United States Patent [19]

Amano

[11] **3,835,235**

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[54] **KEYBOARD TYPE ELECTRONIC MUSICAL INSTRUMENT**

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[52] **U.S. Cl.** **84/1.01**, 84/1.24, 84/1.25, 84/1.26, 84/DIG. 7, 84/433

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

[58] **Field of Search** ..... 84/423, 433, 1.24, 1.01, 84/1.25, 1.17, 1.26, DIG. 7

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Assistant Examiner—U. Weldon
Attorney, Agent, or Firm—Kenneth S. Goldfarb

[57] **ABSTRACT**

A keyboard type electronic musical instrument, which is capable of producing such musical effects as tremolo and glide, is disclosed. A flexible hollow tube is provided below each key together with a light source and a light-sensitive variable resistor provided at opposite open ends of the tube, so that the tube forms a passage through which the light travels from the light source to the light-sensitive variable resistor, the tube being adapted to be deformed by depressing the associated key to an extra extent or driving it toward left or right from its lower set position to thereby vary the quantity of light from the light source incident on the light-sensitive variable resistor. The light-sensitive variable resistor serves to produce a signal corresponding to the quantity of light incident on it, the signal being used to produce tremolo or other musical effects.

11 Claims, 14 Drawing Figures

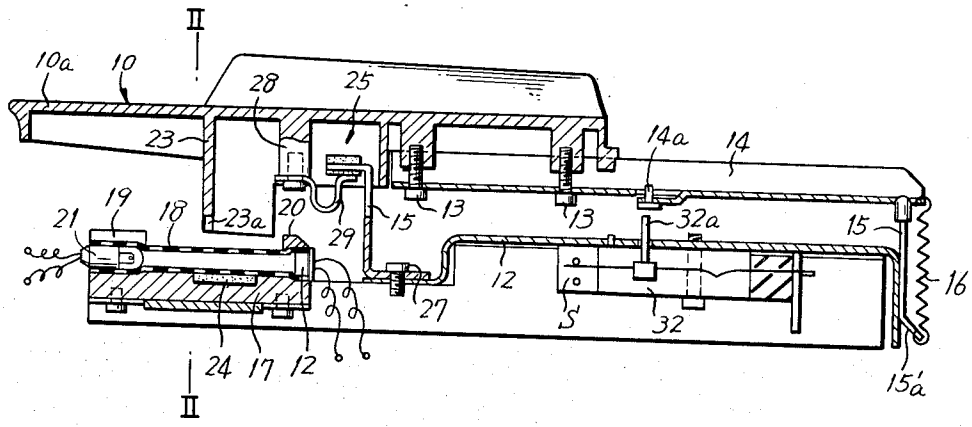


FIG. 1

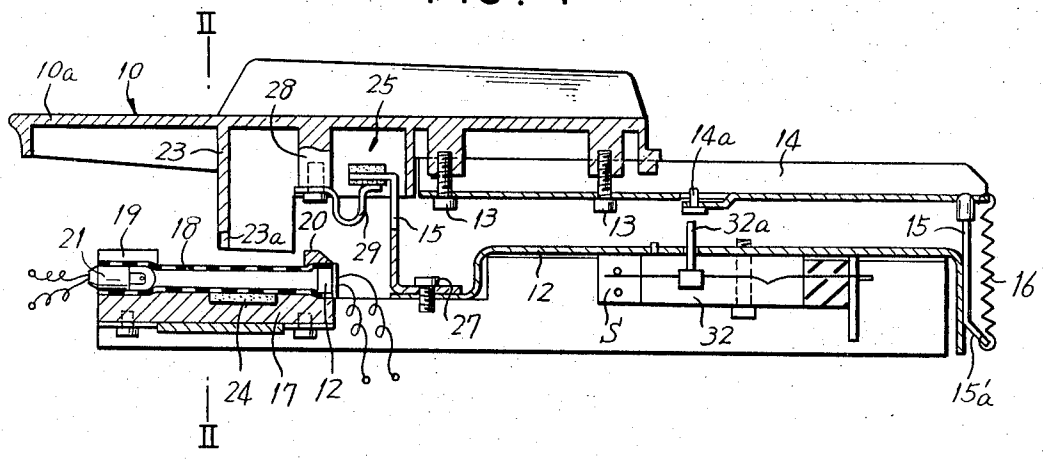


FIG. 2

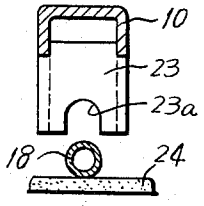


FIG. 3

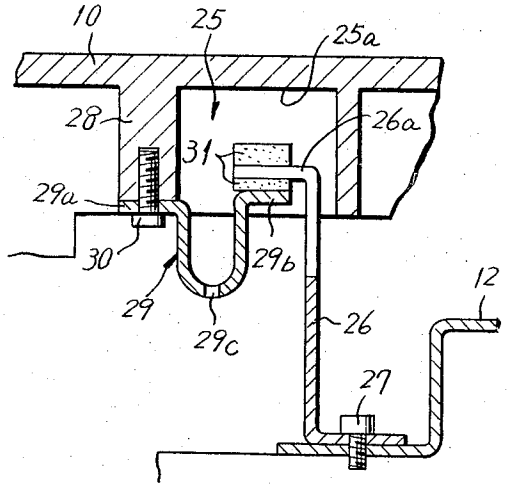


FIG. 4

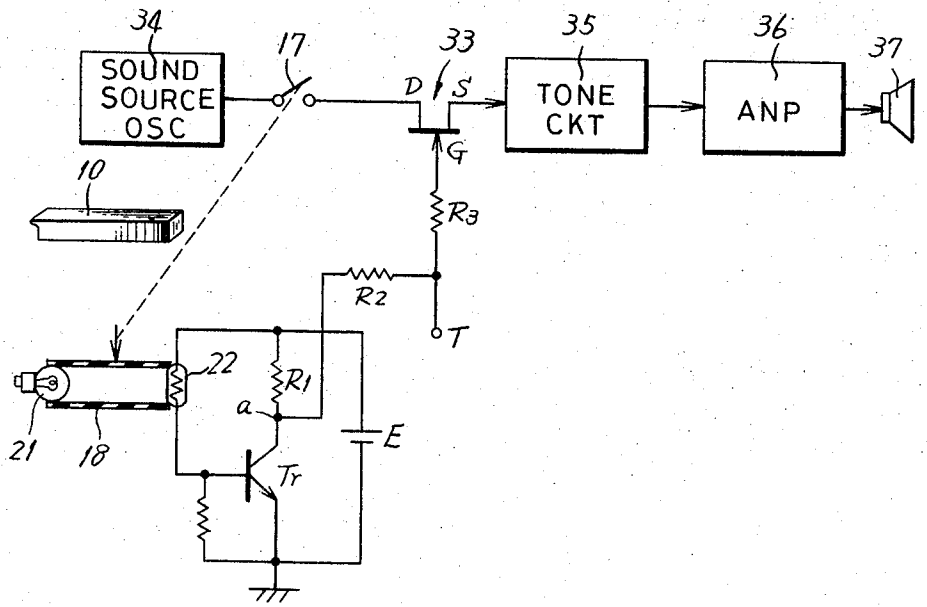


FIG. 5A

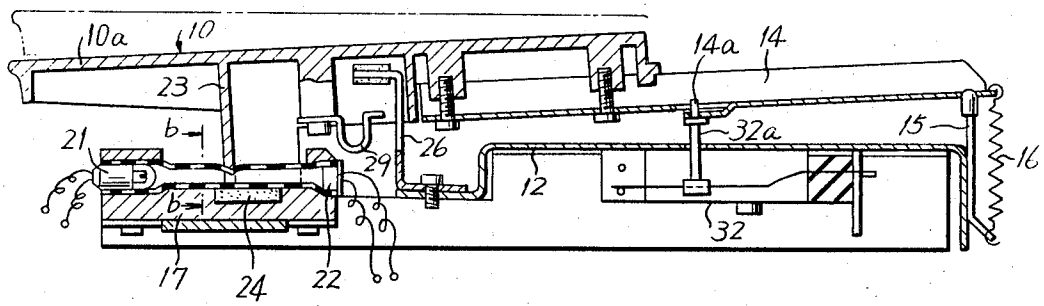


FIG. 5B

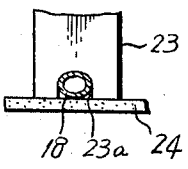


FIG. 6A

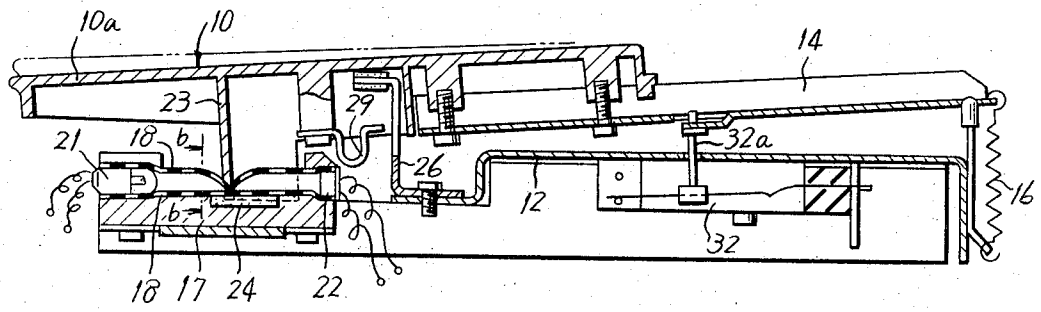


FIG. 6B

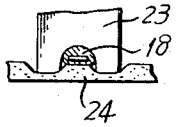


FIG. 7

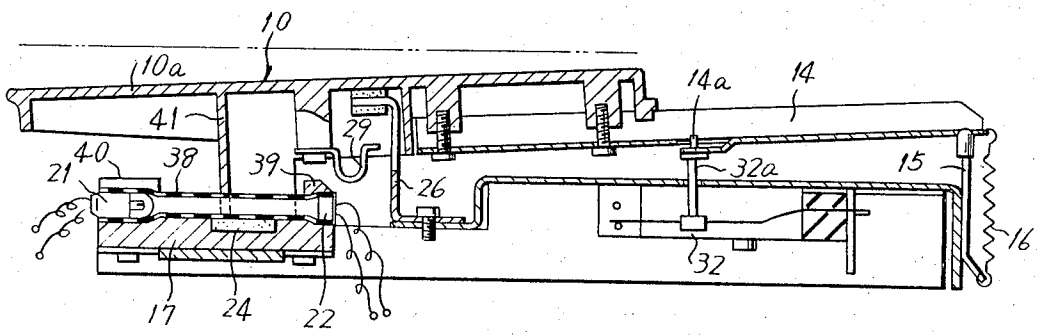


FIG. 8A

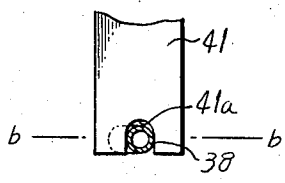


FIG. 9A

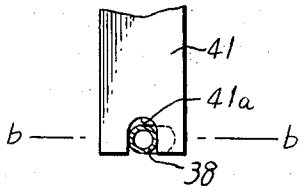


FIG. 8B

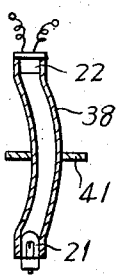


FIG. 9B

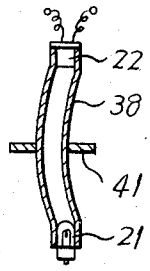
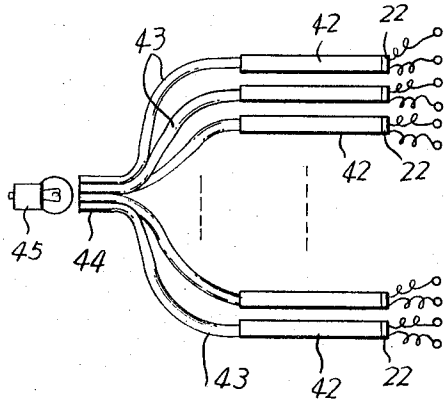


FIG. 10



KEYBOARD TYPE ELECTRONIC MUSICAL INSTRUMENT

BACKGROUND OF THE INVENTION

This invention relates to keyboard type electronic musical instruments and, more particularly, to one which permits to add such musical effects as tremolo or glide to the musical sound produced from the loudspeaker by depressing the key to an extra extent or driving it toward left or right from its lower set position and in which means for determining the upper and lower set position of the key has a simplified construction and permits ready adjustment of the horizontal of the top of the keys through a U-shaped member provided to each key.

In the performance of the prior art keyboard type electronic musical instrument, a switch circuit thereof is controlled by operating the key, sound source signals from sound source oscillator means being thereby coupled through the switch circuit to a tone circuit where the input signal is converted into a corresponding tone of flute or string timbre. This type of musical instrument is also provided with expression control means for controlling the volume of sound produced from the loudspeaker.

However, the expression control means is operable by foot or knee, and it is very difficult to introduce various sophisticated musical effects. Particularly, an unskilled performer finds it almost impossible.

In some instruments, manual levers or knob for expression control are provided in the keyboard section so that desired performance effects may be produced by operating them.

With this type of the instrument, however, the desired performance control such as giving tremolo effect, control of tremolo speed and giving glide effect cannot be made when both hands are engaged in the operation of the keyboard.

SUMMARY OF THE INVENTION

The primary object of the invention is to provide a keyboard type electronic musical instrument, which permits to add such musical effects as tremolo to the musical sound produced from the loudspeaker only by the operation of keys without substantial sacrifice in the keyboard performance.

Another object of the invention is to provide a keyboard type electronic musical instrument, in which a flexible tube with a light source at one open end of the tube and a light-sensitive variable resistor at the other open end of the tube is provided for each key, so as to pass therethrough the light from the light source to the light-sensitive variable resistor, the tube being adapted to be deformed by depressing the associated key to an extra extent from its lower set position so as to control the quantity of light from the light source incident on the light-sensitive variable resistor, thereby producing a signal corresponding to the incident light from the light-sensitive variable resistor, the signal thus produced being used to add a musical effect such as tremolo to the musical sound produced from the loudspeaker.

A still another object of the invention is to provide a keyboard type electronic musical instrument, in which a flexible tube with a light source at one end of the tube and a light-sensitive variable resistor at the other end

thereof is provided for each key, the tube being adapted to be deformed by driving the associated tube toward left or right from its lower set position so as to control the quantity of light from the light source incident on the light-sensitive variable resistor, thereby to add such musical effect as tremolo to the musical sound produced from the loudspeaker.

A further object of the invention is to provide a keyboard type electronic musical instrument, in which the light source at one end of the individual flexible tubes as mentioned above are replaced with respective optical fibers arranged to face a common light source, so that the control of the individual light-sensitive variable resistors may be done with a single light source.

A still further object of the invention is to provide a keyboard electronic musical instrument, in which the lower set position of each key when the key is depressed is determined by an associated stopper also serving as a key guide and extending from the keyboard frame supporting the keys and the upper position of the key that is recovered by releasing the key is determined by the engagement between a U-shaped member provided to the key and the stopper, thus permitting ready adjustment of the horizontal of the top of the keys.

The features which are believed to be novel and characteristic of this invention are set forth particularly in the appended claims. The invention itself, however, together with further ogjects and advantages thereof, will be best understood from the following description taken in conjunction with the accompanying drawings which illustrate, by way of example only, some preferred embodiments of the invention and throughout which like reference characters designate like parts.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view showing an example of the keyboard section of the keyboard type electronic musical instrument embodying the invention.

FIG. **2** is a view taken along line II—II in FIG. **1**.

FIG. **3** is a sectional view, to an enlarged scale, showing stopper and U-shaped member in the construction shown in FIG. **1**.

FIG. **4** is a schematic representation of an example of the electric circuit in the sound producing system of the keyboard type electronic musical instrument according to the invention.

FIG. **5A** is a view similar to FIG. **1** but showing the key in its lower set position.

FIG. **5B** is a view taken along line *b—b* in FIG. **5A**.

FIG. **6A** is a view similar to FIG. **1** but showing the key in its position at which the associated flexible tube is deformed to the utmost.

FIG. **6B** is a view taken along line *b—b* in FIG. **6A**.

FIG. **7** is a view similar to FIG. **1** but showing a different embodiment of the keyboard type electronic musical instrument according to the invention.

FIG. **8A** is a view showing the relation between tube operating member and flexible tube obtained when the key shown in FIG. **7** is driven toward right of the keyboard from the lower set position of the key.

FIG. **8B** is a view taken along line *b—b* in FIG. **8A**.

FIG. **9A** is a view showing the relation between tube operating member and flexible tube obtained when the

key shown in FIG. 7 is driven toward left of the keyboard from the lower set position of the key.

FIG. 9B is a view taken along line *b—b* in FIG. 9A.

FIG. **10** is a view showing a modification of the expression control means of the keyboard type electronic musical instrument according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention will now be described in connection with preferred embodiment thereof with reference to the drawings.

FIG. **1** shows an example of the keyboard section of a keyboard type electronic musical instrument embodying the invention. Referring to the Figure, there is shown a key **10,** which horizontally extends above a key support frame **12** with its rear portion made integral with a key arm **14** by means of bolts **13.** The underside of a rear end portion of the key arm **14** is pivotably supported on top of a support member **15** integral with the rear end of the frame **12** such that the key **10** is pivotable in the vertical direction. The front end **10***a* of the key **10** is always upwardly urged by a biasing tensile spring **16** having one end connected to the rear end of the key arm **14** and the other end connected to the lower end **15***a* of the support member **15.**

Numeral **17** designates a support base, which is provided to the frame **12** such that it faces the underside of front part of the key **10.** A flexible hollow tube **18** extending in the longitudinal direction of the key **10** has its opposite ends secured to the top of the support base **10** by retaining members **19** and **20.** The flexible tube is made of rubber or other suitable material, preferably having resiliency. A light source **21** such as a lamp or a luminescent diode is inserted in the tube **18** at one open end thereof, and a light-sensitive variable resistor such as CdS is inserted in the tube **18** at the other open end thereof.

A tube operating member **23** vertically depends from the underside of the key **10** and faces a central portion of the tube **18.** As shown in FIG. **2,** the tube operating member **23** is formed at its lower end with an arcular notch **23***a*, which is adapted to engage with the tube **18.** When the key **10** is depressed in excess of its lower set position, the tube **18** is compressed and deformed by the tube operating member **23,** so that the passage formed in the tube changes its effective cross sectional area through which the light from the source **21** falls upon the light-sensitive variable resistor **22,** whereby the quantity of light from the light source **21** incident on the light-sensitive variable resistor **22** may be controlled.

A cushioning member **24** of such material as felt or sponge rubber is provided in a recess formed in the support base **17** such that it faces the tube operating member **23** so that the downward movement of the key and the compression of the tube **18** may be smoothly effected.

As is shown most clearly in FIG. **3,** a central portion of the underside of the key **10** is formed with a guide recess **25,** in which there extends a stopper **26** secured by bolt **27** to the frame **12.** The stopper **26** has an upper horizontal portion **26***a* extending within the guide recess **25** and facing the upper bottom **25***a* of the recess **25.** The key **10** is also provided with a downward projection **28** adjacent the guide recess **25,** and a U-shaped member **29** is secured by bolt **30** to the projection **29.** The U-shaped member **29** is made from a strip-like member and has horizontally extending end portions **29***a* and **29***b*. The U-shaped member **29** is secured to the key **10** with the horizontal end portion **29***a* secured by bolt **30** to the projection **28.** The other horizontal end portion **29***b* of the U-shaped member **29** extends within the guide recess **25** and faces the underside of the upper horizontal portion **26***a* of the stopper **26.** The U-shaped member **29** is also formed with a hole **29** at the center of its U-shaped portion. The upper and lower sides of the upper horizontal portion **26***a* of the stopper **26** are provided with respective cushioning member **31** of such material as felt. At the time of depressing the key **10,** it assumes its lower set position when the upper bottom **25***a* of the guide recess **25** strikes the upper horizontal portion **26***a* of the stopper **26.** When the force depressing the key **10** is removed, the key is upwardly rotated about the top of the support member **15** by the restoring force of the tensile spring **16,** and its initial upper set position is recovered by the engagement of the horizontal portion **29***b* of the U-shaped member **29** with the upper horizontal portion **26***a* of the stopper **26.**

To adjust the upper set position of the key **10,** the level of the horizontal portion **29***b* may be adjusted by deforming the U-shaped member **29** with a rod-like tool inserted through the hole **29***c* in the U-shaped member **29.** In this way, the level of the top of the individual keys **10** may be aligned.

Numeral **32** designates a key switch mounted on the frame **12** and having an actuator **32***a* penetrating the frame **12** upwardly and adapted to be operated by an operating piece **14***a* provided on the key arm **14.** By depressing the key **10** the contacts S of the key switch **32** is closed by the actuator **32***a*, whereby a corresponding sound source signal is selectively taken out from the sound source oscillating circuit as is well known in the art.

FIG. **4** shows an electric circuit of the expression or additional performance effect control system of the electronic musical instrument including the aforementioned light source **21** and light-sensitive variable resistor **22.** The light-sensitive variable resistor **22** provided to face the light source **21** through the tube **18** is connected with a resistor R_1 between the base and collector of a transistor Tr constituting an amplifier. A power supply E is connected between the emitter of the transistor Tr and the juncture between the light-sensitive variable resistor **22** and resistor R_1.

The connection point *a* between the collector of the transistor Tr and the resistor R_1 is connected through resistors R_2 and R_3 to the gate of a field-effect transistor **33** (hereinafter referred to as FET).

The FET **33** forms a sort of amplitude control circuit, with its drain D connected through the key switch **32** to a sound source oscillator **34** and its source S connected through a tone circuit **35** and an amplifier **36** to a loudspeaker **37.**

The juncture between the resistors R_2 and R_3 constituting the gate circuit of the FET **33** is connected to a gate bias terminal T, to which a suitable bias voltage is impressed; for example, a predetermined bias signal is supplied from an expression control means (not shown).

The operation of the electronic musical instrument of the above construction according to the invention will now be described.

When the key **10** is depressed to its lower set position, that is, to an extent without the flexible tube **18** deformed by the tube operating member **23,** the actuator **32***a* of the switch **32** is lowered by the operating piece **14***a* with the rotation of the key **10** about the top of the support member **15,** thus turning on the key switch **32.**

As a result, a signal corresponding to the depressed key **10** is coupled from the sound source oscillator **34** through the key switch **32** and the amplification control FET **33** to the tone circuit **35.**

In the tone circuit **35** the input signal is converted into a tone signal of a desired timer such as flute timber or string timber. The output of the tone circuit **35** is amplified through the amplifier **36,** whose output is in turn coupled to the loudspeaker **37,** which produces the corresponding musical sound.

In the above operation, the tube **18** is not deformed by the tube operation member **23** at all, and the quantity of light from the light source **21** incident on the light-sensitive variable resistor **22** is not reduced. Therefore, the internal resistance of the light-sensitive variable resistor remains low enough to hold the base potential on the transistor Tr sufficiently high to have the transistor Tr "on" and hold the point *a* at the earth potential.

In this case, no expression control signal is added to the gate G of the FET **33,** that is, no additional performance effect is added to the sound produced from the loudspeaker **37.**

However, since a predetermined gate bias prevails at the terminal T and is applied to the gate G of the FET **33,** sound of a predetermined volume is produced from the loudspeaker **37.**

If a desired performance effect is to be added in performance, for instance if it is intended to vary the volume of each tone produced by depressing each key, the force of depressing the keys may be varied as in the ordinary piano performance.

More particularly, to impart an additional performance effect the key **10** initially in the position indicated by the broken line in FIG. **5**A is depressed into the position of the solid line so that the lower end of the tube operating member **23** touches and pushes the cushioning member **24.** By so doing, the tube **18** is slightly deformed by the tube operating member **23** as shown in FIG. **5**B, so that the quantity of light from the light source **21** incident on the light-sensitive variable resistor **22** is reduced. As a result, the internal resistance of the light-sensitive variable resistor **22** is increased from the value in the afore-mentioned non-deformed state of the tube **18,** so that the base potential on the transistor Tr is reduced from the afore-mentioned value.

Thus, the impedance between the collector and emitter of the transistor Tr is increased, so that a positive voltage corresponding to the extent of deformation of the tube **18** appears at the point *a*. This voltage is impressed in superimposition upon the bias signal prevailing at the terminal T upon the gate of the FET **33** to reduce the impedance between drain and source of the FET **33** so as to increase the amplitude of the input to the tone circuit **35.** In this way, the volume of sound produced from the loudspeaker is increased.

When the key **10** is further depressed from its position of broken line in FIG. **6**A to the position of the solid line, the lower end of the tube operating member **23** further thrusts itself into the cushioning member **24** and deforms the tube **18** to such an extent that a slit-like light passage is formed. Thus, the quantity of light from the light source **21** incident on the light-sensitive variable resistor **22** is extremely reduced to widely increase the internal resistance of the light-sensitive variable resistor **22.**

With further increase of the internal resistance of the light-sensitive variable resistor **22** the base potential on the transistor Tr is further reduced to further increase the collector-emitter impedance thereof, so that the collector potential at point *a* is extremely increased (to be substantially equal to the source voltage E). As positive voltage appearing at point *a* goes through the resistors R_2 and R_3 to the gate of the FET **33,** the drain-source impedance thereof is further reduced to further increase the amplitude of the input to the tone circuit **35,** thus further increasing the volume of sound produced from the loudspeaker **37.**

As has been shown, it is possible to vary the volume of sound produced from the loudspeaker, that is, add the tremolo effect to the output sound, by varying the force of depressing the keys **10.**

FIG. **7** shows another embodiment of the keyboard type electronic musical instrument according to the invention. This embodiment enables the additional performance effect control by driving the key toward left or right from its lower set position. Similar to the arrangement of FIG. **1,** a flexible tube **38** is provided on support base **17** secured to key support frame **12.** The tube **38** is made of such material as synthetic rubber, and its opposite ends are secured by retaining members **39** and **40** to the base **17.** In this embodiment, an intermediate portion of the tube **38** extending between the retaining members **39** and **40** is capable of lateral displacement. Again similar to the arrangement of FIG. **1,** light source **21** is provided in the tube **38** at one end thereof, and light-sensitive variable resistor **22** is provided in the tube at the other end thereof.

A tube operating member **41** vertically depends from the underside of the key **10.** As shown in FIG. **8**A, it is formed at its lower end with a notch **41***a*, which is adapted to engage with the tube **38.** The depth of the notch **41***a* is sufficiently greater than the outer diameter of the tube **38,** so that the tube **38** will not be deformed by the tube operating member **41** even if the notch **41***a* engages the tube **38** with the key depressed into contact with stopper **26.**

In FIG. **7,** like parts to those in FIG. **1** are designated by like reference numerals and are not described in any further detail. It should, however, be noted that the type of the key as shown in FIG. **7** permits the transverse or left and right movement thereof to some extent, besides the usual vertical or up and down movement is effectively employed in this embodiment.

The additional performance effect control circuit employed in this embodiment has the same construction as that of FIG. **4,** so the operation of this embodiment will now be described with reference to FIG. **4.**

In the ordinary performance without giving any additional performance effect, by depressing the key **10** the actuator **32***a* of the key switch **32** is lowered by the operating piece **14***a* with the rotation of the key **10** about

the top of the support member **15,** thus turning on the key switch **32.**

As a result, a signal corresponding to the depressed key **10** is coupled from the sound source oscillator **34** through the key switch **32** and the amplification control FET **33** to the tone circuit **35.**

In the tone circuit **35** the input signal is converted into a tone signal of a desired timber such as flute timber or string timber. The output of the tone circuit **35** is amplified through the amplifier **36,** whose output is in turn coupled to the loudspeaker **37,** which produces the corresponding musical sound.

In the above operation, the tube **38** is not deformed by the tube operating member **41** at all, so that no additional performance effect is produced similar to the case of the previous embodiment of FIG. **1.**

If a desired performance effect is to be added in the performance, for instance if it is intended to add a tremolo effect, the depressed key **10** may further be driven toward left or right from its lower set position. When the key **10** is driven in the lateral direction, the tube **38** engaged by the notch **41***a* of the tube operating member **41** is curved in the lateral direction as shown in FIG. **8B** or **9B.** Thus, the quantity of light from the light source **21** incident on the light-sensitive variable resistor **22** can be varied according to the state of the tube **18** between its straight state in which the incident light is maximum and its fully curved state in which the incident light is zero.

With change in the incident light on the light-sensitive variable resistor **22,** its internal resistance is varied to vary the base potential on the transistor Tr, thus varying the extent of conduction of the transistor Tr and hence the collector-emitter impedance thereof. Thus, a voltage corresponding to the collector-emitter impedance of the transistor Tr appears at point *a.* This voltage is impressed in superimposition upon the bias signal prevailing at the terminal T upon the gate of the FET **33,** thus varying the drain-source impedance of the FET **33.** Thus, the drain current through the FET **33,** that is, the output signal from the sound source oscillator **34,** is amplitude controlled, and the amplitude controlled signal is coupled through the tone circuit **35** and amplifier **36** to the loudspeaker **37,** so that a tremolo effect will be added to the sound produced from the loudspeaker **37.**

While the preceding embodiments of FIGS. **1** and **7** have been detailed in connection with the case of obtaining a tremolo effect, this is by no means limitative, and the invention may also be employed for such control as producing vibrato, glide and other additional performance effects.

FIG. **10** shows a modification of the additional performance effect means of the keyboard type electronic musical instrument according to the invention. In this arrangement, each flexible tube provided for each key **10** is provided at one end with an optical fiber **43** capable of guiding light and at the other end with a light-sensitive variable resistor **22.** The individual optical fibers **43** are bundles at their end remote from the flexible tubes **42.** A lamp **45** is disposed to face the bundled end **44** of the optical fibers **43,** so that light from the lamp **45** may be guided through the optical fibers to the respective flexible tubes **42.**

In this construction, only a single lamp is needed for the control of the individual light-sensitive variable resistors **22.**

I claim:

1. A keyboard type electronic musical instrument comprising a plurality of keys mounted depressably in the vertical direction on a key support frame, a plurality of light guide members each provided for each key, each said light guide members having a passage through which light can travel, and being deformable to change the effective cross sectional area of the passage and provided at one end with a light-sensitive variable resistor and at the other end with a light source, the underside of each said key being provided with an operating member adapted to deform the associated light guide member when the associated key is depressed from a lower set position thereof to thereby control the quantity of light from the light source incident on the light-sensitive variable resitor, an additional performance effect control circuit controlled by electric signals from said individual light-sensitive variable resistors, a sound producing system connected to said performance effect control circuit, and

switches each operated by depressing an associated key, said switches being connected between sound sources and said performance effect control circuit.

2. The keyboard type electronic musical instrument according to claim **1,** wherein each said light guide member is a tube having resiliency.

3. The keyboard type electronic musical instrument according to claim **1,** wherein each said operating member is formed at the lower end thereof with a notch adapted to engage with the associated light guide member.

4. The keyboard type electronic musical instrument according to claim **1,** wherein said individual light guide members are arranged with their longitudinal direction aligned to the longitudinal direction of the respective keys and supported on respective support bases, each said light guide member having its opposite ends secured to the associated support base by retaining members.

5. A keyboard type electronic musical instrument comprising a plurality of the keys mounted depressably in the vertical direction on a key support frame, a plurality of light guide members each provided for each key, each said light guide member having a passage through which light can travel, and being deformable to change the effective cross sectional area of the passage and provided at one end with a light-sensitive variable resistor and at the other end with a light source, the underside of each said key being provided with an operating member adapted to deform the associated light guide member laterally when the associated key is driven in the lateral direction from a lower set position thereof to thereby control the quantity of light from the light source incident on the light-sensitive variable resistor, an additional performance effect control circuit controlled by electric signals from said individual light-sensitive variable resistors, a sound producing system connected to said performance effect control circuit, and switches each operated by depressing an associated key, said switches being connected between sound sources and said performance effect control circuit.

6. The keyboard type electronic musical instrument according to claim **5,** wherein each said light guide member is a tube having resiliency.

7. The keyboard type electronic musical instrument according to claim **5,** wherein each said operating

member is deformed at the lower end thereof with a notch adapted to engage with the associated light guide member.

8. The keyboard type electronic musical instrument according to claim **5,** wherein said individual light guide members are arranged with their longitudinal direction aligned to the longitudinal direction of the respective keys and supported on respective support base, each said light guide member having its opposite ends secured to the associated support base by retaining members and its intermediate portion extending between said retaining members capable of being deformed in the lateral direction.

9. A keyboard type electronic musical instrument comprising a plurality of keys mounted depressably in the vertical direction on a key support frame, a plurality of light guide members each provided for each key, each said light guide member having a passage through which light can travel, and being deformable to change the effective cross sectional area of the passage and provided at one end with a light-sensitive variable resistor and at the other end with an optical fiber, the individual optical fibers being bundled at their end remote from the light guide members, a light source disposed to face the bundled end of said optical fibers, the underside of each said key being provided with an operating member adapted to deform the associated light guide member when the associated key is driven at a lower position thereof to thereby control the quantity of light from said light source incident on the associated light-sensitive variable resistor, an additional performance effect control circuit controlled by electric signals from said individual light-sensitive variable resistors, a sound producing system connected to said performance effect control circuit, and switches each operated by depressing an associated key, said switches being connected between sound sources and said performance effect control circuit.

10. The keyboard type electronic musical instrument according to claim **9,** wherein each said light guide member is a tube having resiliency.

11. The keyboard type electronic musical instrument according to claim **1,** wherein each said operating member is formed at its lower end with a notch adapted to engage with the associated light guide member.

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