United States Patent

Peterson et al.

[15] **3,657,459**

[45] **Apr. 18, 1972**

[54] MUSICAL INSTRUMENT WITH VARIABLE AMPLITUDE

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[22] Filed: **Nov. 2, 1970**

[21] Appl. No.: **86,143**

[52] **U.S. Cl.** **84/1.01,** 84/1.09, 84/1.1, 84/1.27, 84/1.12

[51] **Int. Cl.** **G10h 1/00**

[58] **Field of Search** ..... 84/1.01, 1.13, 1.17, 1.18, 84/1.24, 1.26, DIG. 7, 1.27, 1, 423, 424; 200/5 A, 5 R, 159 A, 159 B, 166 C

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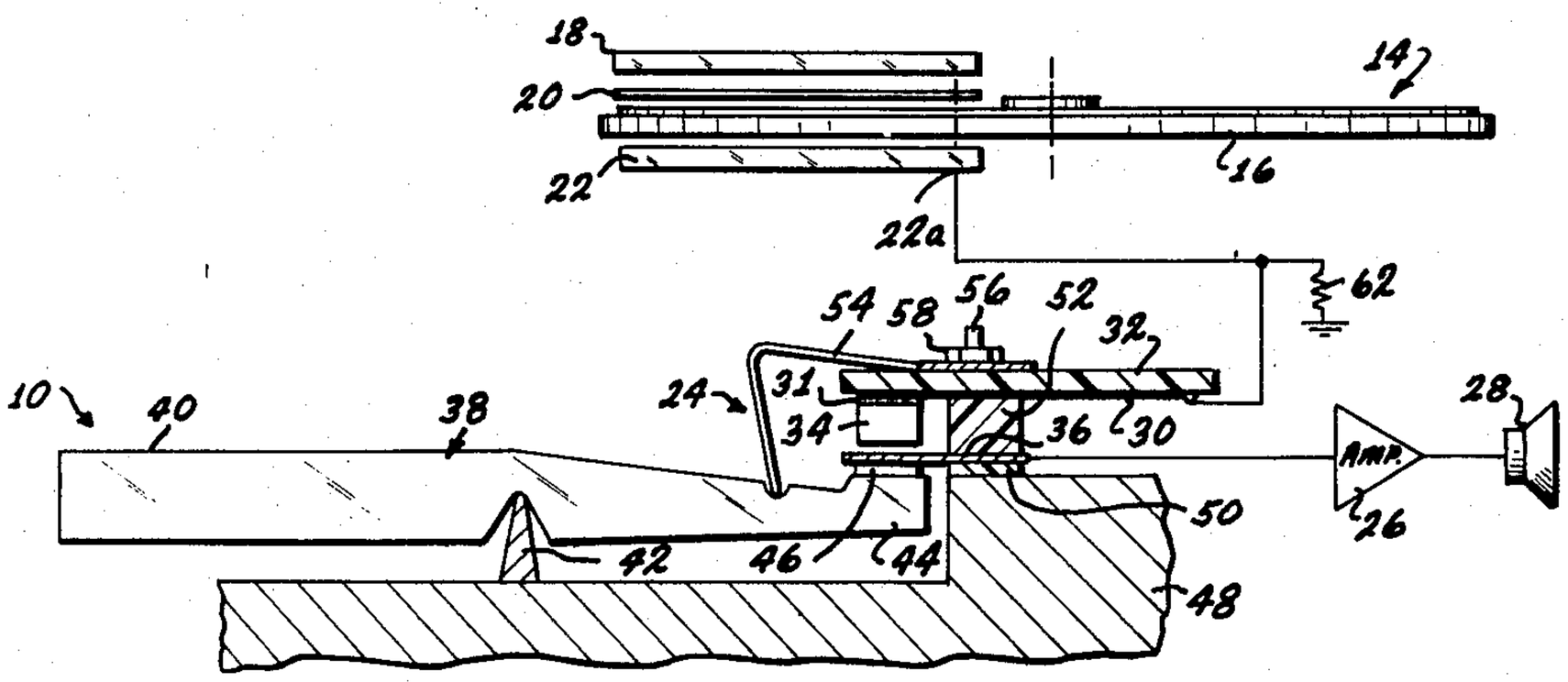
[57] **ABSTRACT**

An electronic organ with tone generators that are coupled to a loudspeaker by depressing key-operated switches, wherein each switch provides a resistance dependent upon the pressure applied to the key so that the musician can control the loudness, attack and decay of a musical note. Each switch includes a highly compressible resistance member whose resistance changes greatly with degree of compression, a first conductor which supports an upper end of the resistance member, and a resilient second conductor normally spaced below the resistance member. Manual depression of a key deflects the lower switch conductor up against the resistance member and compresses it in an amount dependent upon the pressure applied to the key. The fact that the resistance member initially has an extremely high resistance when the first contact touches it, prevents the production of a "-popping" sound as the key is depressed.

1 Claim, 4 Drawing Figures



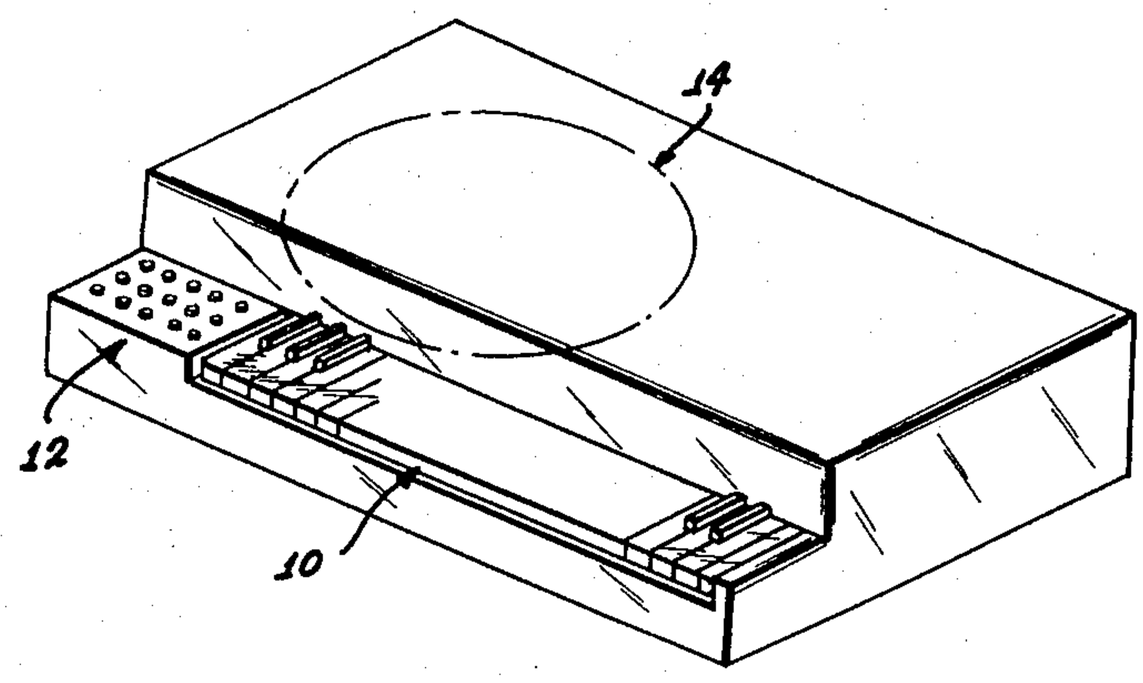
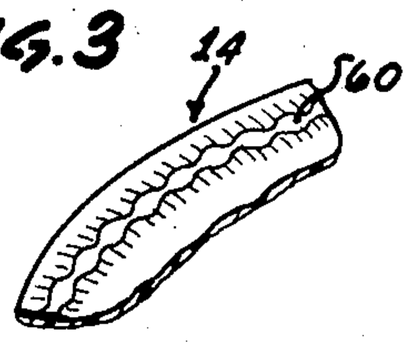


FIG. 1

FIG. 3



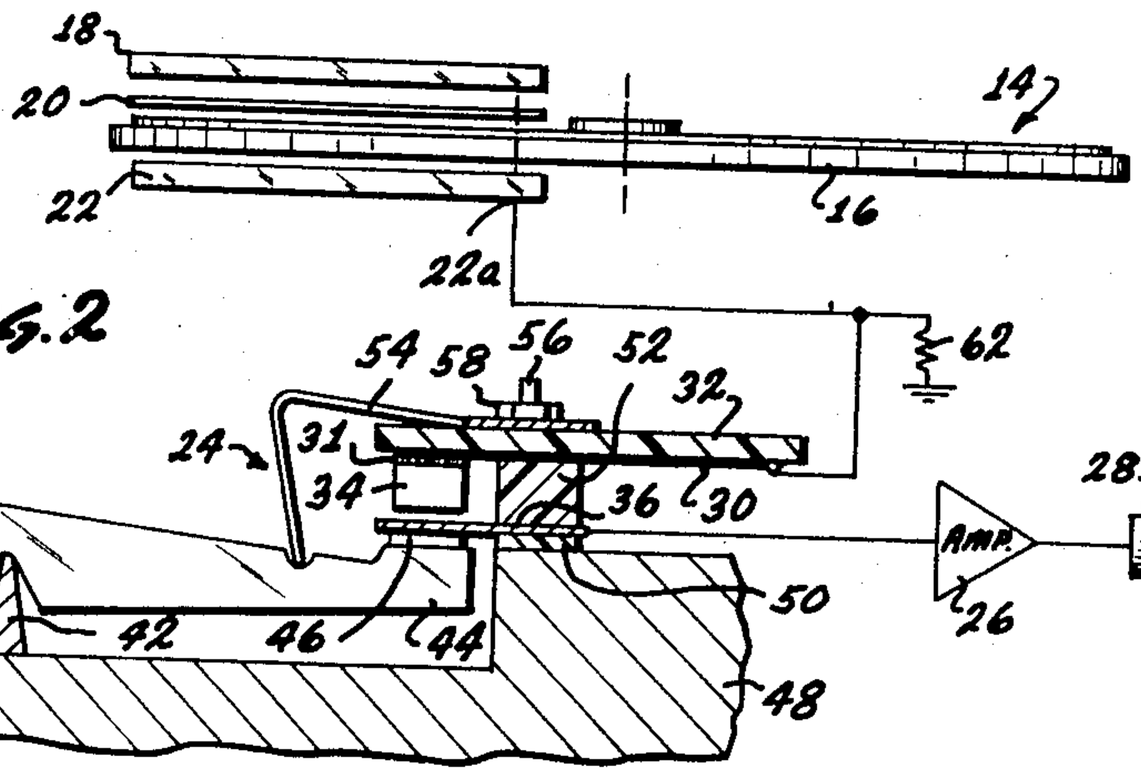


FIG. 2

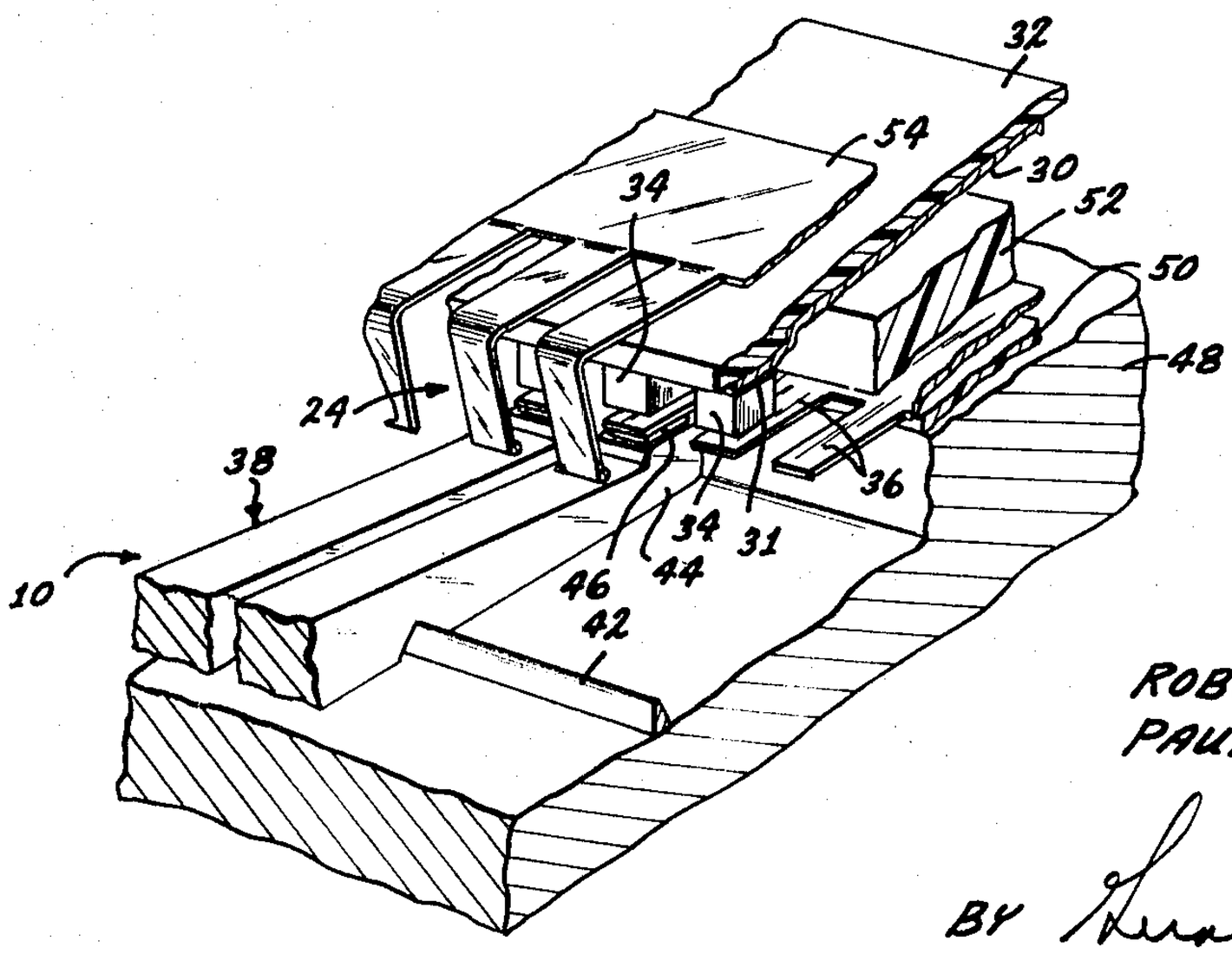


FIG. 4

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MUSICAL INSTRUMENT WITH VARIABLE AMPLITUDE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to musical instruments.

2. Description of the Prior Art

One type of electronic organ includes a group of tone generators, each of which can be connected to a common loudspeaker by depressing a corresponding key to close a switch. In some types of organs, oscillator circuits are used which are energized when the switch is closed, and the fact that the oscillations must build up to their maximum value reduces the tendancy of the circuit to create a popping sound as the switch is closed. However, in one type of organ which employs a rotating optical disc with patterns that vary the amount of light to a photocell, and where each key-operated switch serves to connect the photocell to a loudspeaker, a popping sound can occur when the switch is closed. This is due partially to the fact that the photocell creates a signal containing an appreciable DC bias, and that the switch may close at an instant when the AC portion of the signal has a large value.

In organs where a tone signal is coupled to the speaker through a simple key-operated ON-OFF switch, the volume is independent of the pressure applied by the musician to the key, and the musician has limited control over the character of a note. Furthermore, even if the organ is manufactured so that the tones have a noticeable attack or decay, the musician cannot readily adjust the attack or decay for individual notes. In considering the design of apparatus for enabling a musician to control attack, decay and volume, consideration must always be given to the fact that cost must be kept as low as possible in order that the instrument be economical enough to be widely sold.

OBJECTS AND SUMMARY OF THE INVENTION

An object of the present invention is to provide an electronic musical instrument of simple and economical construction, which permits close musician control of attack, decay and loudness of musical notes.

Another object is to provide an economical electronic musical instrument of the type which employs tone generators which produce DC bias, which reduces any tendancy to create a pop or other objectionable noise when a key is depressed.

In accordance with one embodiment of the present invention, an organ is provided of a type which has a rotating optical disc for regulating the passage of light from a lamp to a photocell to create tones, and key-operated switches which can be manually depressed to connect the output from any of the photocells to a loudspeaker. Each switch includes a compressible resistance member constructed of a compressible cellular material such as a foam, impregnated with a carbon solution, and a pair of electrical contacts on either side of the resistance member for compressing it. Manual pressure on the key moves one of the contacts towards the resistance member in an amount dependent upon the pressure applied to the key, so the musician can vary the signal strength passing through the switch to the loudspeaker by varying the pressure he applies to the key.

The switch is constructed with a first contact above the resistance member and attached to it so that the resistance member hangs from it. A second of the contacts lies below and spaced from the bottom of the resistance member. When the key is depressed, it moves the lower contact against the bottom of the resistance member, the resistance of the resistance member being initially so great that not enough current can flow to a loudspeaker to create a popping sound. The lower contact member is a resilient member that tends to spring downwardly away from the resistance member when the key is released, the springiness of the lower contact member helping to urge the key towards its initial up position.

The novel features of the invention are set forth with particularity in the appended claims. The invention will be best understood from the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a simplified perspective view of an organ constructed in accordance with the invention;

FIG. **2** is a partial elevation, partial schematic view of the organ of FIG. **1**;

FIG. **3** is a partial perspective view of the optical disc of FIG. **2**, showing the form of an optical track thereon; and

FIG. **4** is a partial perspective view of the switch portion of the organ of FIG. **1**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** illustrates an electronic organ constructed in accordance with the invention, which has a piano-type keyboard **10** for playing sustained tones and a chord section **12** with keys or buttons for playing chords. Both tones and chords are generated by an optical disc **14** which has many tracks thereon defining the various tones and chords. As shown in FIG. **2**, the disc **14** is mounted on a transparent turntable **16**. A lamp **18** produces light that passes through a slit **20**, through the optical disc and turntable, and into a group of photocells **22**. AND TURNTABLE, AND INTO A GROUP OF PHOTOCELLS **00**. Each photocell senses the amount of light passing through one optical track on the record, and it generates a current which can pass through a switch **24** to an amplifier **26** that drives a loudspeaker **28**. Thus, an electrical signal representing music is produced by the photocells **22** and each sound is converted to an audible signal when a respective switch **24** is closed.

The switch **24** includes a strip of conductive material or conductor **30** on a circuit board **32**, and a compressible resistance member **34** whose upper end is attached to the strip conductor **30** by a conductive adhesive **31** or other means that provides a conductive path between the conductor **30** and member **34**. A resilient conductor **36** is normally spaced below the bottom of the resistance member **34**. The strip or upper conductor **30** is connected to one photocell **22**a, while the resilient or lower conductor **36** is coupled through the amplifier **26** to the loudspeaker **28**. When the lower conductor **36** is deflected upwardly and contacts the resistance member **34**, a conductive path of initially high resistance is provided to allow some current to flow from the photocell **22***a* to the speaker.

The resistance member **34** is constructed of an easily compressed elastomeric material impregnated with conductive particles, such as a compressible polyurethane foam which has been impregnated with a solution containing carbon particles. A piece of such material undergoes a dramatic change in resistance between a state wherein it is uncompressed or slightly expanded and a state wherein it is highly compressed by the level of force which can be readily applied by a musician's fingers, a typical change being from several megohms to 100 ohms. Although a solid material, such as rubber or polyvinylchloride material impregnated with a conductive material can be used, a foam base material is generally preferable to provide a wide change of resistance throughout a greater distance of compression. A manually operable switch member of key **38** is provided for enabling a musician to deflect the lower conductor **36** and make it contact and compress the resistance member **34**. The key has an outer end **40** which is depressed by a musician's finger, a center portion which is pivotally mounted on a bearing **42**, and an inner portion **44** which lies beneath the lower conductor **36**. A pad **46** is mounted on the top of the inner key end and it constantly contacts the resilient lower conductor.

When a musician depresses the outer end **40** of the key, the lower conductor **36** is deflected and pressed upwardly against the resistance member **34**. The greater the depressing force

applied by the musician to the outer end **40** of the key, the greater the compression of the resistance member, and therefore the lower resistance therethrough and the louder the signal produced by the loudspeaker **28**. A musician can therefore press lightly or hard to produce a soft or loud note, and can apply and remove pressure on the key at various rates to vary the attack and decay of the musical note Accordingly, this arrangement enables close musician control over some of the note characteristics, using a relatively simple switch arrangement.

The switch apparatus is mounted on a frame **48** of the instrument, the pivot **42** being mounted on the frame and a first spacer **50** also being mounted thereon. The resilient lower conductor **36** is mounted on the first spacer **50**, and a second spacer **52** is mounted over the lower conductor to space it from the circuit board **32**. The resilient member **36** tends to bias the inner end of the key downwardly, but additional spring force is provided by a spring **54** which is mounted on the top of the circuit board **32**. Rods **56** project through the spring, circuit board, lower conductor, and spacers, to hold them in alignment with each other, and nuts **58** on the rods hold down the assembly to the frame **48**. FIG. **4** is a perspective view showing several switch assemblies, and the form of the various components. As shown in that Figure, the spacers **50**, **52** are long strips of insulative material, the lower conductive member **36** is a strip of material with fingers formed therein, and the spring **54** is a long strip of material with bent fingers formed therein. However, individual upper conductors **30** are formed on the circuit board, and individual resistance members **34** and keys **38** are used for the switches.

FIG. **3** illustrates a typical track **60** on the record, which is represented by a transparent line defined by opaque regions on either side of it, the transparent line having many undulations in width. This track **60** defines a sustained musical note or tone of constant volume, the volume produced being dependent upon the switch. When light shines through this track, the photocell receives an AC component representing the sound to be produced plus a DC bias. The DC bias can cause an electrical charge buildup which results in a "pop" being produced when the switch is first closed. A "pop" can also be produced if a switch is closed when the AC component is at a high instantaneous magnitude. The popping sound is reduced to a low level when a compressible resistance member **34** of the type shown in FIG. **2** is utilized, which provides a high initial resistance when the switch is first closed. However, some noticeable popping can still occur. This popping sound is further reduced to an unnoticeable level by the use of a resistor **62** of high resistance such as 50 kilohms to drain off any accumulated charge. It may be noted that in previous organs where a simple switch was used which had no appreciable resistance when first closed, a simple bias resistor was insufficient and an active DC bias source was needed to offset the DC bias of the photocell. The photocells displayed different DC biases, so a large number of bias resistors of different values had to be used to offset the biases. The elimination of active DC biases, through the use of the compressible resistance member **34**, helps to lower the cost of the musical instrument. The compressible resistance member also reduces popping due to the AC signal components, which could not be reduced even with the use of many bias resistors.

Thus, the invention provides a musical instrument with electronic tone generators in the form of an optical disc that regulates the light to photocells, and relatively simple switches which control the flow of current from the photocells to a loudspeaker (via an amplifier). Each switch has a resistance whose resistance level can be varied by a factor of many times in response to the force applied by a musician to a key, to permit the musician to vary the loudness and attack and decay of musical sounds. This is accomplished by the use of a compressible resistance member whose resistance varies greatly with degree of compression and by the coupling of a manually operated key to conductors that compress the resistance member. The compressible resistance member is attached to one of the conductors, while the other conductor is normally spaced from the compressible resistance member, so that even a low level of sound does not leak through to the loud-speaker. The use of the compressible resistance member with a very high initial resistance, reduces popping that can result from the creation of a DC bias by the photocell, and even this low level of popping can be reduced to a negligible amount by a simple bias or draining resistor. The compressible resistance member also reduces popping that may be caused by the AC portion of the signal produced by the photocell.

Although particular embodiments of the invention have been described and illustrated herein, it is recognized that modifications and variations may readily occur to those skilled in the art and, consequently, it is intended that the claims be interpreted to cover such modifications and equivalents.

We claim:

1. A musical instrument comprising: a plurality of generating means for generating a plurality of electrical signals, each representing a musical sound;

speaker means for producing acoustic sounds of frequencies dependent upon the frequencies of electrical inputs thereto, and of amplitudes dependent upon the amplitudes of the electrical inputs thereto;

a circuit board having a plurality of electrically conductive strips insulated from each other, each of said strips connected to one of said generating means;

a plurality of resistance members constructed of compressible material which undergoes a change in resistance of many times between a highly compressed state and an uncompressed state, each resistance member having a first face attached to one of said strips on said circuit board and a second face;

a sheet electrically conductive spring material coupled to said speaker means, said sheet having a plurality of slots along one edge forming fingers and each finger disposed opposite the second face of a different resistance member; and

a plurality of manually depressible keys for deflecting said fingers against said second faces of said resistance members with forces dependent upon the depressing forces manually applied to the keys.

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