

- [54] **ELECTRONIC MUSICAL INSTRUMENT**
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- [73] Assignee: **Nippon Gakki Seizo Kabushiki Kaisha**, Hamamatsu, Japan
- [22] Filed: **Apr. 3, 1974**
- [21] Appl. No.: **457,646**

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June 16, 1973	Japan.....	48-68172
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Sept. 11, 1973	Japan.....	48-106413

[52] **U.S. Cl.** 84/1.19; 84/1.24; 84/DIG. 8; 84/DIG. 9; 84/DIG. 20

[51] **Int. Cl.** G10h 1/00; G10h 5/00

[58] **Field of Search** 84/1.01, 1.09, 1.1, 1.11, 84/1.19, 1.24, 1.27, DIG. 2, DIG. 7, DIG. 20, 1.13, 1.22, 1.25, 1.26, DIG. 8, DIG. 9

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Attorney, Agent, or Firm—Cushman, Darby & Cushman

[57] **ABSTRACT**

An electronic musical instrument comprising: a tone generator including a voltage-controlled oscillator; a voltage-controlled filter for coloring tone signal; a voltage-controlled amplifier for imparting a desired envelope to the tone signal; voltage waveform generators for generating controlling voltage waveforms for the oscillator, filter and amplifier; and a waveform controller for controlling said controlling voltage waveforms by the use of voltage parameters representing the initial level, attack level, attack time, first decay time, sustain level, and second decay time, thereby controlling the generated musical sounds in a time-dependent manner easily and variously. The waveform controller can include a plurality of fixed and variable memories which can be easily pre-set and/or selected, or totally replaced.

8 Claims, 29 Drawing Figures

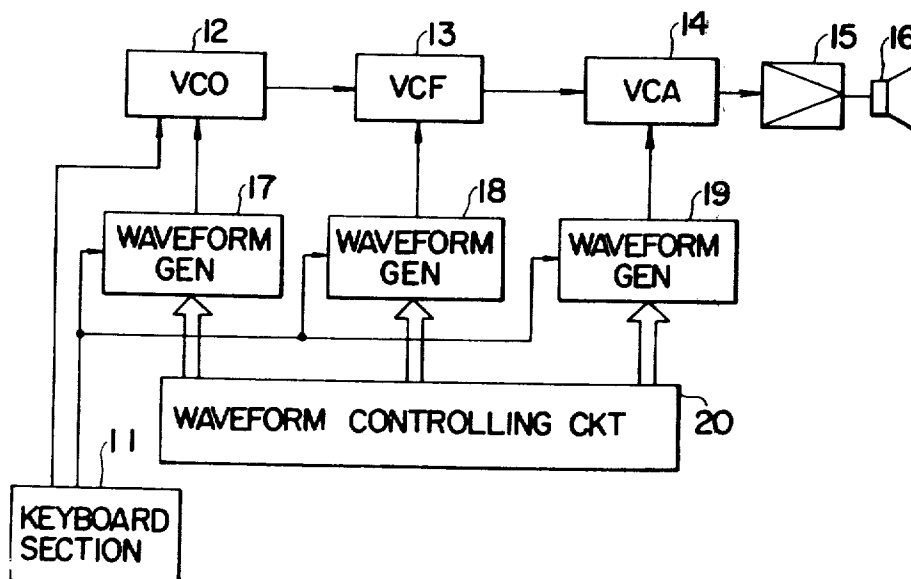


FIG. 1

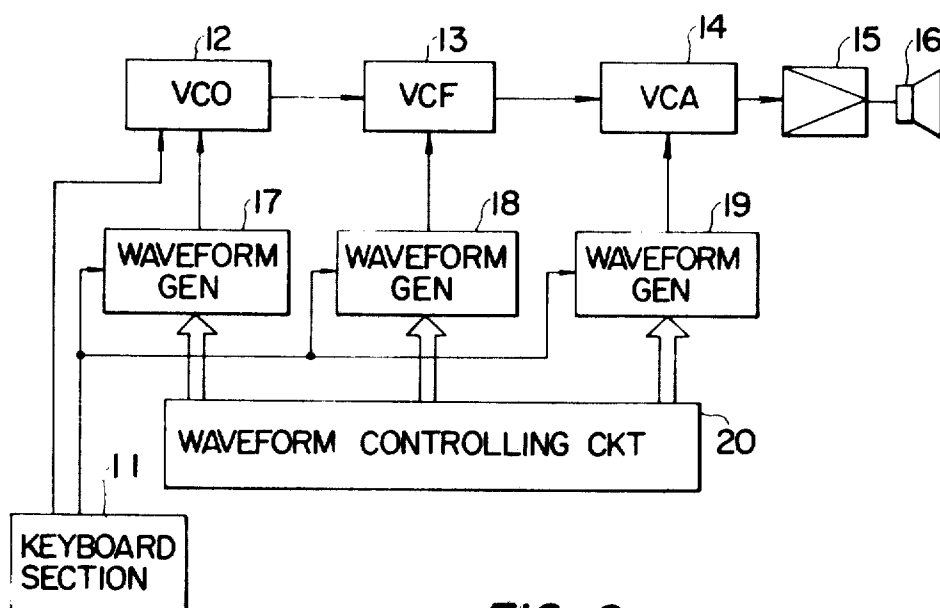


FIG. 2

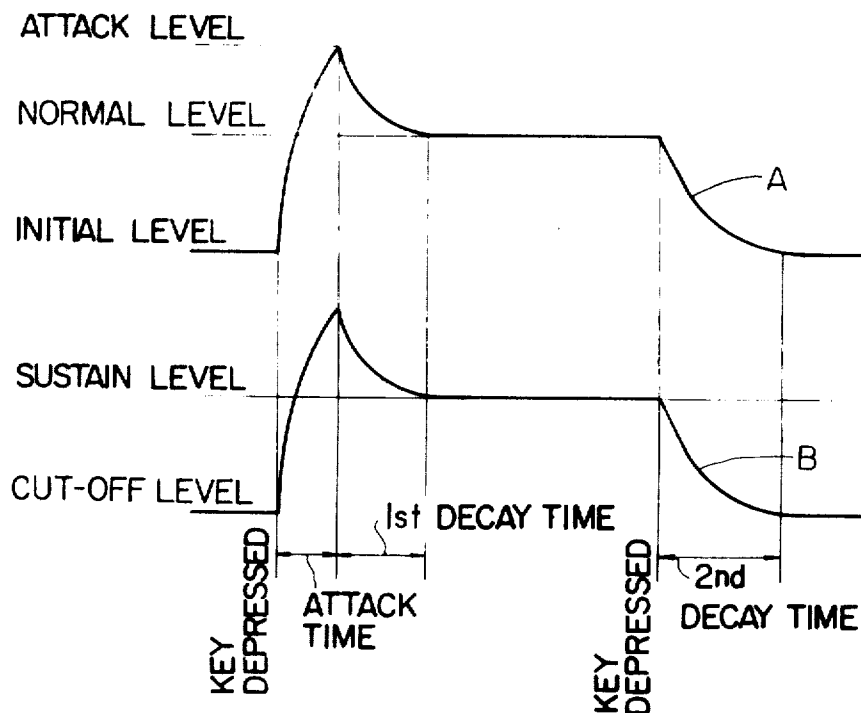


FIG. 3A

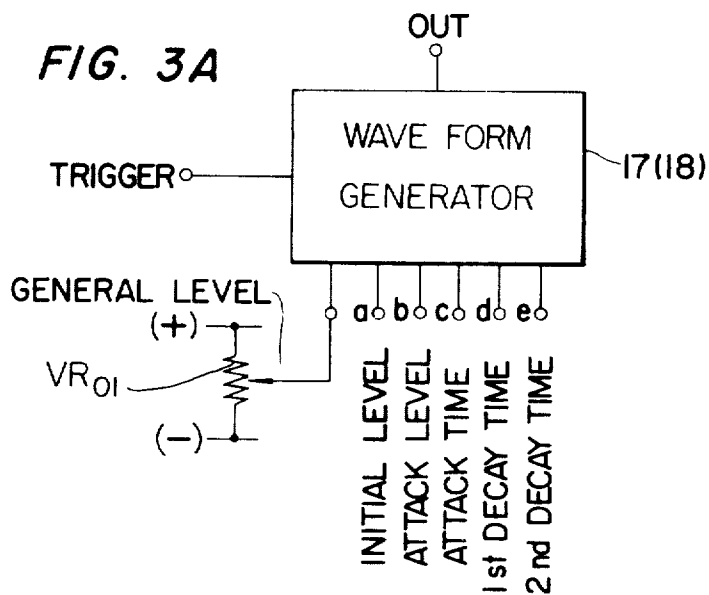


FIG. 3B

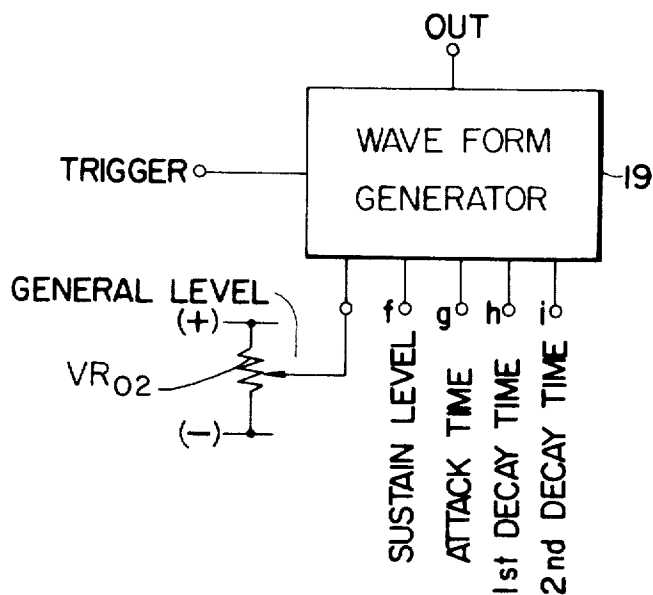


FIG. 4

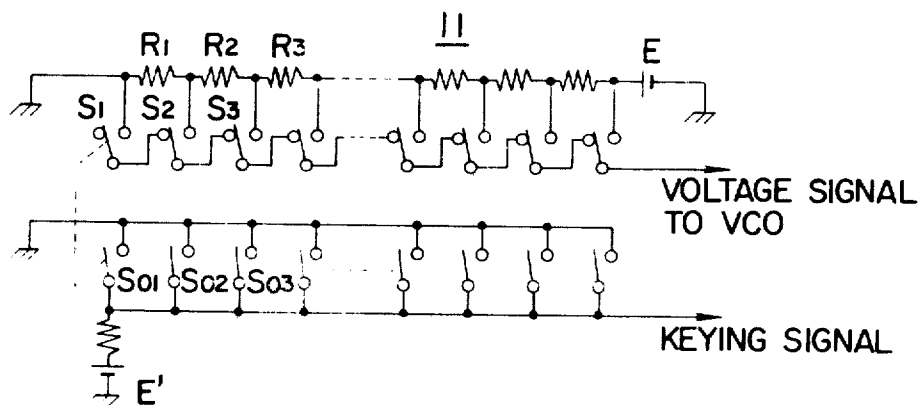


FIG. 5

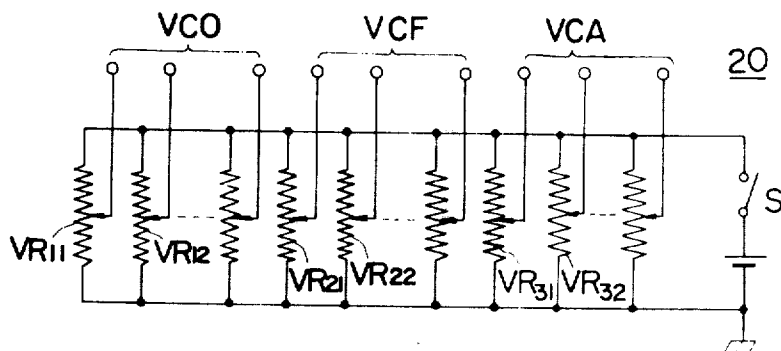


FIG. 6

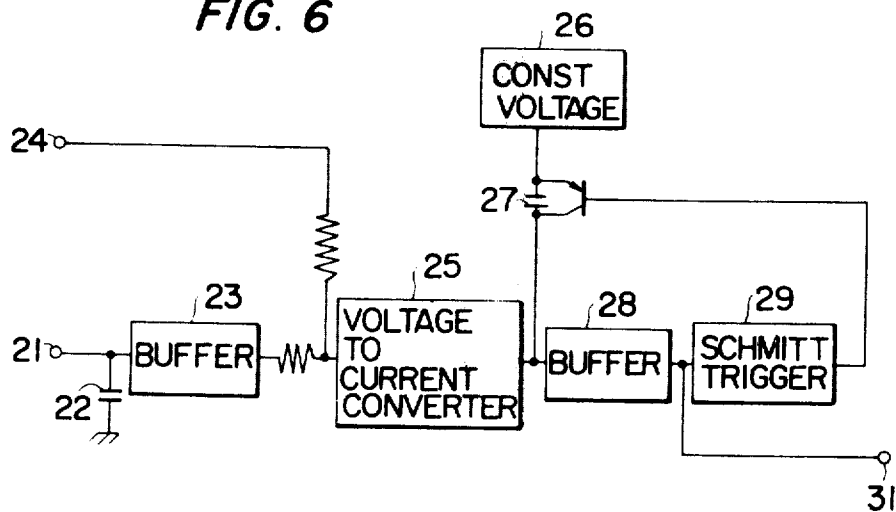


FIG. 7

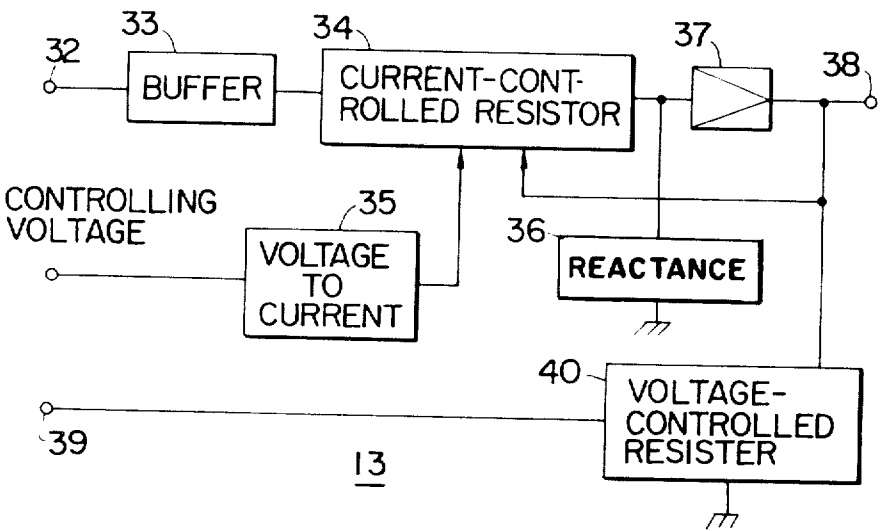
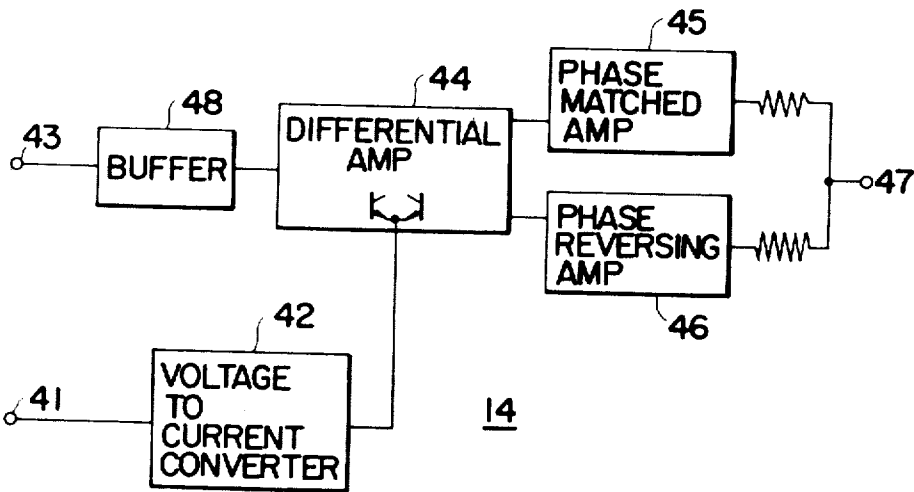


FIG. 8



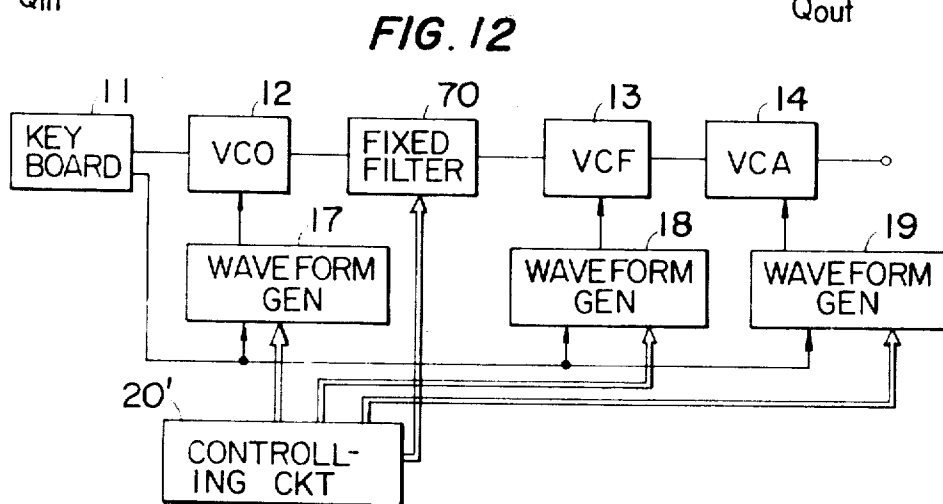
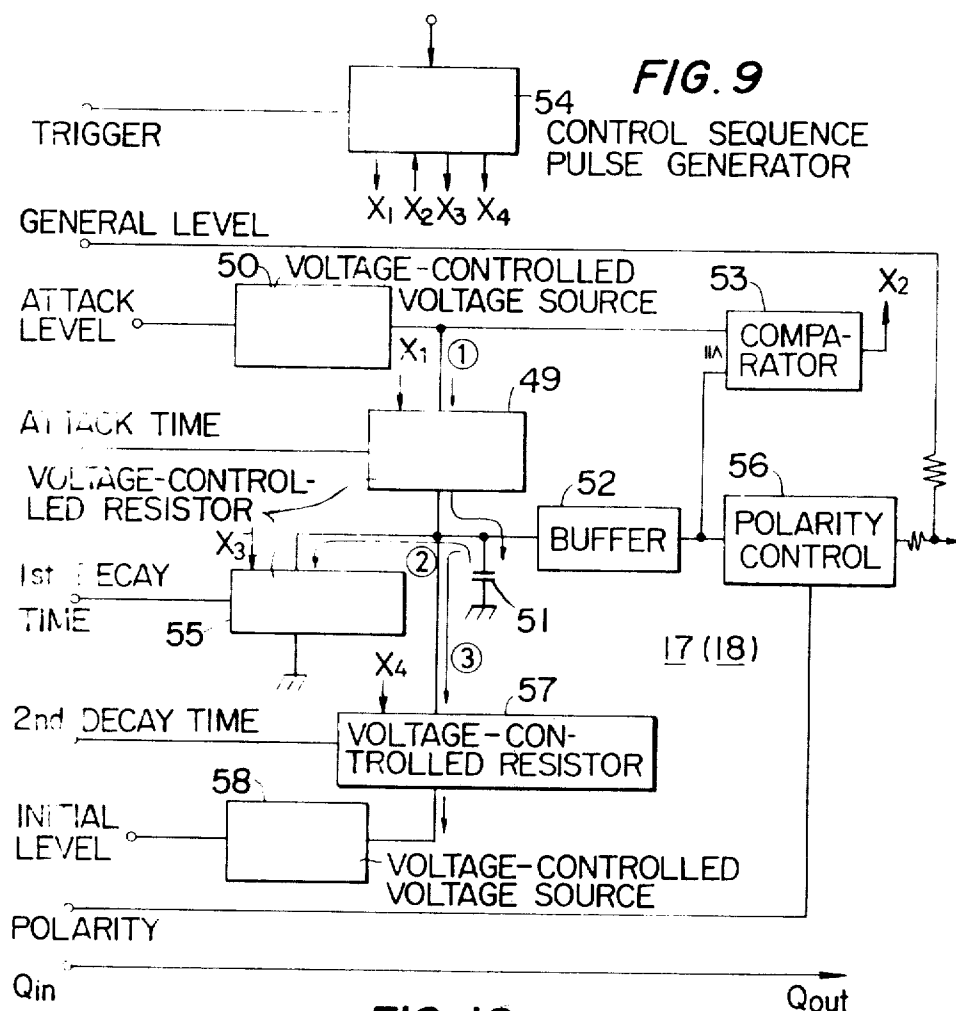


FIG. 10

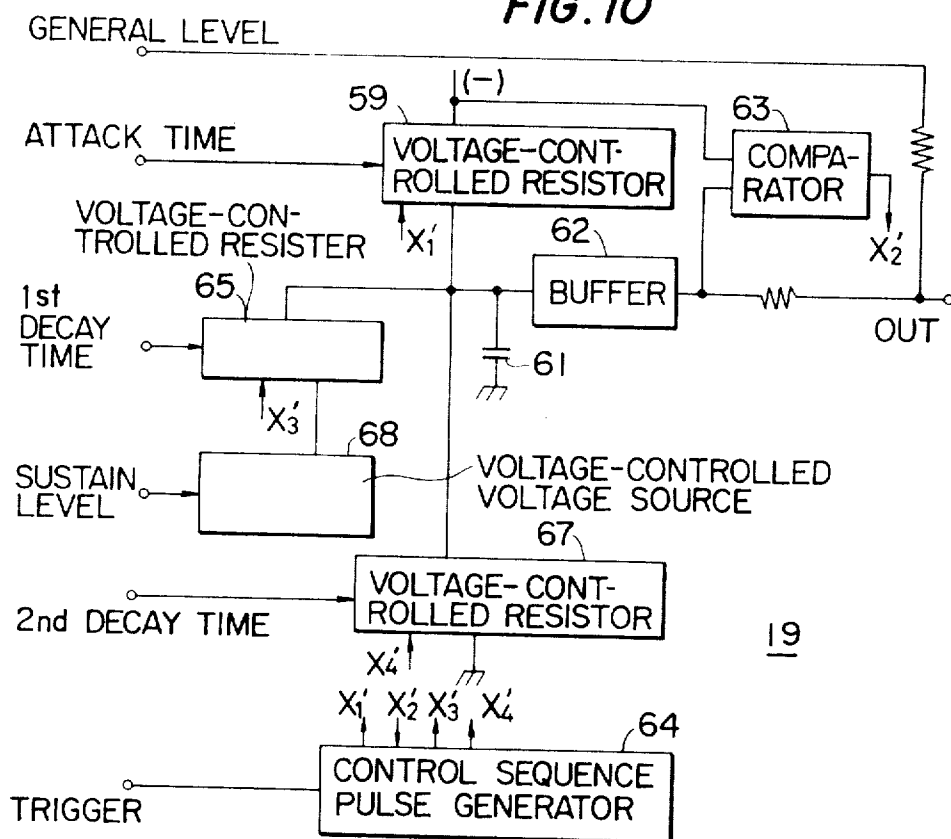


FIG. 11

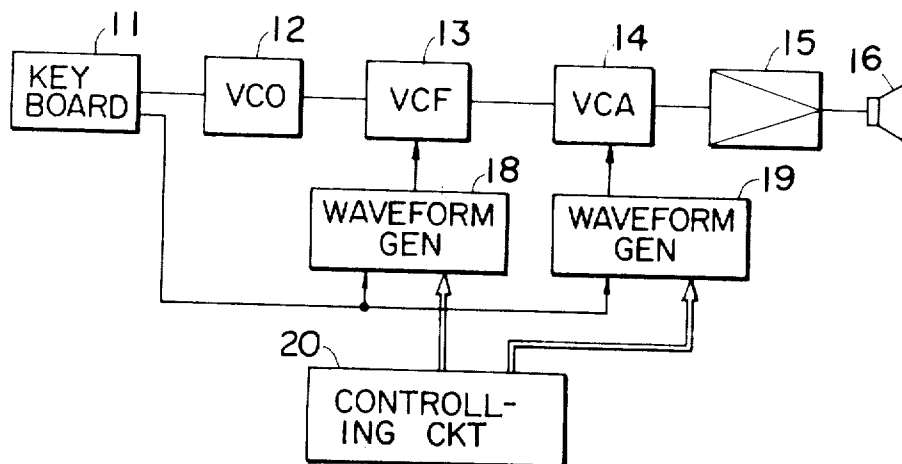


FIG. 13

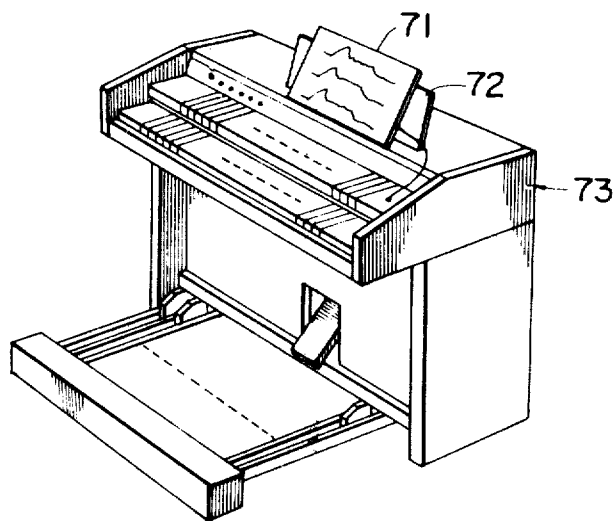


FIG. 14

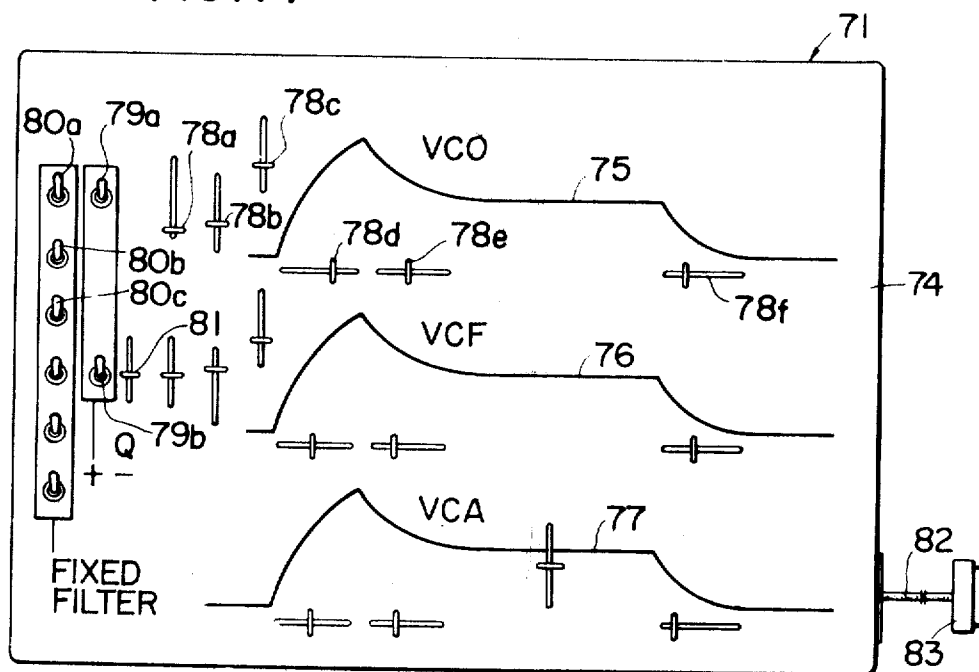


FIG. 15

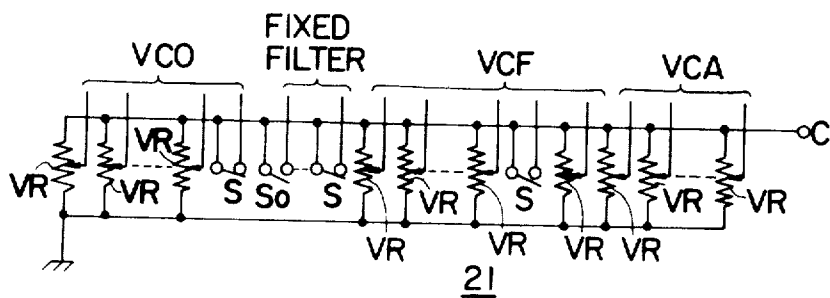


FIG. 16

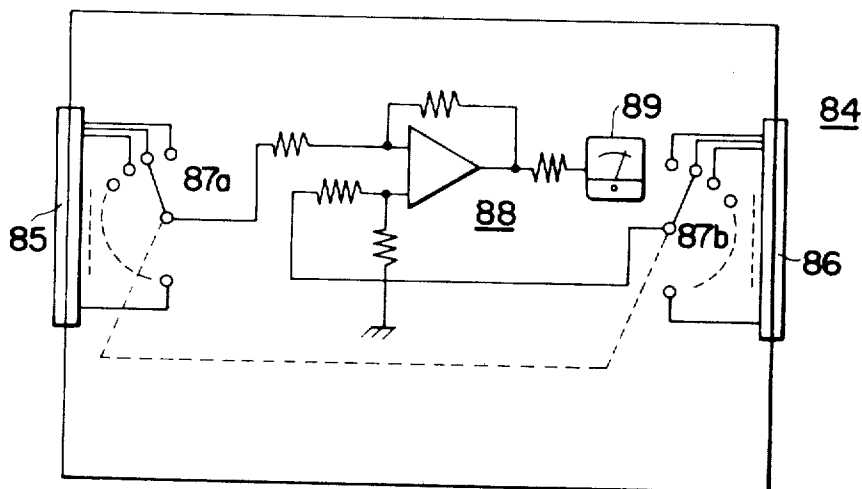


FIG. 17A

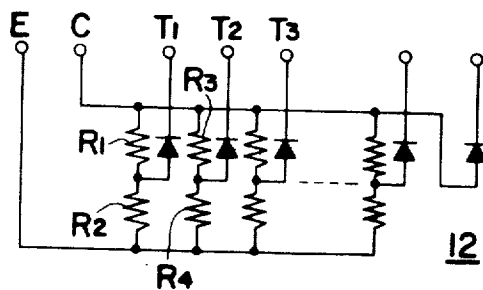


FIG. 17B

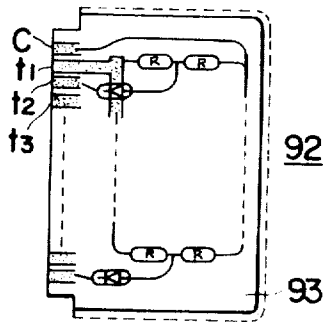


FIG. 17C

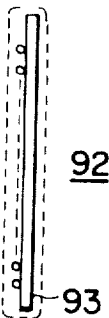


FIG. 18

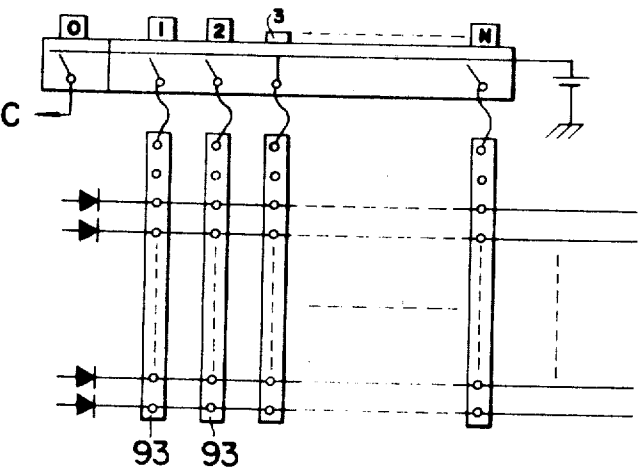


FIG. 19A

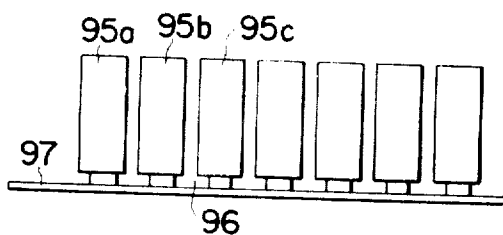


FIG. 19B

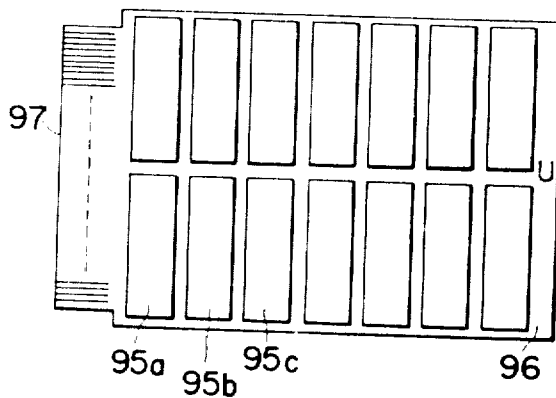


FIG. 20

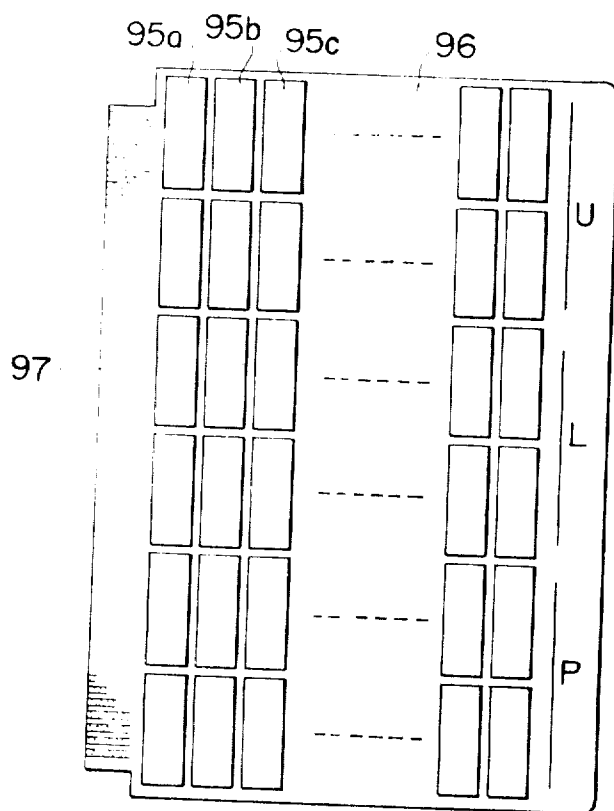


FIG. 21

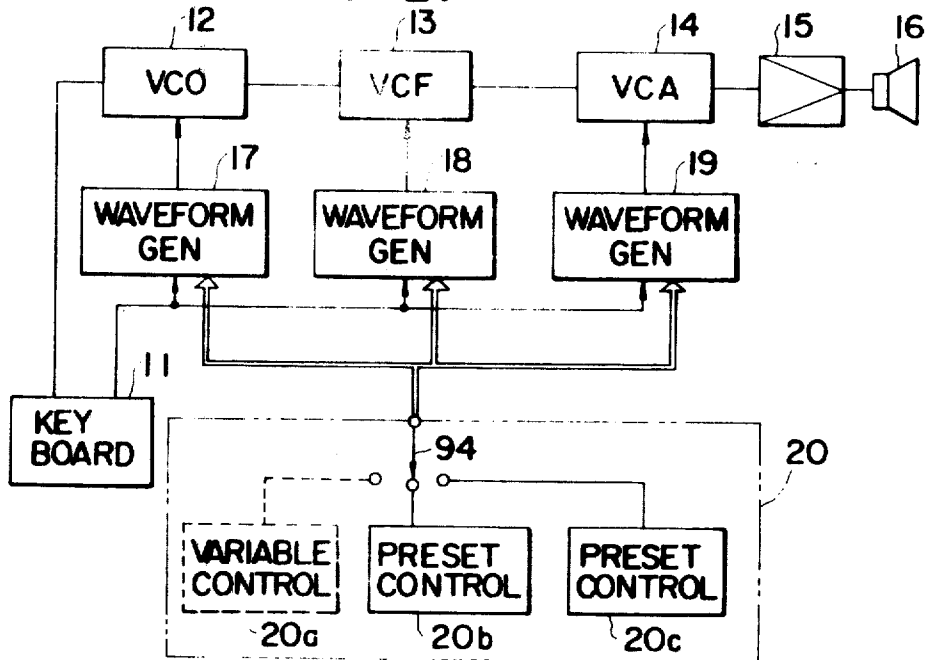


FIG. 22

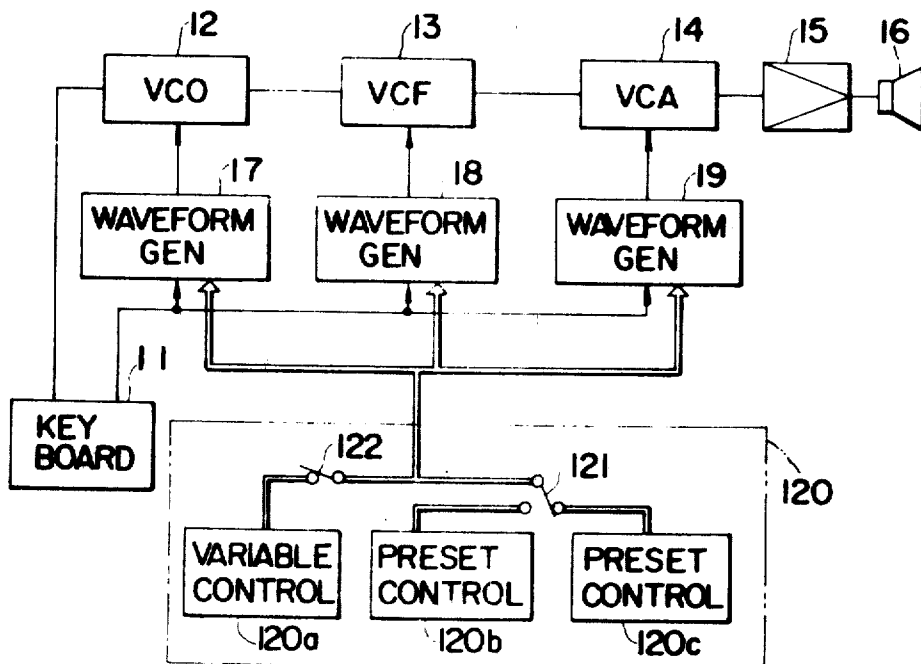


FIG. 23

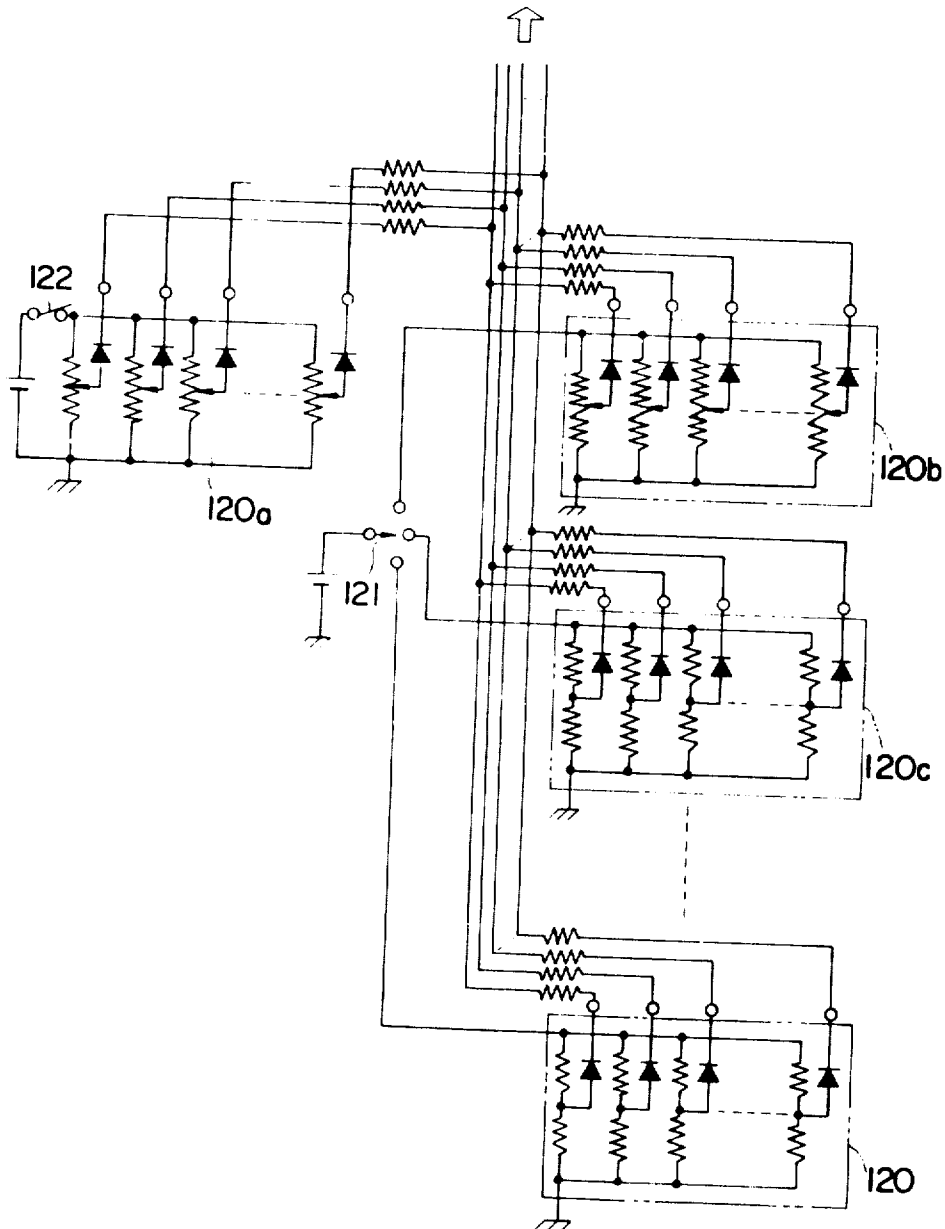


FIG. 24

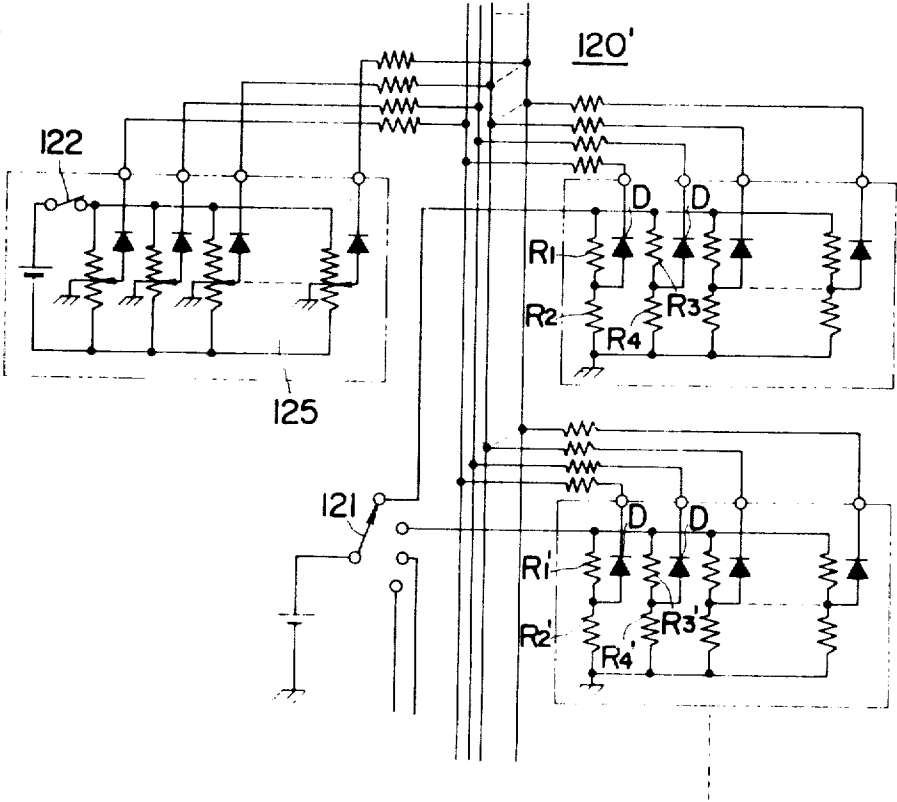
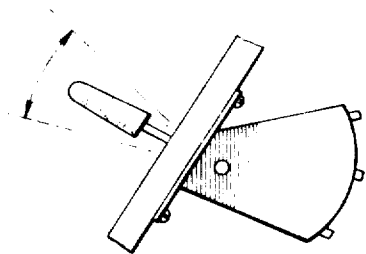


FIG. 25



ELECTRONIC MUSICAL INSTRUMENT

This invention relates to an electronic musical instrument, and more particularly to an electronic musical instrument capable of producing musical sounds each of which is time-dependently controlled.

An electronic musical instrument basically comprises tone generators including oscillators and frequency dividers for generating tone signals corresponding to respective tone pitches, tone filters for coloring the tone signals generated from the tone generators, amplifiers for amplifying the tone signals transmitted through filters. The tone generators are coupled to a keyboard so as to selectively supply tone signals corresponding to the depressed keys. The tone signals transmitted through said filters and amplifiers are supplied through a common amplifier to a speaker system.

For variously modifying the generated tones, controlling circuits for controlling tone generators, filters and amplifiers may be provided. Alternations of tone control, however, are not done easily or rapidly.

SUMMARY OF THE INVENTION

An object of this invention, therefore, is to provide an electronic musical instrument capable of easily and variably controlling the tone signals with time-dependently varying signals.

Another object of this invention is to provide an electronic musical instrument capable of generating tone signals whose tone coloring and amplitude envelope can be easily and variously altered.

A further object of this invention is to provide an electronic musical instrument capable of generating tone signals whose tone pitch, tone coloring and amplitude envelope can be easily and variously altered.

A still further object of this invention is to provide an electronic musical instrument comprising a plurality of pre-set memories operative to store various sets of controlling parameters which can be easily and selectively connected to waveform generators for generating controlling voltage waveforms for modifying the tone signals.

According to this invention, the tone pitches, the tone colors and the envelopes of the tone signals can be easily and variously modified, and the modes of tone control can be easily and rapidly interchanged.

According to an embodiment of this invention, there is provided an electronic musical instrument comprising a keyboard section including a plurality of keys, tone generator means coupled to said keyboard section and generating a tone signal having a frequency determined by the operated one of said keys, a voltage-controlled frequency-variable filter connected to said tone generator means and receiving said tone signal, a first controlling voltage waveform generator connected to said keyboard section and said filter and generating a time-dependent voltage waveform upon operation of said key for time-dependently controlling said frequency-variable filter, and a controlling circuit supplying voltage information to said waveform generator for determining said voltage waveforms.

BRIEF DESCRIPTION OF THE DRAWINGS

Description will hereunder be made of some preferred embodiments in conjunction with the accompanying drawings in which:

FIG. 1 is a block diagram of the electric circuit of an embodiment of the electronic musical instrument according to this invention;

FIG. 2 shows controlling voltage waveforms generated from the waveform generators in the circuit of FIG. 1;

FIGS. 3A and 3B are electric circuit diagrams of the waveform generators for generating controlling waveforms as shown in FIG. 2;

FIG. 4 is an electric connection diagram of the key switch in the circuit of FIG. 1;

FIG. 5 is an electric connection diagram of the waveform controller in the circuit of FIG. 1;

FIG. 6 is an electric connection diagram of the voltage-controlled oscillator in the circuit of FIG. 1;

FIG. 7 is an electric connection diagram of the voltage-controlled filter in the circuit of FIG. 1;

FIG. 8 is an electric connection diagram of the voltage-controlled amplifier in the circuit of FIG. 1;

FIG. 9 is an electric connection diagram of the waveform generator for the voltage-controlled oscillator and the voltage-controlled filter in the circuit of FIG. 1;

FIG. 10 is an electric connection diagram of the waveform generator for the voltage-controlled amplifier in the circuit of FIG. 1;

FIG. 11 is a block diagram of the electric circuit of another embodiment of the electronic musical instrument according to this invention;

FIG. 12 is a block diagram of the electric circuit of still another embodiment of the electric musical instrument according to this invention;

FIG. 13 is a perspective view of an electronic musical instrument provided with a pre-set mother board according to this invention;

FIG. 14 is a front view of the pre-setting board;

FIG. 15 is a circuit diagram of the waveform controller;

FIG. 16 is a circuit diagram of an information-copying system for copying information in the pre-set mother board to a pre-set board;

FIGS. 17A, 17B and 17C are a circuit diagram, a plan and a side view of a fixed memory board for use in the waveform controller;

FIG. 18 is a schematic diagram of a pre-set board selector means;

FIGS. 19A and 19B are a side and a plan view of a pre-set memory board including a plurality of fixed memory units;

FIG. 20 is a plan view of another pre-set memory board;

FIG. 21 is a block diagram of yet another embodiment of the electronic musical instrument according to this invention;

FIG. 22 is a block diagram of the electric circuit of a further embodiment of the electronic musical instrument according to this invention;

FIG. 23 is an electric circuit diagram of the waveform controller in the circuit of FIG. 20;

FIG. 24 is an electric circuit diagram of another example of the waveform controller in the circuit of FIG. 21; and

FIG. 25 is schematic side view of a variable resistor used in the circuit of FIG. 24.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows an embodiment of an electronic musi-

cal instrument. A keyboard section 11 generates voltage signals corresponding to the tone pitches of depressed keys and also generates trigger signals representing the depression and release of keys in connection with the operation of keys. The tone pitch signal is supplied to a voltage-controlled frequency-variable oscillator 12 (hereinbelow referred to as VCO) to generate therefrom a tone signal of the frequency corresponding to the depressed key. The tone signal generated from this VCO 12 is transmitted through a voltage-controlled frequency-variable filter 13 (hereinbelow referred to as VCF) for coloring the tone, i.e., modifying the tone signal into a musical sound signal. The filtered tone signal is then supplied to a voltage-controlled amplifier 14 (hereinbelow referred to as VCA) for imparting a desired envelope to the tone signal. The tone signal which is controlled as above is then supplied through an amplifier 15 (including an expression control) to a speaker system to voice a musical sound. Said VCO, VCF and VCA 12, 13 and 14, respectively are controlled with controlling voltage waveforms supplied from respective waveform generators 17, 18 and 19 which are triggered by the keying signals supplied from the key board 11 and are controlled by the waveform controlling signals supplied from a waveform controller 20. The controlling voltage waveforms for the VCO, VCF and VCA 12, 13 and 14, respectively are such as shown in FIG. 2. Voltage waveform A in FIG. 2 is for the VCO 12 and/or the VCF 13, which rises from an initial level to an attack level in an attack time following the depression of a key, and decays down to the normal level in a first decay time, and then sustains at the normal level until the release of the key, and then decays down to the initial level in a second decay time. The VCO 12 finely alters the oscillation frequency according to said controlling voltage waveform for resembling the pitch of a tone signal to that of a natural musical sound. Namely, the oscillation frequency increases rapidly from a little lower frequency to a little higher frequency upon the depression of a key in the attack time, and decreases to the normal frequency in the first decay time, and therefrom sustains constant at the normal frequency until the release of the depressed key, and then decreases to the initial frequency in the second decay time. The VCF 13 alters the cut-off frequency according to the controlling voltage waveform A similar to the VCO 12. For a musical sound, the tone pitch and the tone coloring should be basically very stable. This corresponds to the stability of the sustain level, in the VCO and VCF. Therefore, the controlling voltage waveform A stays at the normal level at the sustain level. The controlling voltage waveform B is for the VCA 14, which rises from the cut-off (initial) level to an attack level in an attack time, decays down to a sustain level in a first decay time, sustains at the sustain level until the release of the depressed key, and decays down to the cut-off level in the second decay time. The VCA 14 alters the amplification factor according to said controlling voltage waveform B so as to envelope-control the tone signal. In this case, the sustain level is also variable.

The general levels (the whole levels) of the controlling voltage waveforms can be set by resistor circuits in the waveform controller as shown in FIGS. 3A and 3B. Namely, a constant voltage is applied between the two fixed contacts of a variable resistor VR₀₁ or VR₀₂, and the sliding contact is set at a controlled position. In the

waveform generator 17 or 18 shown in FIG. 3A, controlling parameters of the initial level, the attack level, the attack time, the first decay time, and the second decay time are also supplied through input terminals *a*, *b*, *c*, *d* and *e* for generating a voltage waveform as shown by the curve A in FIG. 2. In the waveform generator shown in FIG. 3B, controlling parameters of the attack time, the first decay time, the sustain level, and the second decay time are supplied through input terminals *f*, *g*, *h* and *i* for generating a voltage waveform as shown by the curve B in FIG. 2.

Here, the variable range of the attack time may be from 1 msec. to 1 sec., and those for the first and second decay times may be from 10 msec. to 10 sec. Furthermore, a polarity reversible circuit may be provided for reversing the polarity of the waveforms for the VCO 12 and VCF 13 by a manipulation on the control panel of the musical instrument (not shown). The controlling waveforms generated from the waveform generators 17 and 18 for the VCO 12 and the VCF 13 and from the waveform generator 19 for the VCA 14 can be differently controlled. Thus, the tone control during the depression of a key can also be easily performed.

Description will hereunder be made of further details of the circuitry.

The tone pitch signal is generated by depressing a key. A keyboard circuit 11 is shown in FIG. 4. In FIG. 4, a source voltage E is divided by voltage-dividing resistors R₁, R₂, R₃, . . . , and key switches S₁, S₂, S₃, . . . are connected to respective voltage-dividing terminals and actuated by the depression of respective keys to derive a divided voltage upon the depression of a key. The selected voltage signal is sent to the VCO 12. The respective key switches S₁, S₂, S₃, . . . are interlocked with switches S₀₁, S₀₂, S₀₃, ... These interlocked switches S₀₁, S₀₂, S₀₃, . . . provide a triggering keying signal from a voltage source E'. Namely, a voltage signal corresponding to the tone pitch of a depressed key is provided through the switches S₁, S₂, . . . to set the fundamental oscillation frequency in the VCO 12 and a keying signal representing the depression or the release of a key is provided through the switches S₀₁, S₀₂, . . . to set the key depression or release time in the waveform generators 17 to 19.

The waveform controller 20 is shown in FIG. 5, in which a plurality of variable resistors VR₁₁, VR₁₂, . . . , VR₂₁, VR₂₂, . . . , VR₃₁, VR₃₂, . . . are connected in parallel between the terminals of a constant voltage source through their fixed terminals. The sliding terminals of these variable resistors are connected to output terminals. The variable resistors VR₁₁, VR₁₂, . . . represent the waveform parameters of the initial level, the attack level, the attack time, the first decay time, the second decay time, etc., respectively, which are supplied to the waveform generator 17 shown in FIG. 3A. The variable resistors VR₂₁, VR₂₂, . . . , VR₃₁, VR₃₂, . . . represent the waveform parameters for the waveform generators 18 and 19. These parameters can include the general level adjusters. To change the profile of the controlling voltage waveforms from the waveform generators 17, 18 and 19, the variable resistors VR₁₁, VR₁₂, . . . , VR₂₁, VR₂₂, . . . , VR₃₁, VR₃₂, . . . are adjusted. The oscillation frequency of the VCO 12 is controlled by the tone pitch signal from the keyboard 11 and the controlling voltage waveform from the waveform generator 17 controlled by the outputs of the waveform controller 20.

An example of the circuit structure of the VCO 12 is shown in FIG. 6, in which the tone pitch signal derived from the keyboard 11 shown in FIG. 4 is supplied through a terminal 21, stored in a capacitor 22 and derived through a buffer 23 of high input impedance. The controlling voltage waveform from the waveform generator 17 is supplied through a terminal 24 and added with the tone pitch signal from the output of the buffer 23. The resultant signal is supplied to a voltage-to-current converter 25 to supply a current signal. The current signal from this converter 25 is allowed to charge a capacitor 27 connected between a constant voltage source 26 and the voltage-current converter 25. The voltage at one electrode of the capacitor 27 is supplied through a buffer 28 to a Schmitt trigger circuit 29 which triggers a transistor 30 forming a discharging circuit for the capacitor 27 to be conductive when the input voltage reaches a certain level. Thus, the capacitor 27 repeats charging and discharging. The corresponding oscillating output is derived from an output terminal 31 connected to the output of the buffer 28, as a tone signal. Namely, since the charging rate for the capacitor 27 changes in accordance with the output current of the voltage-to-current converter 25, the oscillation frequency is controlled by the voltage (tone pitch signal) corresponding to the operated key and the voltage waveform from the tone pitch controlling waveform generator 17.

An example of the VCF 13 connected to the VCO 12 and the waveform generator 18 and supplying an output to the VCA 14 is shown in FIG. 7, in which the tone signal input from the VCO 12 is supplied through an input terminal 32 and a buffer amplifier 33 to a current-controlled resistor 34. The controlling voltage waveform from the waveform generator 18 and a general level are synthesized and supplied to a voltage-to-current converter 35 to provide a current signal. The current-controlled resistor 34 is controlled by this current signal. This current-controlled resistor 34 may be formed of diodes or the like and sets the cut-off frequency of the filter in cooperation with a reactance 36 (e.g., a capacitor). The filtered tone signal is appropriately amplified in an amplifier 37 and supplied from an output terminal 38 as a colored tone signal. A Q-controlling signal may also be applied from the waveform generator 18 or the waveform controller 20 through a terminal 39 to a voltage-controlled resistor 40 to be transformed into a resistance therein which determines the magnitude of the feed-back from the amplifier 37 to the current-controlled resistor 34, thereby setting the Q-value of the filter.

An example of the VCA 14 connected to the VCF 13 and the waveform generator 19 and supplying an output to the common amplifier 15 is shown in FIG. 8. The controlling voltage waveform from the waveform generator 19 is supplied through a terminal 41 to a voltage-to-current converter 42 to be transformed into a current signal therein. The tone signal from the VCF 13 is supplied through an input terminal 43 and a buffer amplifier 48 to a differential amplifier 44 which is controlled by said current signal. The differential amplifier 44 supplies a phase-matched and a phase-reversed outputs through a phase-matched amplifier 45 and a phase-reversing amplifier 46. The two outputs are synthesized to supply an output tone signal from a terminal 47. Here, from the differential amplifier 44, the tone signal is derived in the opposite phase and the DC fluctuation component in the input tone signal is derived in phase in the two outputs. Thus, only the pure tone signal appears at the output terminal 47.

tuation component in the input tone signal is derived in phase in the two outputs. Thus, only the pure tone signal appears at the output terminal 47.

An example of the waveform generator 17 or 18 for generating the tone pitch — or tone color — controlling voltage waveform as shown by the curve A in FIG. 2 is shown in FIG. 9. When a keying signal is generated, it is supplied to a control sequence pulse generator 54 to provide a signal X_1 . This signal X_1 controls a voltage-controlled resistor 49 to charge a capacitor 51 in a time which is determined by the voltage-controlled resistor 49 to a voltage determined by the voltage-controlled voltage source 50. The terminal voltage of this capacitor 51 is derived through a buffer 52 of high input impedance, and compared with the voltage set by the voltage-controlled voltage source 50 in a comparator 53. When the voltage of the capacitor 51 exceeds the attack level, charging to the capacitor 51 is stopped and the comparator 53 generates an output signal X_2 which is supplied to the control sequence pulse generator 54. Upon reception of this signal X_2 , the control sequence pulse generator 54 generates a signal X_3 which is supplied to a voltage-controlled resistor 55 to control it. This voltage-controlled resistor 55 allows the capacitor 51 to discharge to the reference (general) level. When the control sequence pulse generator 54 receives a key release signal, it generates a signal X_4 which is applied to a voltage-controlled resistor 57. Then, the capacitor 51 discharges through the voltage-controlled resistor 57 to the initial level. The terminal voltage of the capacitor 51 is derived through the buffer 52 and a polarity reversible circuit 56 which is controlled by a polarity signal. Thus, a controlling voltage waveform as shown by the curve A in FIG. 2 is provided. The controlling parameters such as the normal level, the attack level, the attack time, the first decay time, the second decay time, the initial level, and the polarity, are supplied from the waveform controlling circuit 20, and the keying signal is supplied from the key switch circuit. In the waveform generator 18, there may be provided a Q-controlling line which transmits the Q-controlling signal from the controller 20 to the VCF 13.

An example of the volume-controlling waveform generator 19 for controlling the VCA 14 is shown in FIG. 10, which receives the controlling parameters of the general level, the attack time, the first decay time, the sustain level, and the second decay time from the waveform controller 20, and the keying signal from the keyboard 11.

Similar to the waveform generator 17 or 18, when a key depression signal enters the control sequence pulse generator 64, a signal X'_1 is generated and supplied to a voltage-controlled resistor 59 to charge up a capacitor 61 in the attack time determined by this voltage-controlled resistor 59. The terminal voltage of this capacitor 61 is supplied through a buffer 62 of high input impedance to a comparator 63 to compare it with a predetermined attack level. When the capacitor voltage exceeds the attack level, the comparator 63 generates a signal X'_2 and supplies it to the control sequence pulse generator 64. Then, this control sequence pulse generator 64 generates a signal X'_3 and applies it to a first decay time circuit 65 which then allows the capacitor 61 to a sustain level determined by a voltage-controlled voltage source 68 and holds the output voltage at the sustain level. When the control sequence pulse generator 64 receives a key release signal, it generates a signal X'_4 which is applied to a voltage-controlled resistor 67 to discharge the capacitor 61 to the initial level. The terminal voltage of the capacitor 61 is derived through the buffer 62 and a polarity reversible circuit 66 which is controlled by a polarity signal. Thus, a controlling voltage waveform as shown by the curve B in FIG. 2 is provided. The controlling parameters such as the normal level, the attack level, the attack time, the first decay time, the second decay time, the initial level, and the polarity, are supplied from the waveform controlling circuit 20, and the keying signal is supplied from the key switch circuit. In the waveform generator 19, there may be provided a Q-controlling line which transmits the Q-controlling signal from the controller 20 to the VCF 13.

erates a signal X' , which is supplied to a voltage-controlled resistor 67. This voltage-controlled resistor 67 allows the capacitor 61 to discharge to the ground potential. Thereby, a controlling voltage waveform as shown by the curve B in FIG. 2 can be provided from the buffer 62 through an output terminal. According to the above embodiment, there is provided a tone signal having the tone pitch, the tone color and the envelope which is controlled time-dependently according to the arbitrarily set controlling waveforms.

The percussive or sustain effect in the tone attenuating period can be well expressed when the tone coloring and the tone envelope is well modified.

FIG. 11 shows another embodiment which resembles the system of FIG. 1 but lacks the time-dependent control for the VCO 12. The respective constituents of the system of FIG. 11 are like those of the system of FIG. 1 and thus the description thereof is dispensed with here. When a percussive effect is desired, controlling voltage waveforms having no sustain level are generated from the waveform controllers 18 and 19 so that the higher harmonics are gradually cut off by the VCF 13 and the tone amplitude softly fades away by the VCA 14.

The tone coloring is one of the most important problems in electronic musical instruments. Tone coloring can be enhanced by improving the filter circuit. This can be achieved by combining filters in place of VCF. Furthermore, when several pieces are to be played successively, different tone modifications are often desired. This can be solved by preparing several sets of memories which carry different sets of tone modifying parameters.

FIGS. 12 and 13 show another embodiment of the electronic musical instrument system, which resembles the system of FIG. 1 but further comprises fixed filters 70 which can be selectively connected between the VCO 12 and the VCF 13 by the order from the controlling circuit 20', and a pre-setting board 71 which may be mounted on the music stand 72 of the instrument body 73.

The pre-setting board 71 is formed as shown in FIG. 14, in which basic controlling waveforms 75, 76 and 77 for the VCO 12, the VCF 13 and the VCA 14 are depicted on a panel board 74 and operating knobs 78a, 78b, . . . corresponding to the controlling variables of the initial level, the attack level, etc. are provided at the corresponding positions. For example, the reference level for the VCO is set in the knob 78a, the initial level in the knob 78b, the attack level in the knob 28c, the attack time in the knob 28d, and so on. Namely, the controlling parameters to be given from the controlling circuit 20' to the waveform generators 17, 18 and 19 can be set in this pre-setting board. Besides said knobs, there are provided polarity-controlling circuits 29a and 29b for the controlling waveforms for the VCO and VCF, selection switches 30a, 30b, . . . for the fixed filters 13, and also a Q-value selecting knob 31 for the VCF 13.

On the backside of this panel board 74, variable resistors are provided corresponding to the respective knobs. These variable resistors are connected as is shown in FIG. 15 so that voltage signals corresponding to the set positions in the variable resistances can be derived from terminals 91a, 91b, 91c, ... Regarding the switches 79a, 79b, 80a, 80b, . . . , voltage signals corresponding to the set positions can be derived.

These voltage signals can be used as the controlling parameters for the controlling waveform generators. Namely, when the terminals 91a, 91b, 91c, . . . in the circuit of FIG. 15 are led out to a coupler means 83 through lead-out wires 32 and the coupler means 83 is connected to the main circuit, this pre-setting unit 71 can work as the controlling circuit 20' in FIG. 12.

Although pre-setting unit 71 can be used as the controlling circuit 20', in practical use it is desired to prepare a plurality of such controlling circuits, i.e., memories, pre-set variously and select an appropriate one for each piece. In this case, each memory is preferably integrated compactly on a board. Thus, a plurality of small size variable resistors should be densely integrated in a memory board and the controlling parameters for the controlling waveforms should be stored in such a memory board.

The pre-setting unit 71 of said structure can be effectively used for storing the controlling parameters in a memory board correctly. Namely, controlling parameters set in the pre-setting unit 71 can be easily copied in a memory board by the use of an information copying unit 84 as shown in FIG. 16. In FIG. 16, the copying unit 84 comprises a coupler means 85 adapted for connecting the coupler 83 of the pre-setting board 71, another coupler means 86 adapted for connecting a memory board, interlocked rotary switches 87a and 87b, a comparator circuit 88 and a meter 89. The rotary switches 87a and 87b select a pair of corresponding terminals of the presetting board and the memory board and connect them to the two inputs of the comparator circuit 88 including an operational amplifier. The comparator circuit 88 generates an output according to the difference of the two inputs and supplies it to the meter 89 where the difference can be easily observed. The information in the pre-setting board 71 which can be set easily preliminarily can be copied in a memory board by successively selecting the terminals of the rotary switches 87a and 87b and adjusting the small size variable resistors in the memory board to make the read in the meter 89 zero (null method). In such a manner, a plurality of memory board can be easily set to store the desired information.

In the preceding embodiment, a plurality of variable memories is provided. The number of musical instruments used in the majority of the cases, however, is not so large. Therefore, it is convenient to provide a certain number of fixed memories in combination with variable memories.

FIGS. 17A, 17B and 17C show an embodiment of a fixed memory to be used in place of the controlling circuit 20 or 20'. The circuit diagram of a fixed memory shown in FIG. 17A is like that of FIG. 15, but each variable resistor is replaced with a series connection of two voltage dividing resistors. Removal of mechanically movable portions greatly enhances the manufacture of the memory board. FIGS. 17B and 17C show one form of the fixed memory of FIG. 17A in which resistors forming voltage dividing circuits and diodes forming output circuits are disposed on a printed board 93 having output terminals along one edge and connected to form the circuit of FIG. 17A. The total memory board 92 may be molded with an insulating material as shown by the broken lines.

Mounting and selection of such memory boards 93 can be done with selector means 94 as shown in FIG. 18, in which depression of a selector switch selects a

corresponding memory board. Thus, different kinds of tone modification mode can be obtained rapidly.

FIGS. 19A and 19B show another form of memory means including a plurality of memory units. The memory board shown in the figures corresponds to one part of the waveform controller circuit, for example that for the upper manual keys. Respective unit memories 95a, 95b, . . . carry different information for shaping controlling waveforms for forming different musical sounds. Voltage source and output terminals are assembled in a terminal portion 97 formed on one edge of a main board 96 through connectors and wirings in the main board 96. The assembly is connected to the controlling circuit in the instrument body through a selector means. According to this embodiment, different kinds of tone modification are available in either one of the following two ways, one by the selection of a desired unit memory from among a plurality of such memories provided on one main board and the other by the replacement of the main board as a whole.

A modification of this embodiment is shown in FIG. 20, in which a main board 96 carries unit memories 95a, 95b, . . . for all of the upper manual keyboard U, the lower manual keyboard L and the pedal keyboard P.

The above embodiments using fixed memories can be schematically represented by the block diagram of FIG. 21. Namely, in the controller circuit 20, a plurality of fixed and variable memories are provided, and one of them is selected rapidly through a selector means 94. According to this system, however, when a number of different but almost the same tone modifications are wanted or when a part of the tone modification is to be altered, that number of fixed memories should be provided or otherwise a lot of information should be stored in variable memories. Furthermore, when the need for a change occurs in the midst of a play, there is no solution.

FIG. 22 shows another embodiment of the system of an electronic musical instrument, in which variable control can be used in cooperation with fixed control. The controlling circuit 120 includes pre-set memories 120b, 120c, . . . and a variable memory 120a, a pre-set memory selector switch 121, and a variable memory connection switch 122. The pre-set memories include fixed and pre-set variable memories. Modification of a pre-set memory can be easily done by adjusting the variable resistors provided on the panel of the instrument cabinet. Namely, the variable control means 20a comprising variable resistors is disposed in the panel of the instrument cabinet at a position where it can be easily manipulated. The information outputs of the variable control means 120a is coupled to the waveform generators 17, 18 and 19 through the switch 122. On the other hand, the information outputs of one of the pre-set memories 120b, 120c, . . . are coupled to the waveform generators 17, 18 and 19 through a pre-set selector switch 121.

Namely, the information outputs of the variable control means 120a is added to those of a pre-set memory, and the waveform generators are controlled by these two kinds of outputs.

Here, the variable resistors provided on the panel are preferably arranged in such a manner that the information outputs from the variable control means are normally zero.

A circuit diagram of the controller circuit 120 including said variable and pre-set controlling means 120a, 120b, 120c, . . . is shown in FIG. 23, in which each one fixed terminal of the variable resistors in the variable control means is grounded.

FIG. 24 shows another example of the controller circuit. In the controller circuit 120' of FIG. 24, a variable control means 125 comprises variable resistors which generate no output when the sliding contacts are positioned substantially at the centers. An example of such a variable resistor is shown in FIG. 25.

We claim:

1. An electronic musical instrument comprising:

a keyboard section including a plurality of keys each generating when depressed a voltage signal representing a tone pitch of a depressed key and a trigger signal indicating the operation of said key;

tone generator means including a voltage controlled oscillator coupled to said keyboard section and generating a tone signal having a frequency determined by said voltage signal representing the depressed key;

a voltage controlled frequency-variable filter connected to said tone generator means and receiving said tone signal;

a first controlling voltage waveform generator connected to said keyboard section and said filter and generating upon operation of a key a voltage waveform having levels and transient times varying with time for controlling said frequency variable filter in accordance therewith; and

a controlling circuit independent of said keyboard section and connected to said waveform generator for supplying voltage information to said waveform generator thereby determining said levels and transient times of the voltage waveform.

2. An electronic musical instrument according to claim 1, further comprising: a second controlling voltage waveform generator controlled by a signal representing the operation of a key and generating upon operation of a key a voltage waveform having levels and transients varying with time for controlling said voltage controlled oscillator in accordance therewith, and wherein said controlling circuit supplies voltage information to said second waveform generator thereby determining said voltage waveform of said second generator.

3. An electronic musical instrument according to claim 2, in which said levels of voltage waveforms are fixed at reference levels.

4. An electronic musical instrument according to claim 2, in which said controlling circuit includes

a panel board having a depiction of controlling waveforms for the time dependent tone pitch and tone coloring control;

a plurality of manipulating means disposed at positions corresponding to said depiction corresponding to the variables for determining the shape of said controlling waveforms;

a plurality of variable setting circuits disposed in correspondence to the respective manipulating means and capable of setting variables for said controlling variables, each of said variable setting circuit includes a voltage-dividing resistance circuit and a switch circuit;

means for independently deriving the variable setting signals from said variable setting circuits.

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5. An electronic musical instrument according to claim 2, in which said controlling circuit includes a plurality of memory means setting a plurality of variables for determining the shape of the controlling waveforms with resistance circuits and a selection switch for selecting one of said memory means and connecting it to said waveform generators.

6. An electronic musical instrument according to claim 2, in which said controlling circuit includes an assembling board mounting a plurality of unit memory boards each of which contains a plurality of resistance circuits for storing the voltage information for determining the controlling waveforms, and a selecting means for selectively connecting one unit memory

board.

7. An electronic musical instrument according to claim 2, in which said controlling circuit includes a memory circuit storing a plurality of variables for determining the shape of said controlling voltage waveforms and a variable control means including variable resistances for variably controlling said variables by adding variations to the outputs of said memory circuit.

8. An electronic musical instrument according to claim 7, in which said additive variation is zero when the manipulator for the corresponding variable resistor is at its center of the movable range.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

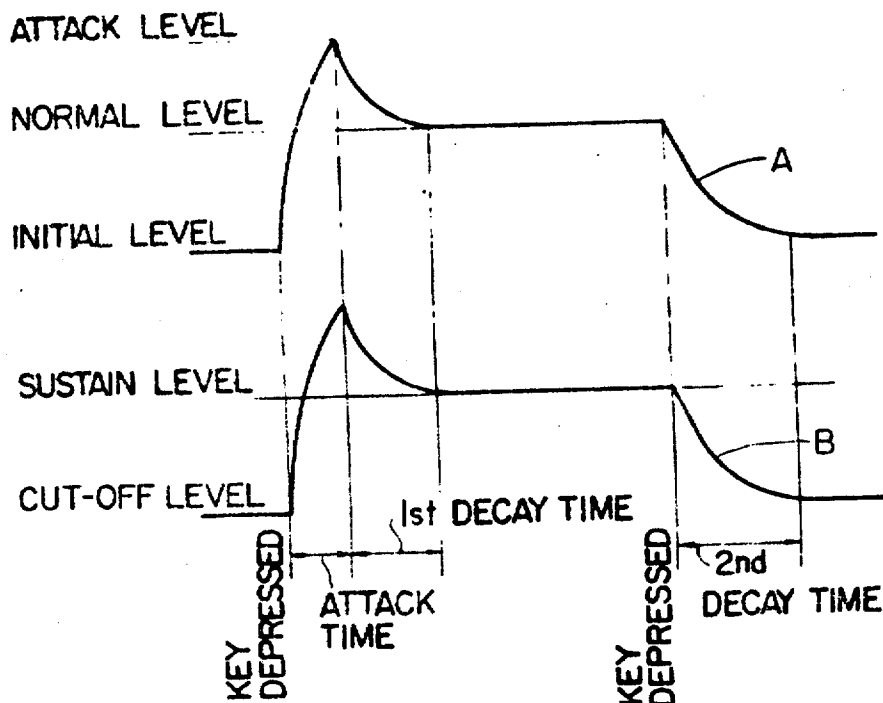
Patent No. 3,897,709 Dated August 5, 1975

Inventor(s) Teruo Hiyoshi et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Figure 2, should appear as shown below:

FIG. 2



Signed and Sealed this
twenty-fifth Day of May 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,897,709

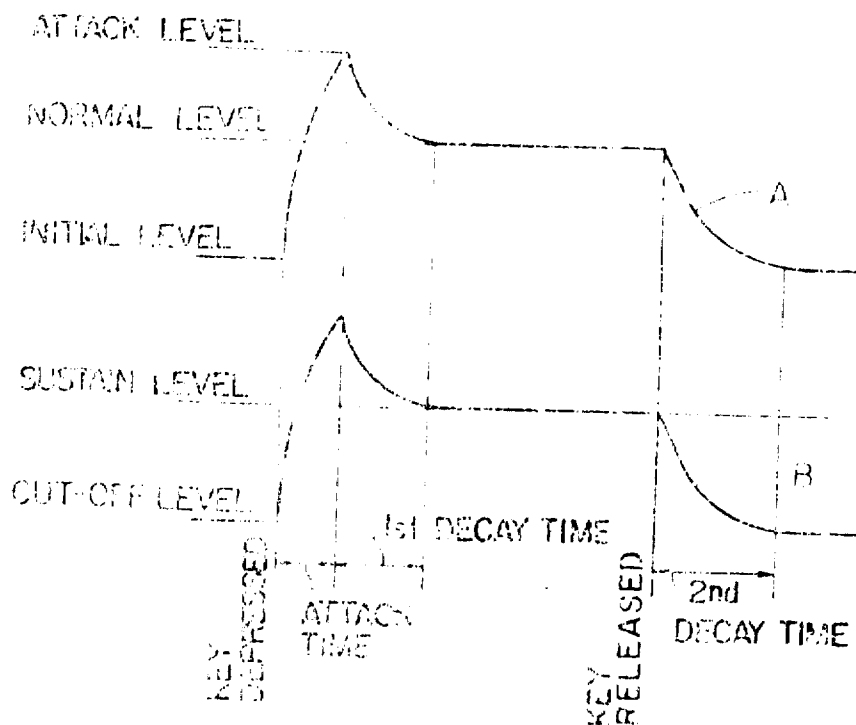
Dated August 5, 1975

Inventor(s) Teruo Hiyoshi et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Figure 2 should appear as shown below and as set forth in the Request for Certificate of Correction filed January 21, 1976:

FIG. 2



Signed and Sealed this

Nineteenth Day of October 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks