United States Patent

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[33] **Japan**
[31] **43/45402 and 43/45403**

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[54] **ELECTRONIC MUSICAL INSTRUMENT KEY ASSEMBLY WITH PRESSURE SENSITIVE RESISTOR**
3 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **84/1.01,** 84/1.27
[51] **Int. Cl.** **G10c 3/12,** G10h 1/00
[50] **Field of Search** ..... 84/1.01, 1.11, 1.07–1.09, 1.24, 1.26, 1.27 (D)(LSR)

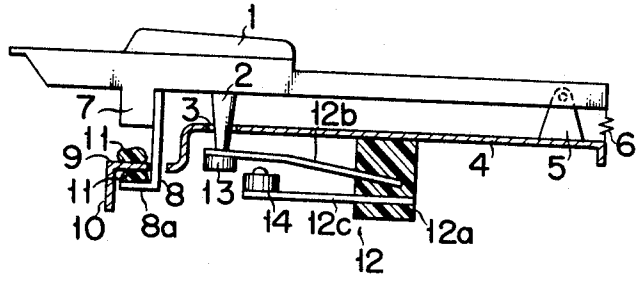
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Primary Examiner—W.E Ray
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ABSTRACT: A key assembly involves a plurality of keying switches, each of which is provided with a stationary contact element and a movable contact element cooperable at their contact point. Said movable contact element has a weight block disposed at the free end thereof and is elastically bendable by an actuating member mounted on the bottom side of a key member. At the contact point of the stationary contact element is positioned a sensor whose electric resistance makes varying responses in accordance with the magnitude of pressure applied thereto.



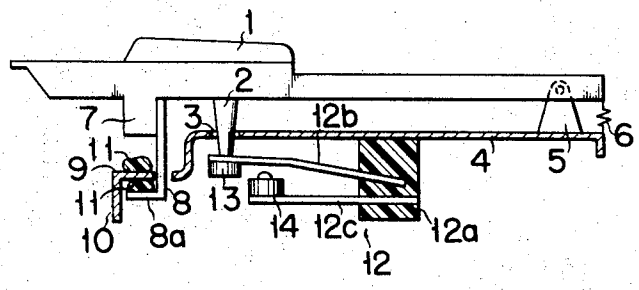


FIG. 1

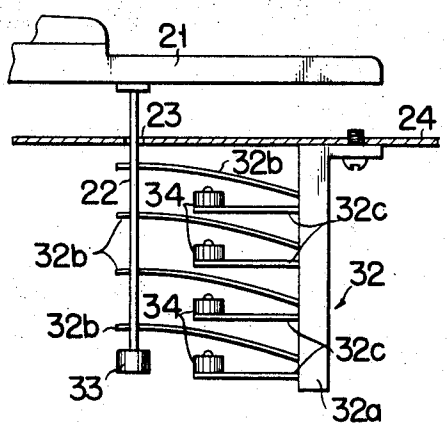


FIG. 2

FIG. 3

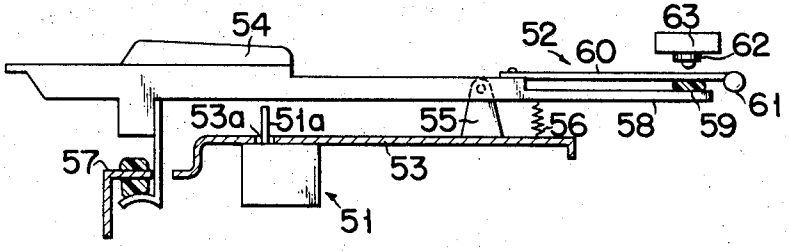
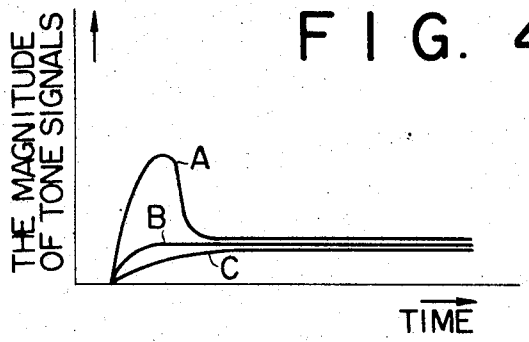


FIG. 4



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ELECTRONIC MUSICAL INSTRUMENT KEY ASSEMBLY WITH PRESSURE SENSITIVE RESISTOR

BACKGROUND OF THE INVENTION

This invention relates to a key assembly for an electronic musical instrument wherein the magnitude of a tone signal passing through a key switch is controlled in accordance with the magnitude of the force with which a key member depressed.

The key switch of the prior art key assembly was operated merely to cause a tone signal from a tone generator to pass through said key switch with a prescribed magnitude. Namely, the magnitude of the tone signal can not be controlled in accordance with the magnitude of the force with which a key member is depressed, because a pair of contact elements involved in said key switch are merely brought together or separated from each other.

SUMMARY OF THE INVENTION

An object of this invention is to provide a key assembly for an electronic musical instrument improved so that the tone signal passing through a key switch can be made sufficiently strong at the moment the key member is depressed.

In an aspect of this invention, said key assembly comprises a plurality of key members, a plurality of key switches arranged in correspondence to the respective key members, an actuating member disposed on each said key members, a stationary contact element and a movable contact element cooperable at their contact point and disposed in correspondence to each of said key members, a weight block disposed at the free end of said movable contact element, and a sensor positioned at the contact point of said stationary contact element, the electric resistance of the sensor making varying responses in accordance with the magnitude of pressure applied thereto, whereby the magnitude of the tone signal passing through the key switch is varied in accordance with the magnitude of the force with which the key member is depressed.

BRIEF EXPLANATION OF THE DRAWING

FIG. 1 is a side view of a key assembly embodying this invention;

FIG. 2 is a fragmentary side view of another embodiment of a key assembly;

FIG. 3 is a side view of a key assembly further modified from that of FIG. 1; and

FIG. 4 is a graph indicating the relationship of time with the magnitude of tone signals passing through the keying switch of said key assembly of this invention.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 indicates the key assembly of an electronic musical instrument embodying this invention. Said key assembly comprises a plurality of key members, one of which is shown in the drawing by the reference numeral 1, arranged in a row in corresponding relationship to the respective notes of a chromatic musical scale. Each of said key members 1 has an actuating arm 2 attached to the bottom side thereof and extending downward through a bore 3 formed in a key support frame 4. Said key member 1 is pivoted to a bearing member 5 rising above said key support frame 4. Between the rear portions of said key member 1 and key support frame 4 is stretched a tension spring member 6 shaped into a coil. At the forward portion of said key member 1 is integrally formed a skirt 7 to which is attached an L-shaped engaging member 8. A stopper 9 integrally formed with a front panel 10 faces the upper side of the hook-shaped portion 8*a* of said engaging member 8 and the lower end of said skirt 7. Said stopper has cushion members 11 of felt or foamed synthetic resin attached to the upper and lower portions thereof by adhesive agent. Under the key support frame 4 is disposed a keying switch 12 in correspondence to each of said key members 1. Said keying switch 12

involves a base 12*a* of electric insulating material mounted on said key support frame 4, a movable contact element 12*b* consisting of an elastically bendable copper strip member extending horizontally and a stationary contact element 12*c* positioned substantially parallel to, and in vertically spaced relationship to said movable contact element 12*b*. The end of each of said contact elements 12*b* and 12*c* is securely molded in said base 12*a* acting as a support. The free end of said movable contact element 12*b* faces the lower end of the actuating arm 2 and has a weight block 13 attached to the lower side thereof. At the free end of said stationary contact element 12*c*, i.e., the contact point thereof is positioned a sensor 14, the electric resistance of which makes varying responses in accordance with the magnitude of pressure applied thereto. The sensor 14 faces the lower side of said movable contact element 12*b*. Said sensor is generally called a piezoresistance element.

When the key member 1 is depressed, the actuating arm 2 is operated so as elastically to bend the movable contact element 12*b* at a velocity corresponding to the force with which said key member is depressed, thereby to cause the movable contact element 12*b* to contact the stationary contact element 12*c* with the result that the lower side portion of said movable contact element 12*b* depresses the piezoresistance element or sensor 14.

When the key member 1 is depressed, the sensor 14 initially receives at a moment with the aid of the inertia force of the weight block 13 a greater pressure than that which would be applied to said sensor without the aid of said inertia force. After the dissipation of kinetic energy of the weight block, the pressure applied to the sensor 14 is reduced to that level applied to the key member, i.e., the level of the force only with which the contact element 12*b* contacts said sensor 14. This causes the tone signal passing through the key switch 12 to be made sufficiently strong at the moment the key member is depressed so that the contact elements 12*b* and 12*c* are mutually contacted.

The curve B in FIG. 4 indicates the characteristic of the tone signal passing through the key switch where a force for depressing the key member 1 initially results in an inertia force of the weight block smaller than that represented by the curve A in the aforesaid embodiment, though the depressing force finally causes the same force to be applied to the sensor 14 as that with which the contact element 12*b* contacts said sensor in the aforesaid embodiment. Furthermore, the curve C in FIG. 4 indicates the characteristic of the tone signal passing through the key switch, where a force for depressing the key member 1 results in an inertia force of the weight block which is insufficient or fails to cause the specified form of envelope of the tone signal at an initial step.

When the depressing force is removed from the key member 1, the action of the spring member 6 causes said key member 1 to return to the original position and the movable contact member 12*b* is carried away from the contacting position and brought back to the original position by its accumulated elastic pressure. In this case, the vertical movement of the key member 1 is, as is well known, limited by the stopper 9.

FIG. 2 indicates a key assembly provided with a plurality of key members 21, each having a multiple type keying switch 32, which in turn involves a plurality of pairs of movable and stationary contact elements 32*b* and 32*c*. Said contact elements 32*b* and 32*c* are vertically spaced to each other. At the free end of each of the stationary contact elements 32*c* is formed a piezoresistance element or sensor 34. An actuating arm 22 extending downward from the bottom side of the key member 21 is connected in common to the free ends of the movable contact elements 32*b*. To the lower end of the actuating arm 22 is attached a weight block 33. Since the other parts of the key assembly consist of members of a substantially identical type with those mentioned in the first embodiment, said parts are not explained herein, but only illustrated in the FIG. by the reference numerals in which the digits in the first place are the same as those indicated in the first embodiment,

though the digits 0 and 1 in the second place are replaced by 2 and 3 position therein.

In operation, the inertia force of the weight block 33 due to the forcible depression of the key member 21 is equally distributed over all the movable contact members, with the result that the mutual contact of the movable and stationary contact elements 32*b* and 32*c* causes the tone signal to be made sufficiently strong at the moment the key member is depressed. The characteristics of the tone signals passing through the key switches 32 of this embodiment are the same as that explained in the aforementioned embodiment.

FIG. 3 indicates a key assembly modified from that of FIG. 1. Said key assembly particularly includes a keying switch 51 of a general type and another keying switch 52 of this invention, the latter being prepared separately from the former. Said keying switch 51 is disposed at the lower side of a key support frame 53 and provided with an operating member 51*a* vertically rising from the top of the casing thereof through a bore 53*a* formed in said key support frame 53.

Each of key members 54 of synthetic resin arranged in a row of corresponding relationship to the respective notes of a chromatic musical scale is pivoted to a bearing member 55 rising above the key support frame 53. A coiled tension spring member 56 bridges the key member 54 and key support frame 53 at a point behind the bearing member 55 so as upwardly to urge the forward portion of said key member 54.

The vertical movement of the key member 54 is, as is well known, limited by the stopper 57.

Said key member 54 further involves an actuating member 58 integrally formed therewith in a manner to extend rearwardly from the rear end thereof. To the rear upper portion of said actuating member 58 is secured a cushion member 59 consisting of foamed synthetic resin or rubber.

A movable contact element 60 consisting of an elastically bendable member such as plate or leaf spring member is attached to the rear upper end of said key member 54 in a manner to extend rearwardly parallel to the actuating member 58 with a suitable space allowed between said members 58 and 60, and to lie on the cushion member 59. To the rear end of said movable contact element 60 is attached a weight ball 61. The upper surface of said movable contact element 60 faces a sensor 62 consisting of a piezoresistance element positioned above the element 60. Said sensor 62 is attached to a stationary contact element 63 and used by being coupled with said movable contact element.

When the key member 54 is depressed, the movable contact element 60 is vertically lifted to the stationary contact element 63 with its head supported by the cushion member 59, so that the actuating member 58 causes the movable contact element 60 to depress the sensor 62. Initially with the aid of the inertia force of the weight ball 61 due to the quick movement of said movable contact element 60, the sensor 62 receives a greater pressure than that which would be applied to said sensor 62 only by the depressing of the movable contact element having no weight block. After the dissipation of kinetic energy of the weight ball, the pressure applied to the sensor 62 is reduced to that level applied to the key member, i.e., the level of the force only with which the contact element 60 contacts said sensor 62, without the inertia force of the weight ball 61.

This causes, as already mentioned in the first embodiment, a tone signal passing through the key switch 52 to be made sufficiently strong at the moment the key member is depressed so that the contact elements 12*b* and 12*c* are mutually contacted.

When the depressing force is removed from the key member 54, the action of the spring member 56 causes said key member 54 to return to the original position, and the movable contact element 60 is carried away from the contacting position and returns to the original position.

In the last embodiment, the keying switch 51 is electrically cooperated with said sensor 62 by its serial connection with said sensor.

We claim:

1. A key assembly for an electronic musical instrument comprising a plurality of key members, a plurality of key switches arranged in correspondence to the respective key members, an actuating member disposed on each of said key members, a stationary contact element and a movable contact element cooperable at their contact point, and disposed in correspondence to each of said key members, a weight block disposed at the free end of said movable contact element, and a sensor positioned at the contact point of said stationary contact element, the electric resistance of the sensor making varying responses in accordance with the magnitude of pressure applied thereto, whereby the magnitude of a tone signal passing through said key switch is varied in accordance with the magnitude of the force with which the key member is depressed.

2. The key assembly claimed in claim 1 in which each of said keying switches involves a plurality of movable and stationary contact elements, a weight block and a sensor.

3. The key assembly claimed in claim 2 in which a plurality of pairs of said movable and stationary contact elements are vertically arranged in a row and jointly operated by one actuating member.