59, then there will be realized not only a portamento performance, but also other performances.

The oscillator shown in FIG. 8 represents a sine wave generator including a capacitor and resistor. However, the variable resistance device of the present invention is also applicable in varying the frequency of a square wave generator such as an astable multivibrator. In such case, there is connected a variable impedance element such as a field effect transistor in series to the stationary resistor constituting an element for determining the frequency of the astable multivibrator. And there is impressed a predetermined D.C. voltage across both ends of the resistance element of the variable resistance

device of the present invention, and the conductor facing the resistance element is connected to the gate electrode of the field effect transistor. Then the device acts as a voltage divider to supply to gate electrode of the field effect transistor with successively varying D.C. voltage with the resultant change in the impedance of the field effect transistor, causing the frequency of the astable multivibrator to be continuously altered. Also in this case, the oscillator remains unoperable, so long as the conductor does not contact the resistance element.

What is claimed is:

1. A variable resistance device used in a tone signal generator for a portamento performance comprising:

a coiled spring member;

an elongate resistor member used as an element for determinging the output frequency of said tone signal generator; and

supporting means of electrically insulating material for holding said coiled spring member and elongate resistor member in mutually facing relationship at a predetermined space;

said coiled spring member being movable toward said resistor member by the depression of said coiled spring.

2. A variable resistance device according to claim 1 wherein said supporting means is provided with first and second components each having a notched portion, the notched portions of said components facing each other with a predetermined space formed therebetween; and said coiled spring, subjected to deformation against the elasticity of said spring, is inserted in said space so that the exertion of a force on said coiled spring permits further deformation of said coiled spring, enabling said coiled spring to move toward said resistor member.

3. A variable resistance device according to claim 2 wherein said coiled spring member consists of turns of wire forming an open space therein, said open space being filled with flexible material.

4. A variable resistance device according to claim 2 wherein said coiled spring has a portion thereof projecting outward from said space formed between said notched portions of said supporting components.

5. A variable resistance device according to claim 1 wherein said supporting member consists of an elastic insulating material and has a substantially cylindrical space and a further space communicating with said substantially cylindrical space; and said coiled spring is inserted in said substantially cylindrical space, said supporting member being deformable against the elasticity of said supporting member under a force acting thereon, whereby said coiled spring is brought into contact with said resistor member.

6. A variable resistance device according to claim 1 further comprising an elastic conductive contact plate with a plurality of ribbon-shaped electrically insulating films coated thereon, said contact plate being disposed between said coiled spring and resistor member by laminating said contact plate on said resistor member, said contact plate and resistor member being spaced apart from each other by the thickness of said insulating films.

7. A variable resistance device according to claim 6 wherein said insulating films are coated on said conductive contact plate along both lengthwise edges.

8. A variable resistance device according to claim 6 wherein said insulating films are deposited on said conductive contact plate at a predetermined space at right angles to the lengthwise direction of said contact plate.

9. A variable resistance device according to claim 6 wherein said insulating films are spatially formed on said conductive contact plate so as to extend slantwise from one lengthwise edge to the other of said plate at a predetermined angle to its transverse direction.

10. A variable resistance device according to claim 1 wherein said supporting means is provided with first and second components each having a notched portions, the notched portions of said components facing each other with a predetermined space formed therebetween; and said coiled spring consisting of turns of wire is inserted in said space with each of said turns directed obliquely to the lengthwise direction of said coiled spring, said obliquely directed turns being subjected to deformations against the elasticity of said coiled spring, whereby, when a force is applied to said coiled spring to move said coiled spring toward said resistor member, said coiled spring is further deformed with the obliquity of said turns increased and is permitted to travel toward said resistor member.

* * * * *