# United States Patent

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[33] **Japan**
[31] **2792/43**


[54] **MARIMBA TONE FORMING SYSTEM FOR AN ELECTRONIC MUSICAL INSTRUMENT**
**7 Claims, 5 Drawing Figs.**


[52] **U.S. Cl.** ..... **84/1.13,** 84/1.26
[51] **Int. Cl.** ..... **G10h 3/00**
[50] **Field of Search** ..... 84/1.01, 1.13, 1—11, 1—12, 1—19, 1.24, 1.26 (B)



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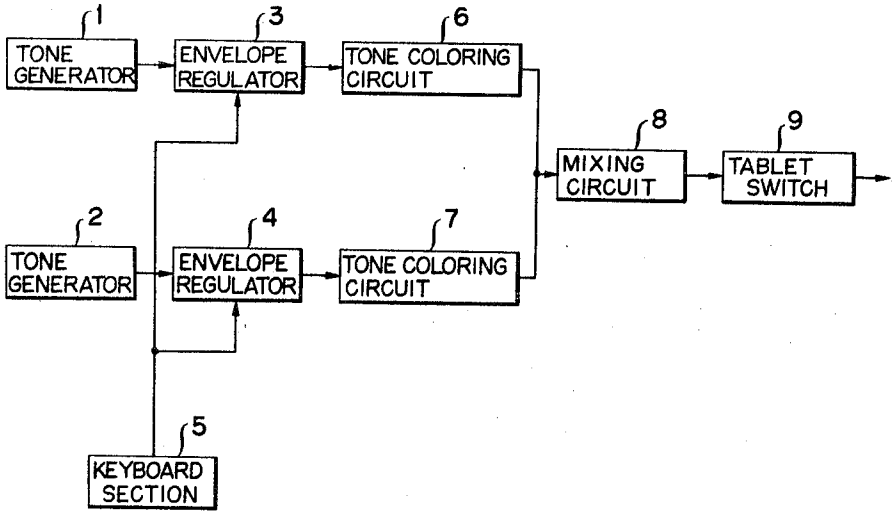
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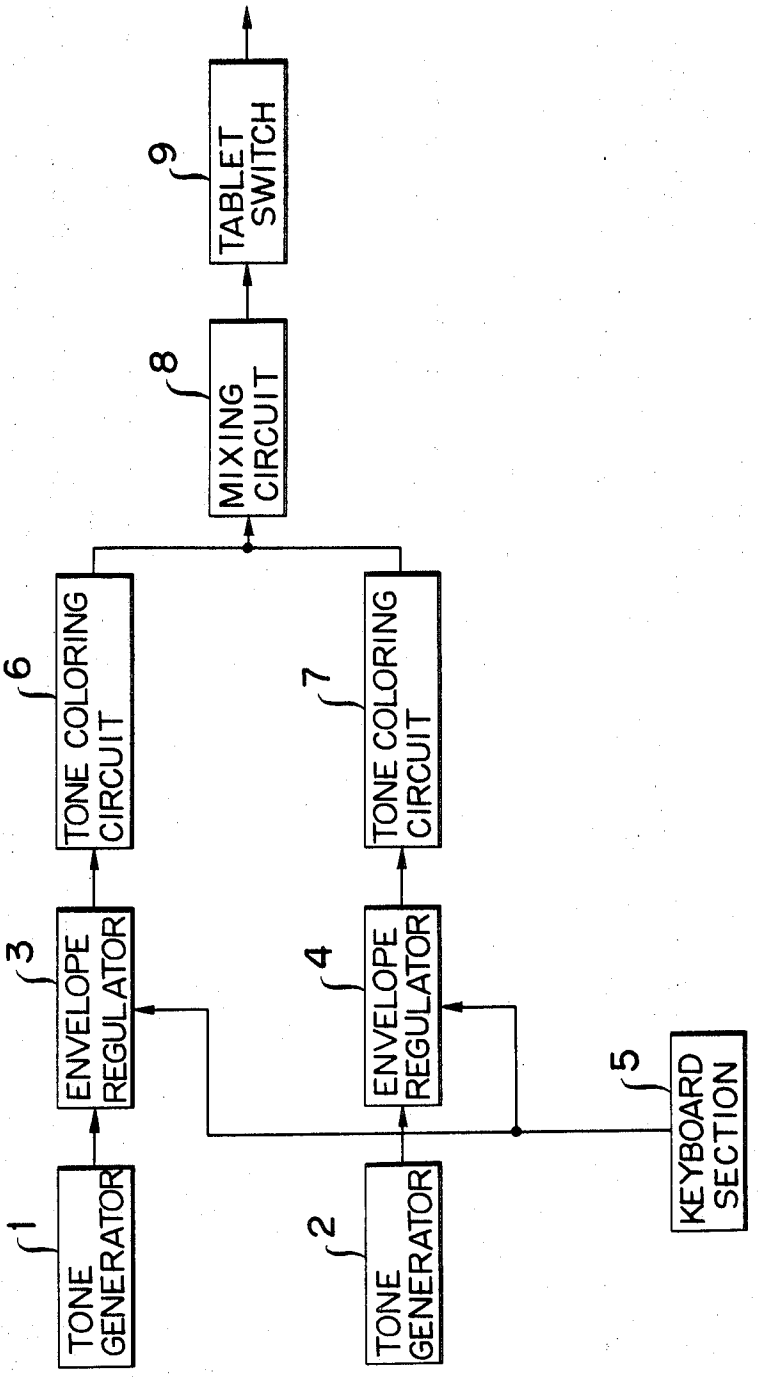


**ABSTRACT:** A marimba tone forming system mixes a fundamental tone signal of a flute voice, having an envelope whose rising time is about 10 milliseconds and whose attenuation time is about 1 second, with a sixth or third order overtone signal of the same voice, having an envelope whose maximum amplitude is slightly larger than that of said fundamental tone signal, whose rising time is about 3 to 5 milliseconds and whose attenuation time is about 100 milliseconds. The said fundamental tone and said overtone sound at the same time.

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FIG. 1




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FIG. 2a

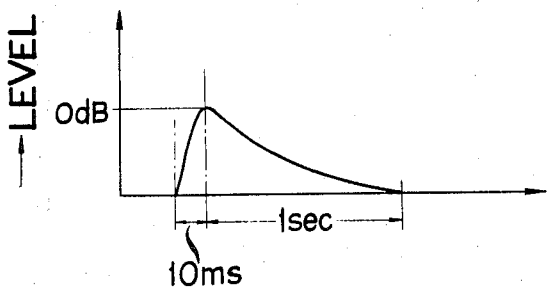



FIG. 2b

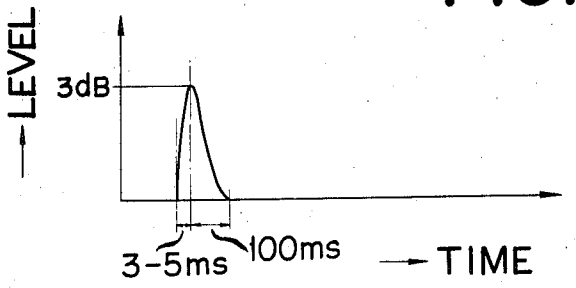
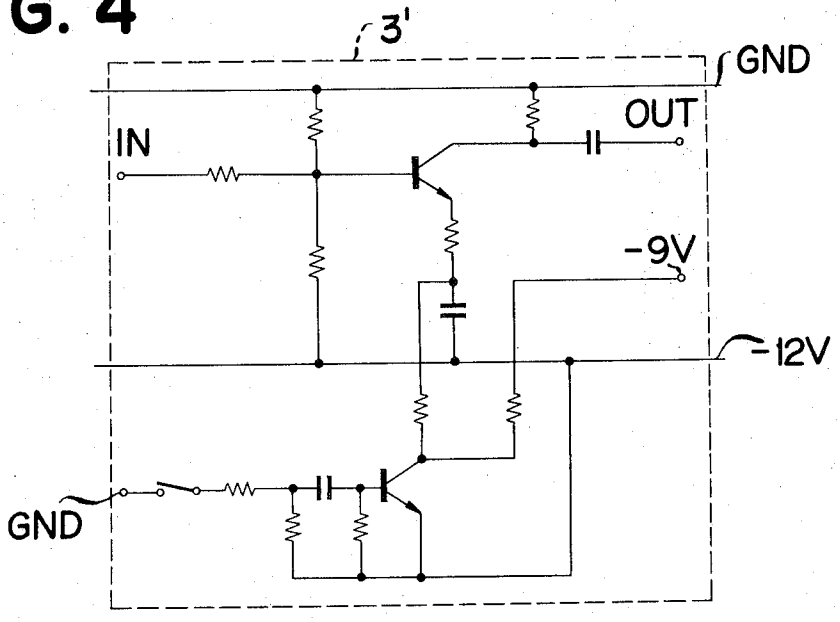



FIG. 4



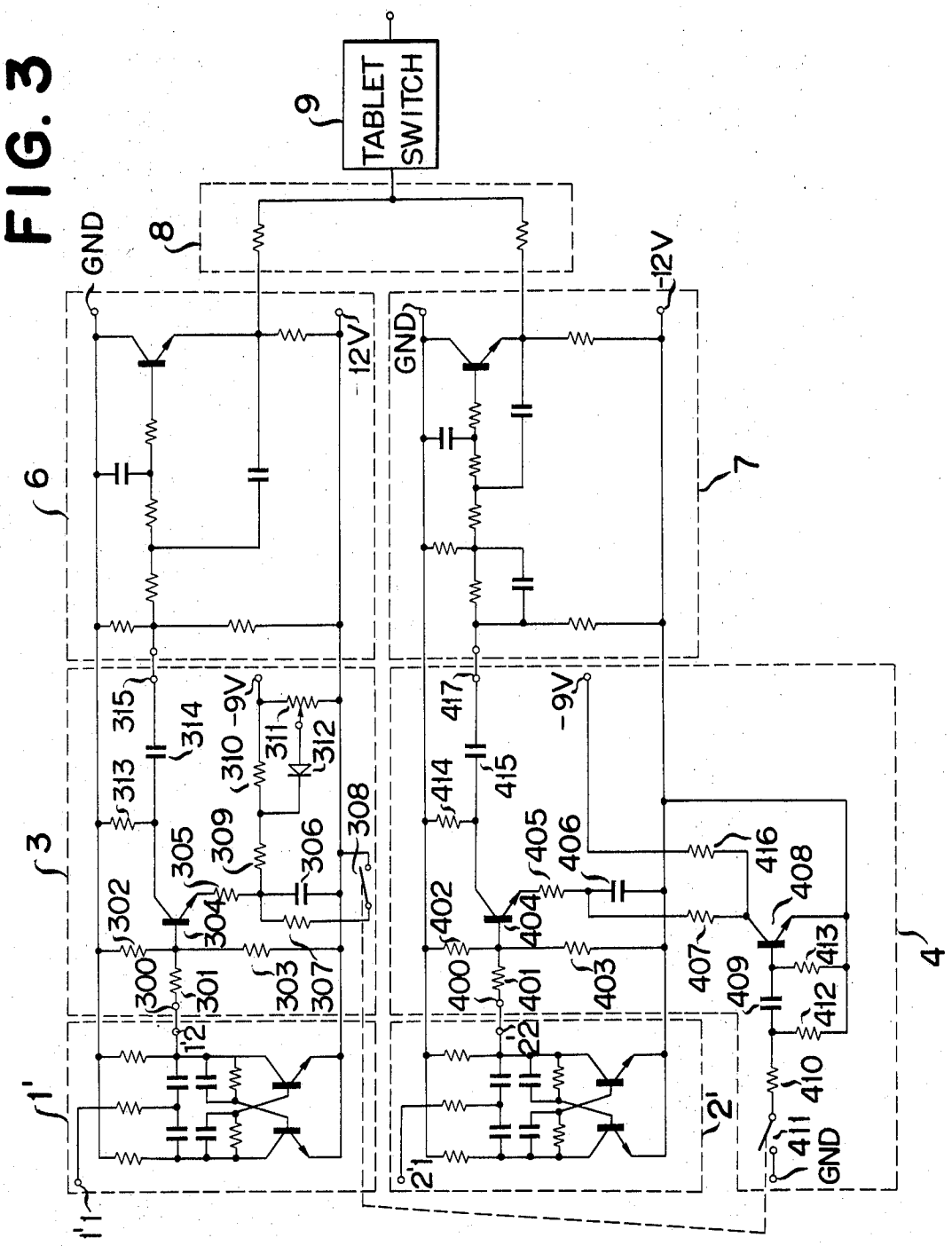

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FIG. 3




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# MARIMBA TONE FORMING SYSTEM FOR AN ELECTRONIC MUSICAL INSTRUMENT

## BACKGROUND OF THE INVENTION

The present invention relates to an electronic musical instrument and more particularly to a marimba tone-forming system capable of giving forth a tone color approximating that derived from a marimba.

The conventional electronic musical instrument is generally so arranged to give music involving the tone colors of reed, string and pipe instruments by selecting the required tone colors through operation of switches and keyboards. The prior art electronic musical instrument produced with relative ease a tone color like that of an organ, but presented great difficulties in representing the tone color of an instrument played with a stick. Particularly the tone color derived from a marimba could not be simulated by any conventional electronic musical instruments.

## SUMMARY OF THE INVENTION

It is accordingly the object of the present invention to provide a marimba tone-forming system for an electronic musical instrument capable of exhibiting musical tones having a tone color resembling that of a marimba.

According to the present invention, there are mixed a fundamental tone signal of the tone color of a flute voice and a sixth or third order overtone signal of the said tone color. The envelope of the fundamental tone signal exhibits a rising time of about 10 milliseconds and an attenuation time of about 1 second. The sixth or third order overtone signal has an envelope exhibiting a rising time of about 3 to 5 milliseconds and an attenuation time of about 100 milliseconds, and is slightly larger (3db.) in amplitude than the fundamental tone signal. The fundamental tone and overtone signals start rising at the same time. By the mixing, there are formed musical tones approximating the tone color of a marimba.

## BRIEF EXPLANATION OF THE DRAWINGS

FIG. 1 is a block diagram of a marimba tone forming system according to an embodiment of the present invention;

FIGS. 2*a* and 2*b* show the envelope of signals at parts of the embodiment of FIG. 1;

FIG. 3 illustrates a concrete circuit arrangement of the system of FIG. 1; and

FIG. 4 is a modification of the envelope regulating circuit involved in the circuit of FIG. 3.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, numerals 1 and 2 designate tone generators connected to envelope regulators 3 and 4 respectively. These envelope regulators 3 and 4 are actuated by operation of the keyboard section of an electronic musical instrument. THe first envelope regulator 3 takes out the fundamental tone signals corresponding to the keys operated by the keyboard section 5 and regulates, as shown in FIG. 2*a*, the envelope of the fundamental tone signal in such a manner that it rises in about 10 milliseconds and is later attenuated in about 1 second. The second envelope regulator 4 takes out a tone signal of the sixth order overtone corresponding to the keys operated by the keyboard section 5, and regulates, as shown in FIG. 2*b*, the envelope of said 6th overtone signal in such a manner that said envelope has a slightly larger maximum amplitude (about 3db.) than that of the fundamental tone signal, rises in about 3 to 5 milliseconds and is later attenuated in about 100 milliseconds.

The fundamental tone signal and 6th overtone signal from the first and second envelope regulators 3 and 4 whose envelopes have been regulated as described above are supplied to the tone coloring circuits 6 and 7. These circuits 6 and 7 convert the envelope-regulated fundamental tone signal and 6th overtone signal respectively to those of flute voice having small components of harmonics.



The tone coloring circuits 6 and 7 are connected to a mixing circuit 8, which mixes the fundamental tone signal and the 6th overtone signal of the flute voice to form musical tone signals bearing the tone of a marimba. The musical tone signals thus prepared are supplied through a tablet switch 9 and other related members to a speaker circuit (not shown) to be sounded.

FIG. 3 is a concrete circuit diagram of the system of FIG. 1. The same parts as in FIG. 1 are designated by the same numerals. The numeral 1′ shows a bistable multivibrator disposed in the tone generator 1. An input terminal 1′1 is connected to a preceding circuit and an an output terminal 1′2 of said multivibrator is connected to an input terminal 300 of the envelope regulator 3. At the output terminal 1′2 is generated a train of rectangular wave pulses having a frequency equivalent to half the frequency of outputs from the preceding circuit, and the pulse repetition frequency corresponds to a pitch of 8 foot tone.

The envelope regulator 3 has a resistor 301, one end of which is connected to the output terminal 1′2 of the multivibrator 1′. The other end of the resistor 301 is connected to a junction point of resistors 302 and 303 interposed between a bus line of ground potential and that of −12 volts. The junction point of three resistors 301, 302 and 303 contacts a base electrode of a transistor 304. An emitter electrode of the transistor 304 is connected to the bus line of −12 volts through a resistor 305 and capacitor 306 connected in series. Conducted from a junction point of the resistor 305 and capacitor 306 is a circuit serially connecting a resistor 307 and key switch 308, said circuit being further connected to the bus line of −12 volts. The key switch 308 is actuated by the operation of the keyboard section 5. Also conducted from the junction point of the resistor 305 and capacitor 306 is a circuit serially connecting resistors 309 and 310, said circuit being further connected to a source terminal of −9 volts. Interposed between the terminals of −9 volts and bus line of −12 volts is a variable resistor 311. A diode 312 is incorporated such that its anode is connected to a movable element of the variable resistor 311 and its cathode is connected to a junction of the resistors 309 and 310. Interposed between a collector electrode of the transistor 304 and ground potential bus line is a collector resistor 313. A capacitor 314 for coupling is connected between the collector electrode and the tone-coloring circuit 6.

When the diode 312 is biased in the forward direction, i.e. the anode of the diode 312 is conducted to the −9 V source terminal through the variable resistor 311, the movable element of the variable resistor 311 is positioned closest to the −9 V source terminal. In this case, while the switch 308 is opened, the capacitor 306 is charged so as to rapidly raise the emitter potential of the transistor 304 thereby to immediately render said transistor inoperative.

When the diode 312 is biased in the reverse direction and the movable element of the variable resistor 311 is closest to the −12 V bus line, the capacitor 306, while the switch 308 is opened, is charged so as to slowly raise the emitter potential of the transistor 304 thereby to slowly render said transistor inoperative.

While the diode 312 is biased in the reverse direction, the more closely the movable element is brought to the −12 V bus line, the more slowly the emitter potential is raised.

When the switch 308 is closed (As will be hereinafter explained the key switch 308 is interlocked with a key switch 411 of the envelope regulating circuit 4.), capacitor 306 is discharged through the resistor 307 and switch 308.

The rising time of the envelope of the fundamental tone signal is fixedly set at about 10 milliseconds. The attenuation time of said envelope is variable by shifting the position of the movable element of the variable resistor 311. The tone-coloring circuit 6 is comprised by a filter which functions to convert the supplied fundamental tone signal into a flute tone with small components of harmonics.

The reference numeral 2' designates another bistable multivibrator disposed in the tone generator 2, an input terminal 2'1 of the multivibrator being connected to preceding circuit and the output terminal 2'2 to the input side of the envelope regualtor 4. The repetition frequency of pulse train appearing at the output terminal 2'2 corresponds to a 1⅓ foot tone or overtone of the sixth order.

The envelope regulator 4 has a resistor 401, one terminal of which is connected to the output terminal 2'2 of the multivibrator 2'. The other terminal of the resistor 401 is connected to a junction point between resistors 402 and 403 which are connected in series across a bus line of ground potential and that of −12 volts. The junction point of the three resistors 401, 402 and 403 is connected to a base of a transistor 404. An emitter of the transistor 404 is connected to the −12 V bus line through a series circuit consisting of a resistor 405 and a capacitor 406. Through a resistor 407 is connected a collector of a switching transistor 408, an emitter of which is directly connected to the −12 V bus line. A base of the switching transistor 408 is connected through a capacitor 409 and a resistor 410 to the key switch 411 interlocked with the key switch 308. Resistors 412 and 413 are respectively connected across the terminals of the capacitor 409 and the −12 V bus line.

The transistor 404 has a collector with a collector resistor 414 and a coupling capacitor 415 connected thereto.

The collector of the transistor 408 is also connected to the source terminal of −9 volts through a resistor 416.

The envelope regulator 4 operates as follows:

While the switch 411 is opened, the capacitor 406 is charged by the −9 V supply terminal. The resistances of the resistors 407 and 416 and the capacitance of the capacitor 406 are so selected as to raise the emitter potential of the transistor 404 at about 100 milliseconds. Thus the desired attenuation of the envelope of the overtone signal is achieved.

When the key switch 411 is closed, the capacitor 409 is charged to raise the base potential of the transitor 408. When the base potential is raised, the capacitor 406 is discharged through the resistor 407 and the transistor 408. Then the transistor 404 is rendered operative to permit the overtone signal of the sixth order to pass through said transistor 404. When the capacitor 409 is fully charged, the base potential of the switching transistor 408 is rendered in operative to make nonconductive the transistor 404. In this manner, the envelop regulator 4 achieves the desired rising time of the envelope of the overtone signal of about 3 to 5 milliseconds.

The peak of the overtone signal is larger than that of the fundamental tone signal, preferably by 3db.

The tone-coloring circuit 7 consists of a filter functioning to convert the supplied overtone signal of the sixth order into a flute tone signal of small components of harmonics.

As hereinabove described, the key switches 308 and 411 are simultaneously turned on, so that the envelopes of the fundamental tone signal and the overtone signal of the sixth order simultaneously start rising. The mixing circuit 8 superposes such tone signals upon each other, whereby there is produced a signal of a musical tone having the tone color of a marimba. The produced tone signal is supplied through the tablet switch 9 to a speaker circuit not shown.

FIG. 4 shows a modification of the envelope regulator 3. The circuit arrangement of this modified regulator 3' is the same as the envelope regulator 4 in FIG. 3, excepting that the capacitor and the resistors corresponding to those designated by 406, and 407, 416 in the circuit 4 are different in value from the latter elements to attain the desired envelope.

According to the previously described embodiment 3, the attenuation time of the envelope of the fundamental tone signal is adjustable, so that a player can vary the decay length at his preference. In contrast, according to the modified embodiment 3' the attenuation time of the envelope is fixedly set at about 1 second, so that the player can always produce the tone color approximating that of a marimba.

If the tone-generating signal is of the type which contains small components of harmonics and is capable of giving forth the tone color of flute voice, for example a sinusoidal signal, then it is unnecessary to use the tone coloring circuits 6 and 7.

If the fundamental tone signal is amplitude and/or frequency modulated by a low frequency of 3 to 7 Hz, there will be obtained musical tones like those of a vibraphone.

According to the above-described embodiments, the fundamental tone signal was mixed with a 6th overtone signal. With this 6th overtone signal, there will be produced tones resembling to a marimba played with a stick made of hard material, for example, wood. However, the fundamental tone signal may be mixed with a 3rd overtone signal (a pitch of 2⅔ foot). Where the 3rd overtone signal is added there will result resembling tones of a marimba played with a stick made of soft material, for example, rubber.

I claim:

1. In an electronic musical instrument, a marimba tone forming system comprising:

a. first and second tone-generating circuits including multivibrators therein, supplying pulse trains having a predetermined frequency relationship with preceeding circuits;

b. first and second envelope regulator circuits coupled to said first and second tone-generating circuits including capacitor impedance timing means, gating circuits and first and second linked switches operatively connected to a keyboard and selectively linking said timing means and gating circuits forming different overtones from the supplied pulse trains with preselected attenuation characteristics determined by said timing means;

c. a tone-coloring filter arrangement receiving the output from said first and second envelope regulator circuits; and,

d. a mixing circuit fed by said tone-coloring filter arrangement.

2. A marimba tone-forming system for an electronic musical instrument according to claim 1, wherein said first envelope regulator comprises a first resistor of which one end is connected to an output terminal of the first multivibrator, a first series circuit of second and third resistors whose junction point is connected to the other end of the first resistor and which is interposed between a bus line of ground potential and a bus line of the negative potential of a DC source, a transistor whose base electrode is connected to the junction point of the first series circuit and the emitter electrode is connected to said negative bus line through a second series circuit of a fourth resistor and a capacitor, a key switch whose one terminal is connected to the junction point of said second series circuit through a fifth resistor and other terminal is connected to said negative bus line, a third series circuit of a sixth and seventh resistor connected between the junction point of said second series circuit and a negative potential terminal of the DC source, a variable resistor interposed between said negative terminal and said negative bus line and having a movable element, a diode of which anode is connected to the junction point of said third series circuit and cathode of which is connected to the movable element, a eighth resistor interposed between said ground bus line and a collector electrode of said transistor, and a coupling capacitor interposed between said collector electrode and said first tone-coloring circuit, a rise time of 10 milliseconds being determined by the value of the fifth resistor and the capacitor and a decay time of 1 sec. being determined by shifting the position of the movable element; said second envelope regulator comprises a first resistor of which one end is connected to said second bistable multivibrator, a first series circuit of a second resistor and a third resistor of which is interposed between a bus line of ground potential and a bus line of negative potential and the junction point of which is connected to the other end of the first resistor, a transistor of which the base electrode is connected to the junction point of the first series circuit, the emitter electrode is conducted to the negative bus line through a second series cir-

cuit of a fourth resistor and a first capacitor, a switching transistor of which the collector electrode is connected to the junction point of the second series circuit through a fifth resistor and a negative terminal of DC source through a sixth resistor and whose emitter electrode is conducted to the negative bus line and whose base electrode is connected to the ground bus line through a second capacitor, a seventh resistor and a key switch interlocked with the key switch of the first envelope regulator, a eighth resistor whose one end is connected to the base electrode of the switching transistor and whose other end is conducted to the ground bus line and a junction point of the seventh resistor and the second capacitor through a ninth resistor, a tenth resistor interposed between the ground bus line and the collector electrode of the transistor, and a coupling capacitor of which both terminals is respectively connected to the collector electrode of the transistor and the second tone coloring circuit, and each value of the fifth and sixth resistor and the first capacitor determine a decay time of 100 milliseconds and each value of the seventh and eighth resistor and the second capacitor determine a rise time of 3 to 5 milliseconds.

3. In an electronic musical instrument, a marimba tone-forming system comprising:

a. first and second tone generator circuits each including a bistable multivibrator disposed therein, each with an input side connected to a preceding circuit and an output side connected to the input side of first and second envelope regulator circuits, said output sides supplying trains of wave pulses having a predetermined frequencies with respect to the frequency of outputs from the preceding circuit;

b. first and second envelope regulator circuits with transistor arrangements including biasing means, supplied by said input in said envelope regulator, first and second switches linked together, responsive to a keyboard actuating on said transistor arrangements, including at least one variable impedance means and at least one capacitor coupled to said transistor arrangement biasing said transistor arrangement in the one or the other direction through said impedance means and fixing attenuation time by the charging of said capacitor, the attenuation time of the envelope regulator circuit being varied by said variable impedance means;

c. first and second tone-coloring circuits (6) including filter means therein coupled to said first and second envelope regulator circuits; and

d. a mixing circuit coupled to the first and second tone coloring amounts to mix the outputs of the first and second tone-coloring circuits.

4. In an electronic musical instrument, a marimba tone forming system comprising:

a. a tone generator circuit (1) including a bistable multivibrator (1') disposed in said tone generator (1) with an input side (1'1) connected to a preceding circuit and an output side (1'2) connected to the input (300) of an envelope regulator circuit (3), said output side (1'2) supplying a train of wave pulses having a predetermined first frequency with respect to the frequency of outputs from the preceding circuit;

b. an envelope regulator circuit (3) with a transistor (304) including biasing means supplied by said input (300) in said envelope regulator circuit, a first switch (308) responsive to a keyboard, actuating said transistor, a diode (316) connected to a variable resistor (311) coupled through said first switch (308) to said transistor (304) and a capacitor (306) coupled to said diode and transistor; the biasing of said diode in the one or the other direction through said variable resistors either immediately or slowly rendering said transistor inoperative by the charging of said capacitor, the attenuation time of the envelope regulator circuit (3) being varied by said variable resistor (311);

c. a second tone generating circuit (2) including a second bistable multivibrator disposed in said second tone generator circuit (2), an input side (2'1) connected to preceding circuit and the output side (2'2) connected to the input of a second envelope regulator circuit (4) supplying a train of wave pulses having a predetermined frequency other than said first frequency;

d. a second envelope regulator circuit (4) including first and second transistors (404, 408) with bias means, a second capacitor (406) operatively connected to said first and second transistors and a second switch (411) linked to said first switch connected to charge one or the other of said first and second transistors (404, 408);

e. first and second tone-coloring circuits (6) including filter means (6, 7) coupled to said first and second envelope regulator circuits; and

f. mixing circuit (8) coupled to the first and second tone-coloring circuits to mix the outputs of the first and second tone-coloring circuits therein.

5. A marimba tone-forming system for an electronic musical instrument comprises:

a. first means for generating a fundamental tone signal of flute voice; and,

b. second means for generating at least one overtone signal of the sixth and the third overtone signals of flute voice, the envelope of said fundamental tone signal having a rising time and a decay time respectively longer than those of the envelope of said overtone signal and exhibiting a maximum amplitude smaller than that of the envelope of said overtone signal, said fundamental tone and said overtone signals being caused to start at the same time.

6. A marimba tone-forming system for an electronic musical instrument according to claim 11, wherein said first means includes a first bistable multivibrator for generating a train of rectangular wave pulse having a frequency equivalent to a pitch of 8 foot tone, a first envelope regulator regulating the envelope of the fundamental tone signal to have a rising time of 10 milliseconds and a decay time of 1 second and a first tone-coloring circuit for converting said envelope-regulated fundamental tone signal to that of flute voice having small components of harmonics, said second means includes a second bistable multivibrator for generating a train of rectangular wave pulse having a frequency equivalent to a pitch of at least one of 1⅓ foot tone and 2⅔ foot tone, a second envelope regulator regulating the envelope of said overtone signal to have a rising time of 3 to 5 milliseconds and a decay time of 100 milliseconds and a second tone-coloring circuit for converting said envelope-regulated overtone signal to that of flute voice having small components of harmonics.

7. A marimba tone-forming system for an electronic musical instrument according to claim 6, wherein said first envelope regulator comprises a first resistor of which one end is connected to an output terminal of the first multivibrator, a first series circuit of second and third resistors whose junction point is connected to the other end of the first resistor and which is interposed between a bus line of ground potential and a bus line of the negative potential of a DC source, a transistor whose base electrode is connected to the junction point of the first series circuit and the emitter electrode is connected to said negative bus line through a second series circuit of a fourth resistor and a capacitor, a key switch whose one terminal is connected to the junction point of said second series circuit through a fifth resistor and other terminal is connected to said negative bus line, a third series circuit of a sixth and seventh resistor connected between the junction point of said second series circuit and a negative potential terminal of the DC source, a variable resistor interposed between said negative terminal and said negative bus line and having a movable element, a diode of which anode is connected to the junction point of said third series circuit and cathode of which is connected to the movable element, a eighth resistor interposed between said ground bus line and a collector electrode of said transistor, and a coupling capacitor interposed between said

collector electrode and said first tone-coloring circuit, a rise time of 10 milliseconds being determined by the value of the fifth resistor and the capacitor and a decay time of 1 sec. being determined by shifting the position of the movable element; said second envelope regulator comprises a first resistor of which one end is connected to said second bistable multivibrator, a first series circuit of a second resistor and a third resistor of which is interposed between a bus line of ground potential and a bus line of negative potential and the junction point of which is connected to the other end of the first resistor, a transistor of which the base electrode is connected to the junction point of the first series circuit, the emitter electrode is conducted to the negative bus line through a second series circuit of a fourth resistor and a first capacitor, a switching transistor of which the collector electrode is connected to the junction point of the second series circuit through a fifth resistor and a negative terminal of DC source through a sixth resistor and whose emitter electrode is conducted to the negative bus line and whose base electrode is connected to the ground bus line through a second capacitor, a seventh resistor and a key switch interlocked with the key switch of the first envelope regulator, a eighth resistor whose one end is connected to the base electrode of the switching transistor and whose other end is conducted to the ground bus line and a junction point of the seventh resistor and the second capacitor through a ninth resistor, a tenth resistor interposed between the ground bus line and the collector electrode of the transistor, and a coupling capacitor of which both terminals is respectively connected to the collector electrode of the transistor and the second tone coloring circuit, and each value of the fifth and sixth resistor and the first capacitor determine a decay time of 100 milliseconds and each value of the seventh and eighth resistor and the second capacitor determine a rise time of 3 to 5 milliseconds.