ELECTRONIC MUSICAL INSTRUMENT WITH A KEYBOARD DEVICE CAPABLE OF PRODUCING SPECIAL MUSICAL EFFECTS UPON KEY DEPRESSION

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ABSTRACT

In an electronic musical instrument, a keyboard device comprises a flexible and substantially non-extensible tape elastically supported on a keyboard frame below playing keys, and a first and a second detectors at both ends of the tape to generate electrical signals each having an amplitude corresponding to the amount of displacement of each tape end. The electric signals from the first and second detectors are supplied to a signal adder and a signal subtractor, the adder giving out signals when the both tape ends move inward and the subtractor giving out signals when one tape end moves inward and the other end outward. The output from the adder is supplied to a volume control circuit, while the output from the subtractor is supplied to a vibrato effect producing circuit. On this instrument, a downward depression of the key produces an expression control effect, and a lateral movement of the key produces a vibrato effect.

19 Claims, 4 Drawing Figures
FIG. 1

FIG. 2
ELECTRONIC MUSICAL INSTRUMENT WITH A KEYBOARD DEVICE CAPABLE OF PRODUCING SPECIAL MUSICAL EFFECTS UPON KEY DEPRESSION

Background of the Invention

This invention relates to an electronic musical instrument and more particularly to a keyboard device for producing special musical effects upon key depression. With a conventional electronic musical instrument such as an electronic organ, one or more keyboard devices are provided solely for deriving tone signals from tone generators selectively upon key depression through key switch means associated with the respective keys depressed. Accordingly, it was impossible to produce various musical effects such as vibrato, tremolo and volume control (i.e. expression control) by key operation alone. To effect volume control, for example, the conventional electronic musical instrument is provided with a separate control means such as an expression pedal operated by a foot during key operation by hand fingers. However, an electronic musical instrument is desired to produce the various musical effects as mentioned above by key operation alone, irrespective of whether there is used a separate control means.

Summary of the Invention

It is, accordingly, the object of this invention to provide an electronic musical instrument comprising a keyboard device capable of producing various musical effects by the vertical movement of a key and the intentional lateral shaking of the key while being depressed.

In accordance with this invention, there is disposed a flexible non-extendible tape below the keys constituting a keyboard, the tape being extended in the transverse direction of the keys. The tape is mounted on a keyboard frame supporting the keyboard at such a height that the key, when depressed, comes in contact with the tape and bends it. There are further provided first and second detectors at both ends of the tape to generate electrical signals each having an amplitude corresponding to the amount of displacement of each tape end due to key depression. The outputs from the first and second detectors are supplied to a signal adder or signal adding circuit and a signal subtractor or signal subtracting circuit, the output from the adder responsive to the vertical movement of the key is supplied to an amplifier to control the gain thereof, and the output of the subtractor responsive to the lateral movement of the key depressed is conducted to tone generators to frequency-modulate the tone signals.

Brief Description of the Drawings

FIG. 1 is a schematic side view of a keyboard device according to this invention;
FIG. 2 is a sectional view taken along line II—II in FIG. 1 and shown in a reduced scale;
FIG. 3 is a block diagram of an electronic musical instrument using the keyboard device of the invention; and
FIG. 4 is a fragmentary sectional view showing a modification of FIG. 2.

Description of the Preferred Embodiments

Referring to FIG. 1, a plurality of keys 11 constituting a keyboard are, as is well known, rockably supported at the rear end by a frame 12 and are arranged in juxtaposed relationship. To the underside of the frame 12 is fitted a switch box 13, which contains key switches associated with the respective keys. Upon key depression, the key switch is actuated by an actuating rod 14 disposed below the key, thereby drawing a tone signal from tone generators corresponding to the key depressed. The key 11 has a projection or stop 15 formed on the front underside thereof. On that part of the frame 12 which faces the underside of the projection 15 is fixed an elongated elastic member 16 made of, for example, foam rubber or sponge at a prescribed space from the projection 15. The elastic member 16 has such a height that when contacted by a key upon its depression, the surface of the member 16 is elastically deformed. On the top of the member 16 is mounted a flexible but substantially non-extendible elongated tape 17 made of, for example, metal or plastic material. Both ends of the tape 17 are secured to the side walls 18 of the frame 12 or support rods set-up on the frame 12 with a proper degree of tension by means of springs 19. If the tape is made of relatively rigid material, the springs 19 may be well substituted by strings. At both ends of the tape 17 near the springs 19 are disposed first and second electrical detectors 20 and 21 for detecting the amount of lengthwise displacement of the tape. The electrical detector 20 or 21 may consist of, for example, a variable capacitor, variable resistor, variable inductor, photoelectric element, piezoelectric element (such as shown in U.S. Pat. No. 3,562,399, for example) and the like.

After the key is depressed to contact the tape 17, a further depression of the key makes the surface of the elastic member 16 to be deformed, as shown in FIG. 2, according to the magnitude of a key-depressing force. As a result, the tape 17 mounted on the elastic member 16 is flexed and the both ends are displaced in the directions indicated by arrows 22 and 23, that is, in opposite directions. At this time there are obtained from the detectors 20 and 21 at both ends of the tape 17 electrical signals corresponding to the amount of displacements of the respective ends of the tape 17. The detectors 20 and 21 are so designed as to generate signals having the same amplitude when the both tape ends move by the same amount.

The electrical signals obtained from the detectors 20 and 21 may either have the same polarity or have opposite polarities when both ends of the tape 17 are displaced in the directions indicated by the arrows 22 and 23, namely, when the key 11 is pressed simply downward.

Where, however, the key is intentionally shaken sidewise while being depressed, the tape ends move in the same direction, as, for example, one end moves inward when the other moves outward and vice versa, assuming a different aspect in the signal-polarity relationship. In the case where signals having the same polarity are obtained from the detectors 20 and 21 by the simple downward depression of the key, the detectors 20 and 21 generate signals of opposite polarities if the key is intentionally shaken sidewise during the key depression. On the contrary, in the case where signals having
opposite polarities are obtained from the detectors by the simple downward depression of the key, the detectors 20 and 21 generate signals of the same polarity if the key is shaken sidewise while being depressed.

FIG. 3 is a schematic block diagram of an electronic musical instrument using the keyboard device of this invention. Tone signals from tone generators 30 are conducted by operation of a keyboard 32 through a keyer 31, tone coloring filter 33 and amplifier 34 in turn and finally to a loudspeaker 35. Now, it will be assumed that the detectors 20 and 21 are so arranged that they generate signals of the same polarity when the key 11 is depressed simply downward and that they generate signals of opposite polarities when the key is shaken sidewise. The signals generated by the detectors 20 and 21, are supplied to a signal adder or signal adding circuit 36 (such as adder 13 of U.S. Pat. No. 3,443,463 issued May 13, 1969) where the amplitudes of the signals are added, and a signal substractor or signal subtracting circuit 37 where the amplitudes of the signals are subtracted. A typical subtractor for use in the present invention may be the combination of the adder 13 and inverter 12 as shown in FIG. 1. of U.S. Pat. No. 3,443,463, issued May 13, 1969. The output from the adder 36, which is obtained corresponding to the simple downward depression of the key, is conducted to an amplifier 34 to have its amplification factor or gain controlled. The output from the substractor 37, which is obtained corresponding to the lateral movement or shaking of the key being depressed, is supplied to the tone generator 30 to frequency-modulate output tone signals therefrom. Control of the amplifier 34 can be fully effected by an automatic gain control system used in an ordinary type of amplifier. Control of the tone generator can be carried out in the same manner as that of the vibrato effect used in an ordinary electronic musical instrument. Further, there can be produced tones of different timbre by varying, as shown by the dotted line 38 of FIG. 3, the inductance of a variable inductor constituting the tone coloring filter 33 or the capacitance of a variable capacitor by the output from the adder 36.

The keyboard device of this invention arranged as described above causes upon light key depression the aforesaid projection 15 simply to contact the elastic member 16 without causing any displacement of the tape 17, thus producing usual musical notes alone. However, in the case of the full depression of a key, the deformation of the elastic member 16 is caused with the resultant deflection of the tape 17, and the both ends of the tape 17 are displaced in opposite directions, so that there are drawn out from the first and second detectors 20 and 21 signals of the same polarity and level in proportion to the degree in which the tape 17 is displaced. At this time the adder 36 generates control signals in proportion to the amount of displacement of the tape 17. When the gain of the amplifier 34 is controlled by the control signals, the volume of tones can be controlled according to the magnitude of the key depressing force. Although the simple downward depression of the key does not produce control signals from the substractor 37, the lateral shaking of the key while being depressed causes signals having opposite polarities to be generated from the first and second detectors 20 and 21, enabling the substractor to generate an output. Since the signals allow the substractor 37 to generate output, the lateral shaking of the key presents a vibrato effect. Of course, control signals from the substractor 37 can be used in obtaining a tremolo effect by feeding the signals at an amplitude-modulating circuit.

Unlike the case explained above, if the simple downward depression of a key causes the detectors 20 and 21 to generate signals of opposite polarities and the sidewise shaking of the key causes the detectors to produce signals of the same polarity, the output from the substractor, which is obtained corresponding to the simple downward depression of the key, is used to control tone volume or timbre, while the output from the adder, which is obtained corresponding to the sidewise shaking of the key, is used to control the vibrato or tremolo effect. In this case, of course, the substractor is connected to an amplifier or a tone coloring filter, and the adder is connected to a tone generator or an amplitude-modulating circuit.

FIG. 4 shows a modification of a keyboard device according to this invention. On the elastic member 16 is disposed a flexible piled tape 40. The underside of the projection 15 facing the tape 17 is bonded with another piled tape 41. The embodiment of FIG. 4 provides greater frictional resistance between the key 11 and tape 17, enabling particularly the vibrato or tremolo effect to be reliably controlled.

What is claimed is:
1. An electronic musical instrument comprising:
a keyboard frame;
a plurality of keys supported on said frame and arranged in juxtaposed relationship, said keys being movable both vertically downward and laterally; an elongated flexible and substantially non-extensible tape transversely disposed below said keys, the relative positions of said keys and tape being such that, when any one of said keys is depressed vertically downward, it comes into contact with said tape and flexes said tape, causing a lengthwise displacement of said tape; and
first and second detector means disposed respectively at both ends of said tape, each detector means generating an electric signal having a magnitude and polarity respectively corresponding to the amount and direction of said displacement of said tape, the vertical downward depression of said key causing both ends of said tape to be displaced in opposite directions and lateral shaking of said key causing said both ends of said tape to be displaced in the same direction.
2. The electronic musical instrument according to claim 1 wherein said flexible and substantially non-extensible tape is supported on an elongated elastic member.
3. The electronic musical instrument according to claim 1 wherein the signals generated by said first and second detector means have the same polarity when the both ends of said tape are displaced in opposite directions, and the signals generated by said detector means have opposite polarities when said both ends of said tape are displaced in the same direction.
4. The electronic musical instrument according to claim 1 wherein the signals generated by said first and second detector means have opposite polarities when
5 the both ends of said tape are displaced in opposite directions, and the signals generated by said detector means have the same polarity when said both ends of said tape are displaced in the same direction.

5. The electronic musical instrument according to claim 1 further comprising means coupled to said detector means, including a signal adder, output signals from said first and second detector means being coupled to said signal adder where said output signals are added, the output from said signal adder being used to provide a musical effect.

6. The electronic musical instrument according to claim 1 further comprising means coupled to said detector means, including a signal subtractor, output signals from said first and second detector means being coupled to said signal subtractor where said output signals are subtracted, the output from said signal subtractor being used to provide a musical effect.

7. The electronic musical instrument according to claim 3 further comprising means coupled to said detector means, including a signal adder, the output signals from said detector means being coupled to said signal adder where said output signals are added, the output from said signal adder being used to provide a musical effect.

8. The electronic musical instrument according to claim 3 further comprising means coupled to said detector means, including a signal subtractor, the output signals from said detector means being coupled to said signal subtractor where said output signals are subtracted, the output from said signal subtractor being used to provide a musical effect.

9. The electronic musical instrument according to claim 4 further comprising means coupled to said detector means, including a signal adder, the output signals from said detector means being coupled to said signal adder where said output signals are added, the output from said signal adder being used to provide a musical effect.

10. The electronic musical instrument according to claim 4 further comprising means coupled to said detector means, including a signal subtractor, the output signals from said detector means being coupled to said signal subtractor where said output signals are subtracted, the output from said signal subtractor being used to provide a musical effect.

11. The electronic musical instrument according to claim 1 further comprising means coupled to said detector means, including a signal adder, and a signal subtractor, the output signals from said first and second detector means being coupled to said signal adder and subtractor where said output signals are added and subtracted respectively, the outputs from said signal adder and subtractor being used to provide musical effects.

12. The electronic musical instrument according to claim 7 wherein said means coupled to said detector means further comprises an amplifier, the output from said signal adder being coupled to said amplifier to control tone volume.

13. The electronic musical instrument according to claim 8 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal adder being coupled to said tone coloring filter to control timbre.

14. The electronic musical instrument according to claim 9 wherein said means coupled to said detector means further comprises a tone generator, the output from said signal adder being coupled to said tone generator to produce a vibrato effect.

15. The electronic musical instrument according to claim 10 wherein said means coupled to said detector means further comprises an amplifier, the output from said signal subtractor being coupled to said amplifier to control tone volume.

16. The electronic musical instrument according to claim 11 wherein said means coupled to said detector means further comprises an amplifier, the output from said signal subtractor being coupled to said amplifier to control tone volume.

17. The electronic musical instrument according to claim 12 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

18. The electronic musical instrument according to claim 13 wherein said means coupled to said detector means further comprises a tone generator, the output from said signal subtractor being coupled to said tone generator to produce a vibrato effect.

19. The electronic musical instrument according to claim 14 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

20. The electronic musical instrument according to claim 15 wherein said means coupled to said detector means further comprises a tone generator, the output from said signal subtractor being coupled to said tone generator to produce a vibrato effect.

21. The electronic musical instrument according to claim 16 wherein said means coupled to said detector means further comprises an amplifier, the output from said signal subtractor being coupled to said amplifier to control tone volume.

22. The electronic musical instrument according to claim 17 wherein said means coupled to said detector means further comprises an amplifier, the output from said signal subtractor being coupled to said amplifier to control tone volume.

23. The electronic musical instrument according to claim 18 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

24. The electronic musical instrument according to claim 19 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

25. The electronic musical instrument according to claim 20 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

26. The electronic musical instrument according to claim 21 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

27. The electronic musical instrument according to claim 22 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

28. The electronic musical instrument according to claim 23 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

29. The electronic musical instrument according to claim 24 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

30. The electronic musical instrument according to claim 25 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

31. The electronic musical instrument according to claim 26 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

32. The electronic musical instrument according to claim 27 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

33. The electronic musical instrument according to claim 28 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

34. The electronic musical instrument according to claim 29 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

35. The electronic musical instrument according to claim 30 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

36. The electronic musical instrument according to claim 31 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

37. The electronic musical instrument according to claim 32 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

38. The electronic musical instrument according to claim 33 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

39. The electronic musical instrument according to claim 34 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

40. The electronic musical instrument according to claim 35 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

41. The electronic musical instrument according to claim 36 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

42. The electronic musical instrument according to claim 37 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

43. The electronic musical instrument according to claim 38 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

44. The electronic musical instrument according to claim 39 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

45. The electronic musical instrument according to claim 40 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

46. The electronic musical instrument according to claim 41 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

47. The electronic musical instrument according to claim 42 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

48. The electronic musical instrument according to claim 43 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

49. The electronic musical instrument according to claim 44 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

50. The electronic musical instrument according to claim 45 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

51. The electronic musical instrument according to claim 46 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

52. The electronic musical instrument according to claim 47 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

53. The electronic musical instrument according to claim 48 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

54. The electronic musical instrument according to claim 49 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.

55. The electronic musical instrument according to claim 50 wherein said means coupled to said detector means further comprises a tone coloring filter, the output from said signal subtractor being coupled to said tone coloring filter to control timbre.